MICHIGAN

WOLF MANAGEMENT PLAN

UPDATED 2022

Michigan Department of Natural Resources
Wildlife Division Report No. 3703
September 2022

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Approved:

Daniel Eichinger, Director

Michigan Department of Natural Resources

Lansing, Michigan

Date: December 8, 2022

Acknowledgments

The Michigan Department of Natural Resources (DNR) appreciates the valuable contributions offered by many individuals, agencies, and organizations for the update of this plan during 2021-22.

We thank the thousands of Michigan residents who helped shape the content of this plan through their participation in public wolf meetings held throughout the State, through the input and opinions they shared during public-comment periods, and through their participation in public-attitude surveys.

We thank our Federal, State, and Tribal agency partners for their cooperation in wolf management and for the information and feedback they offered during the update of this plan. We especially acknowledge the contributions of the USDA Wildlife Services, whose expertise and assistance has been and continues to be a critical component of the wolf management program in Michigan.

We want to thank Drs. Shawn Riley and Megan Cross of Michigan State University's Department of Fisheries and Wildlife for conducting a new survey of public attitudes towards wolves and wolf management in Michigan during 2021. We also want to thank Dr. Jerrold Belant of the State University of New York College of Environmental Science and Forestry's Global Wildlife Conservation Center for his review and compilation of biological science relevant to wolf management in Michigan. Both efforts were critical components of the 2022 update planning process.

Finally, we thank members of the Wolf Management Advisory Council for contributing their comments on how to improve the 2022 updated plan. The plan was compiled by Michael Donovan, Cody Norton, Tyler Petroelje, Emily Pomeranz, and Brian Roell.

A contribution of Federal Aid in Wildlife Restoration, Michigan Project W-147-R

Cover Art by Keith Grove

Keith Grove has had a lifelong interest in wildlife and has promoted this interest as a specialty throughout his 25-year career as an award-winning, commercial illustrator. After completing a commission for three white-tailed deer oil paintings for a series of prints that sold out in a national catalog, Keith decided it was time to concentrate on his own wildlife subjects. Using alkyd oils and a realistic style, Keith tries to "tell a story" by capturing unique, cameo moments of wilderness life. A graduate of the college of Associated Arts, St. Paul, Keith has also studied classical realism and continues to expand his knowledge of computer graphics and large-format printing techniques for the production of his own giclée prints. For more information, contact Keith at grovewildife@aol.com.

List of Abbreviations

DNR	Michigan Department of Natural Resources
LP	Lower Peninsula
NLP	Northern Lower Peninsula
SLP	Southern Lower Peninsula
UP	Upper Peninsula
MDARD	Michigan Department of Agriculture and Rural Development
MSU	Michigan State University
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
NRC	Michigan Natural Resources Commission
NREPA	Natural Resources and Environmental Protection Act

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1. Introduction

1.1 Purpose of Plan

This plan provides strategic guidance for the management of wolves in Michigan. It was developed to help: 1) maintain a viable Michigan wolf population above a level that would warrant its classification as threatened or endangered; 2) facilitate wolf-related benefits; 3) minimize wolf-related conflicts; and 4) conduct science-based wolf management with socially responsible methods.

The DNR has a public trust responsibility for the management of all wildlife species and populations. Primary legal authority for wildlife management and regulation comes from the Natural Resources and Environmental Protection Act (NREPA), Public Act 451 of 1994. Part 401 of NREPA gives specific authorities to the NRC and the DNR Director to issue orders regulating wildlife management and hunting. Accordingly, this plan was developed primarily to guide the DNR's management of wolves and any subsequent recommendations to the NRC. This plan also may inform federal, state, and tribal agencies and private organizations as they develop strategies pertinent to wolves. We hope this plan encourages cooperation and consistent approaches among partners in their efforts to manage wolves in Michigan.

We define "social responsibility" as the DNR using the best available biological and social science to sustainably manage wildlife populations as dictated by the Public Trust Doctrine and state law (Public Act 377 of 1996 [Proposal G]) for the interests of current and future generations of Michigan citizens.

This plan does not outline operational details of wolf management in Michigan. Operational details are specified within guidance documents, protocols, and regulation memos, in which specific management methods are routinely evaluated, adjusted and updated in an adaptive management process as local conditions, research, technology, regulations, and other aspects of management context change. In addition, this management plan will be updated at 10-year intervals to account for changes in management context.

1.2 Context of Plan

In 1997, the DNR finalized the Michigan Gray Wolf Recovery and Management Plan (Michigan DNR 1997). When that plan was developed, the gray wolf (*Canis lupus*) was still classified as a federally endangered species in Michigan and the number of wolves in the State was relatively small. The plan focused on the biological needs of a small population and was a valuable tool for the recovery of wolves in Michigan. It also contributed to the regional recovery of wolves in the western Great Lakes region. As the wolf populations continued to grow and exceed federal recovery criteria, the USFWS removed the gray wolf in the Western Great Lakes Distinct

Population Segment, which included all of Michigan, from the Federal List of Threatened and Endangered Species in 2007 (USFWS 2007).

To address these changes and to continue to manage the wolf population based on the best available scientific information, the DNR revised its original wolf plan and created the 2008 Michigan Wolf Management Plan. The 2008 plan addressed the challenges associated with the biological, social, and regulatory context of wolf management in Michigan at that time. The update completed in 2015, and now in 2022, help ensure that the plan remains relevant as science, policy, and management context changes. From 1997 to 2022, the context of wolf management in Michigan has changed in a variety of ways.

- Wolf population size and distribution have expanded, presenting a different set of biological and social issues that need to be addressed, including the complex and divisive issue of public harvest of wolves.

- Understanding of wolf biology has improved significantly, enabling managers to better predict the consequences of their management decisions.

- Since 2000, USDA Wildlife Services personnel have played a key role in population monitoring, research, training of field staff, and program planning. The DNR and USDA Wildlife Services have formalized their cooperative relationship in a memorandum of understanding.

The legal status of wolves at both the Federal and State level has changed several times, which impacts the ability of all agencies to manage wolves. In April of 2003, wolves were reclassified from Endangered to Threatened, before being returned to Endangered by a federal court ruling in January of 2005. The USFWS proposed delisting wolves in the Eastern Distinct Population Segment, which included Michigan, in July of 2004, only to abandon that attempt in February of 2005. Wolves in the Western Great Lakes Distinct Population Segment, which included Michigan, were removed from the Federal List of Threatened and Endangered Species in March of 2007 but were then returned to the list in September of 2008 due to a federal court ruling. In April of 2009, wolves were removed from the State Threatened and Endangered Species List (Part 365 of Public Act 451 of 1994) and given Protected Animal status under the State's Wildlife Conservation Order. In May of 2009 wolves in the Western Great Lakes Distinct Population Segment were once again removed from the Federal List of Threatened and Endangered Species, only to be returned when the USFWS reached a settlement agreement with plaintiffs in a lawsuit challenging delisting. In January 2012, wolves in Michigan were removed from the Federal List of Threatened and Endangered Species (USFWS 2011a). On two separate occasions, once in 2012 and again in 2013, wolves were classified as game animals in Michigan. The latter statute provided the NRC with the ability to designate species as game, and as such, expanded their authority beyond the method and manner of take of game species. The laws that allowed these classifications were repealed by public referendum in November of 2014. However, in August of 2014, citizen-initiated legislation (Public Act 281 of 2014) then

again classified wolves as game animals. An organization (Keep Michigan Wolves Protected) challenged the constitutionality of PA 281 however the Michigan Court of Claims dismissed the lawsuit in July 2015. Then in November 2016, an appellate court overturned the 2015 Michigan Court of Claims ruling removing the NRC's authority to classify gray wolves as a game species. After the appellate court ruling a Senate Bill was introduced which once again made wolves a game species when it was signed into law in 2016 (PA 382). Furthermore, this legislation added the authority to classify species as game animals to the NRC's already existing authority to decide if a game species will be hunted, and the parameters around a regulated harvest.

In December 2014, a federal court decision returned wolves in the western Great Lakes Distinct Population Segment to the Federal List of Threatened and Endangered Species. Recently, wolves in much of the Lower 48 states were removed from the Federal Endangered Species List in January 2021, only to be returned to the list in February 2022 due to a federal court decision that vacated the USFWS order. This action marked the 6th time, due to lawsuits or threat of lawsuits against USFWS delisting efforts, the Federal legal status of wolves changed in Michigan since 2003.

Regardless of changes in legal status, this updated management plan acknowledges that wolves in Michigan have surpassed State and Federal population recovery goals for 22 years. Further, and regardless of the Federal listing status, the State has and will continue to have management responsibility for wolves in the State. It is the regulatory authority over lethal take of wolves that varies with the changing State and Federal status of wolves. Therefore, the ability of, or the methods used by, the State to implement some parts of this plan will vary depending on the Federal and State legal status of wolves.

2. Planning Process

The DNR developed the 2008 plan through a process that included review of the best available scientific information and substantial involvement of affected stakeholder groups and the general public. The process included the following eight phases:

- Intra- and inter-agency scoping
- Public meetings and comment period
- Focus-group meetings
- Public-attitude surveys
- Review of science relevant to wolf management in Michigan
- Michigan Wolf Management Roundtable
- Plan writing
- Public review and comment

The information compiled and evaluated during all these phases was used to produce a plan that is based on sound science and careful and respectful consideration of the diverse perspectives held by Michigan society. These phases are described under the following headings.

2.1 Intra- and Inter-agency Scoping

In August 2004, the DNR met with Federal and State agency partners to identify issues regarding wolves and their management in Michigan. Each agency shared its vision and concerns regarding wolf management. Agencies also identified future wolf management needs and opportunities for continuing partnerships. After this initial meeting, the DNR Wolf Management Work Group conducted a situational analysis to identify the strengths, weaknesses, opportunities, threats, and issues surrounding future wolf management in Michigan. During the ensuing months, the group continued to explore the issues and formulated a plan and timeline for revising the Michigan wolf management plan.

2.2 Public Meetings and Comment Period

In May 2005, the DNR hosted ten public meetings to discuss wolf management in Michigan. Six meetings took place in the Upper Peninsula (Watersmeet, Houghton, Escanaba, Newberry, Sault Ste. Marie, and Marquette) and four meetings took place in the Lower Peninsula (Clare, Grand Rapids, Ann Arbor, and Gaylord). The purpose of the meetings was to provide the public with an opportunity to identify important issues and express opinions regarding wolves and wolf management in the State. A professional facilitator not affiliated with the DNR moderated each meeting. Meeting participants were given the opportunity to provide verbal comments, and they were also asked to complete a survey regarding their views on wolves and wolf management.

Based on information obtained from sign-in sheets, at least 560 people attended the public meetings. Four hundred twenty-two of those individuals attended the Upper Peninsula (UP) meetings, and the remaining 138 individuals attended the Lower Peninsula (LP) meetings. Four hundred thirty-three people who attended the meetings submitted a completed survey. Results of the survey are summarized in Beyer et al. 2006.

The DNR press release that announced the public meetings also announced the opening of a public-comment period during which people were encouraged to mail or email their wolf-related comments. From April 12 through August 31, 2005, the DNR received 133 emails and 36 letters that specifically dealt with wolves.

2.3 Focus-group Meetings

During the summer of 2005, the Michigan State University (MSU) Department of Fisheries and Wildlife coordinated nine focus-group meetings to discuss wolves and wolf-related issues. The main purpose of the meetings was to refine understanding of issues identified as important by members of different stakeholder groups and to test and improve questions being considered for a statewide public-attitude survey.

The nine focus-groups included: 1) eastern UP livestock producers; 2) western UP livestock producers; 3) UP hunters who hunt with dogs; 4) NLP hunters who hunt with dogs; 5) UP deer hunters; 6) NLP deer hunters; 7) wolf conservationists (i.e., individuals focused on wolves at a population or ecosystem level); 8) wolf protectionists (i.e., individuals focused on the welfare and rights of individual wolves); and 9) trappers. A total of 78 individuals participated in the focus-group meetings.

Topics of discussion differed somewhat among the focus-groups. However, all focus-groups discussed the following six subjects: 1) benefits of having wolves in Michigan; 2) costs of having wolves in Michigan; 3) compensation and losses associated with wolf depredation; 4) preferences regarding quantification of wolf numbers in Michigan; 5) topics that should be addressed by the Michigan Wolf Management Roundtable (see 2.6); and 6) the role of the Michigan Wolf Management Roundtable in the development of the wolf management plan. Overviews of the discussions are provided in Bull and Peyton 2005 (included as Appendix IX in Beyer et al. 2006).

2.4 Public-attitude Surveys

Studies conducted prior to 2005 had assessed the attitudes held by Michigan residents regarding wolves (e.g., Kellert 1990, Mertig 2004). However, those studies may not reflect current public opinions given the substantial changes in wolf abundance and distribution in the UP and limitations of sample size. To ensure current social data were available during development of this plan, the MSU Department of Fisheries and Wildlife undertook a study that explored the attitudes of Michigan residents.

Data for this 2005-2006 study were obtained from public-attitude surveys designed to address specific management questions relevant to the planning process. The questions focused on respondents' preferences and opinions regarding: 1) reasons for having wolves in Michigan; 2) the number of wolves and frequency of wolf-related interactions in different regions of the State; 3) options to address depredation of livestock, hunting dogs and other pets; 4) options to address public concerns regarding human safety; 5) options to address impacts to deer; and 6) a public harvest of wolves.

After survey questions were refined through focus-group discussions and tested through a pilot survey mailing, the final versions of the surveys were mailed repeatedly from November 2005 through January 2006. A general-public survey was mailed to 8,500 Michigan driver's license holders statewide. Slightly modified versions of the survey were mailed to 1,000 licensed furtakers and 1,000 livestock producers. These modified versions were designed to obtain sufficient input from two groups of stakeholders that comprise a relatively small proportion of the general population but experience disproportionately high levels of conflicts with wolves. Repeated mailings resulted in an overall response rate of 53% for the general-public survey, 69% for the furtaker survey, and 69% for the livestock-producer survey. Data from the different versions of the survey were compiled and analyzed separately. The methods and results of the study are provided in Beyer et al. 2006.

2.5 Review of Science Relevant to Wolf Management in Michigan

Concurrent with the phases described above, the DNR and MSU Department of Fisheries and Wildlife developed a document entitled: *Review of Social and Biological Science Relevant to Wolf Management in Michigan* (Beyer et al. 2006). The document summarized the best available biological and social science relevant to wolves, wolf-related issues, and wolf management options in Michigan, and it described the remaining scientific uncertainty on those topics at that time. The information presented was obtained from published scientific literature, agency and university reports, unpublished agency data, and personal communication with wolf experts.

Science allows managers to predict the outcomes of management actions. However, science alone does not establish wildlife management goals. Those goals are often determined within a social context where stakeholder values and priorities must be addressed. Accordingly, the *Review of Social and Biological Science Relevant to Wolf Management in Michigan* does not provide answers to questions of how wolves should be managed in Michigan. Rather, it facilitates understanding of the potential consequences of management approaches, and it thus helps managers make decisions based on the best available science.

The *Review of Social and Biological Science Relevant to Wolf Management in Michigan* is a companion document to this plan, and much of the information it contains is incorporated by reference. The document is available on the DNR website (www.michigan.gov/dnr).

2.6 Michigan Wolf Management Roundtable

To help it develop a plan that is acceptable to a wide range of stakeholder interests, the DNR convened an advisory committee called the Michigan Wolf Management Roundtable (Roundtable). Membership included 20 agencies and organizations (see Appendix 1) that represented the diversity of Michigan interests in wolves. These interests included environmental and ecological interests, hunting and trapping interests, livestock-producer interests, public-safety interests, tourism and resource-development interests, tribes, and wolf-protection interests. Each organization on the Roundtable was selected to ensure the views of all Michigan residents would be represented in a fair and effective manner. Membership included UP and LP residents in roughly the same numbers to ensure adequate representation of the different regions of the State. The charge of the Roundtable, as given by the DNR, was to develop principles to guide management of Michigan wolves and wolf-related issues following federal de-listing.

From June through September 2006, Roundtable members met for a total of 10 days to deliberate on wolf management. They identified and prioritized important wolf-related issues, reviewed relevant social and biological science, and engaged in intense negotiations to reach consensus on a set of guiding principles for wolf management in Michigan.

The Roundtable submitted its final report to the DNR in November 2006. That report, entitled *Recommended Guiding Principles for Wolf Management in Michigan* (Appendix 1), outlines guiding principles pertaining to wolf distribution and abundance, benefits of wolves, management of wolf-related conflicts, information and education, funding, research, hybrid and captive wolves, and future plan revisions.

2.7 Plan Writing

Between November 2006 and August 2007, the DNR evaluated the information and recommendations obtained during the previous phases to develop a draft of this plan. DNR staff and the Michigan Wolf Management Roundtable reviewed the draft prior to its public release.

2.8 Public Review and Comment

In August 2007, the DNR released a draft of this plan for public review and comment. During the 90-day comment period, agencies, organizations, and individuals submitted approximately 1,480 emails and 15 hard-copy letters that offered comments on the draft plan. Based on those comments, the DNR modified the plan, as appropriate, prior to its final approval.

2.9 2015 Plan Update Process

In November of 2014, the DNR announced their intent to update the 2008 Michigan Wolf Management Plan. As an update to the 2008 plan, the four principal goals of the 2008 plan would remain the same in the updated plan. The DNR announced that the update process would include a scientific literature review and inclusion of new information that may influence strategic management direction, an evaluation of plan implementation based on the strategic action items in the plan, updating the strategic action items as necessary, and addressing outdated information or clarifications that are needed.

The DNR asked all 12 federally recognized Tribes in Michigan to provide comments on implementation of the 2008 plan and to provide suggestions for changes to be incorporated into this plan update. In addition, the 2007 Inland Consent Decree Wildlife Technical Committee was briefed on the process used to update the plan and asked to express desires regarding how the five 1836 ceded territory Tribes would like to engage in government-to-government consultation on this update. The DNR continued to reach out to tribal governments on mutually important aspects of wolf management in Michigan.

The DNR provided an online and paper opinion survey for the public to rank performance and comment on the DNR's implementation of the 12 Strategic goals in the 2008 plan. During the 30-day comment period commencing on November 13, 2014, the DNR received 3010 responses online and 21 responses in paper form. The results of the survey were used to help the DNR evaluate implementation of strategic actions and identify those actions that would remain, be modified, removed, or added to the updated plan. The DNR produced a summary of management accomplishments since the inception of The Michigan 2008 Wolf Management Plan as part of this planning effort.

On March 3, 2015, the DNR released a draft of the updated plan for public review and comment. The DNR met on March 9th with the members Michigan Wolf Management Forum to review the plan update process and to answer any questions on the draft updated plan. During the 30-day comment period agencies, organizations, and individuals submitted 1464 emails and 17 hard-copy letters that offered comments on the draft updated plan. Based on those comments, the DNR modified the plan, as appropriate, prior to its final approval.

2.10 2022 Plan Update Process

To inform the 2022 plan update, the DNR collaborated with the MSU Department of Fisheries and Wildlife to conduct a new public-attitude survey regarding wolves (Riley et al. 2022). The 2021 public survey conducted by MSU assessed perceptions of wolves and wolf management by Michigan residents in the three regions: the Upper Peninsula (UP), the Northern Lower Peninsula (NLP), and the Southern Lower Peninsula (SLP). Randomly drawn samples of households in each region provided representation for analysis. A random selection of licensed deer hunters and fur harvesters were sent a similar questionnaire with additional questions

related to animal abundance and stakeholder activities related to wolves. In addition, households in the UP and NLP which were believed to be involved with livestock-related agricultural activities, derived from mailing lists of stockholder livestock producer groups and Michigan State University Extension, were also sent questionnaires that were the same as the general population sample. Results reported from the general population survey reflect weighted and imputed data (see MI DNR 2022a for more information).

The DNR also collaborated with the State University of New York College of Environmental Science and Forestry to update the *Review of Social and Biological Science Relevant to Wolf Management in Michigan* (Beyer et al. 2006). The updated document summarizes the best available biological and social science relevant to wolves, wolf-related issues, and wolf management options in Michigan, and describes the remaining scientific uncertainty on those topics (MI DNR 2022a). The information presented was obtained from the 2022 public-attitude survey, published scientific literature, agency and university reports, unpublished agency data, and personal communication with wolf experts. Results of the public-attitude survey conducted by MSU in 2021 are presented throughout the document.

The DNR asked all 12 federally recognized Tribes in Michigan to provide comments on implementation of the 2015 plan and to provide suggestions for changes to be incorporated into this plan update. In addition, the 2007 Inland Consent Decree Wildlife Technical Committee was briefed on the process used to update the plan and asked to express desires regarding how the five 1836 ceded territory Tribes would like to engage in government-to-government consultation on this update. The DNR continues to reach out to tribal governments on mutually important aspects of wolf management in Michigan.

The DNR convened the Michigan Wolf Management Advisory Council (WMAC) as required by state law (NREPA), to ensure the plan update was acceptable to a wide range of stakeholder interests. The Director of the DNR appointed six members to the WMAC to represent conservation, hunting or fishing, tribal government, agricultural, animal advocacy, and DNR interests as required by law. During August of 2021 to July of 2022, the WMAC met a total of 16 days. The WMAC produced a list of 35 non-binding recommendations to the State Legislature, NRC, and DNR regarding the plan update and other aspects of wolf management. The recommendations (Appendix 2) and minority report (Appendix 3) can be found in the appendices, and other information regarding the WMAC can be found on the DNR website (www.michigan.gov/wmac)

The DNR provided an online questionnaire for the public to provide input on the goals, strategies, and objectives in the 2015 plan. During the 28-day comment period commencing on January 4th, 2022, the DNR received 5,475 responses online and 20 responses via email. Forty-four to 54% of questionnaire respondents indicated each of the four main goals in the 2015 plan were at least somewhat acceptable, while 39% to 53% of questionnaire respondents indicated each of the twelve strategies in the 2015 plan, and their associated objectives, were at least somewhat acceptable (Appendix 4). The results of the survey were used to help the DNR evaluate implementation of strategic actions and identify those actions that would remain,

be modified, removed, or added to the updated plan. The DNR produced a summary of management accomplishments since the adoption of the 2015 plan as part of this planning effort (Appendix 6).

On June 27th, 2022, the DNR released a draft of the updated plan for public review and provided an online questionnaire for the public to provide comments. During the 30-day comment period agencies, organizations and individuals submitted 2,883 responses through the online questionnaire and nine responses via email that offered comments on the draft updated plan. A majority (57-76%) of questionnaire respondents indicated all four of the main goals in the draft updated plan were at least somewhat acceptable, and a majority (57-81%) of questionnaire respondents also indicated all twelve of the strategies, and their associated objectives, in the draft updated plan were at least somewhat acceptable (Appendix 5). Using the responses received, the DNR modified the plan, as appropriate, prior to its final approval.

3. Wolf Biology and Ecology

3.1 Wolf Taxonomy

Scientists have long debated the taxonomy of wolves. At the time the United State Fish and Wildlife Service (USFWS) listed eastern timber wolves (*Canis lupus lycaon*) as an endangered species under the 1973 Endangered Species Act, this scientific debate was focused on the number of subspecies of wolves that existed in North America (USFWS 1992). Since then, the taxonomic classification of wolves in the eastern part of the United States, including the Great Lakes region, has been the subject of numerous studies with differing results (e.g., Nowak 1995, Wayne et al. 1995, Wilson et al. 2000, Kyle et al. 2006, Leonard and Wayne 2008, Koblmuller et al. 2009, vonHoldt et al. 2011, Rutledge et al. 2012, Rutledge et al. 2015, vonHoldt et al. 2016). This debate can be broken into two interpretations: 1) they represent a unique population or ecotype of gray wolf (*C. lupus*), now mostly extinct (Leonard and Wayne 2008, Koblmüller 2009), or 2) they represent a unique admixed population resulting from historic gray wolf and eastern wolf (*C. lycaon*) hybridization, where both gray and eastern wolves may have inhabited the region (Wheeldon and White 2009). While there is no broad consensus on their origin, current analyses demonstrate contemporary wolves from the Great Lakes region are genetically distinct from other gray wolf populations and admixed, with ancestry from gray wolves, eastern wolves, and coyotes (*C. latrans*) (Rutledge et al. 2015, Heppenheimer et al. 2018). Genetic analysis of wolves from the Great Lakes region found no recent evidence of coyote mtDNA or Y-chromosome introgression (or putatively minimal) (Wheeldon et al. 2010). Eastern wolves now persist almost exclusively in Algonquin Provincial Park, Ontario, but likely served as the conduit of gene flow between gray wolves and coyotes. Wolves in the Great Lakes region may also be smaller than the western gray wolf (Wilson et al. 2000), suggesting genetic ancestry may impact morphology of wolves in the region.

Given the scientific uncertainty, for the purpose of this management plan we will continue to refer to wolves in Michigan as gray wolves, *Canis lupus.* Regardless of the taxonomic debate,

wolves in Michigan today represent the same animals the USFWS listed as an endangered species in 1974. Perhaps most importantly, wolves in Michigan appear to function as a single population (Wheeldon et al. 2010) and are fulfilling their ecological role as an apex predator.

3.2 Physical Description

Wolves are the largest members of the Canidae (dog family) in Michigan. Other native Michigan canids are the coyote, red fox (*Vulpes vulpes*) and gray fox (*Urocyon cinereoargenteus*). Wolves are larger than coyotes, with body dimensions exceeding those of a fully grown German shepherd or Alaskan malamute. In Michigan, weights of adult wolves range from 58 to 112 pounds (26-51 kg), with males (average: 87 lbs.; 39 kg) weighing slightly more than females (average: 76 lbs.; 34 kg [Michigan DNR, unpublished data]). Wolves are approximately 6 feet (1.8 m) long from the nose to the end of the tail. Adults stand 30-34 inches (75-85 cm) tall at the shoulder. The feet of wolves are large, with tracks measuring 3.5-4 inches (9-10 cm) wide and 4.5-5 inches (11-13 cm) long. Wolves have cheek tufts that make their faces appear wide and their heads large. Their tails are bushy and straight, not curled like most dogs.

Wolves are well-adapted to cold and temperate climates. The dense underfur in their winter coats is protected by guard hairs that may be up to 6 inches (15 cm) long over the shoulder. Their skeletal and muscular structures make them well-adapted to travel. They have tremendous stamina and often spend 8-10 hours per day on the move, primarily during early morning and evening.

3.3 Social Structure and Behavior

The life of a typical individual wolf is centered on a distinct family unit or pack (Baker 1983). The basic functional unit of a pack is the dominant breeding pair, often called the 'alpha' pair (Mech and Boitani 2003*a*). A pack is typically comprised of these two dominant animals, their pups from the current year, offspring from previous litters, and occasionally other wolves that may or may not be related to the alpha pair (Young and Goldman 1944, Stenlund 1955, Mech 1966). Wolves were once thought to follow a linear dominance hierarchy within the pack, where each member occupies a rank or position (Mech 1970). These early studies of social dynamics were conducted on captive wolves and subsequent research of wild wolves in a wider range of contexts found that not all wolf packs fit a linear dominance hierarchy (Mech 1999, Mech and Boitani 2003a). Alphas change as the health and environment of an individual changes within the pack (Packard 2003). However, the alpha male and female are normally the only animals that breed, but there are exceptions (Ballard et al. 1987).

Based on ten studies, the average pack size of wolves that prey primarily on deer (*Odocoileus* spp.) is 5.7 animals (Fuller et al. 2003). Pack sizes in Montana with more diverse and larger ungulate prey are similar, averaging 5.9 overall and ranging from 4.9 to 7.0 (Sells et al. 2022). Pack sizes in Minnesota have ranged from 3.6 to 5.6 individuals (Erb and Benson 2004, Erb and

Humpal 2021). Average pack size in Michigan in winter during 2000-2020 ranged from 3.2 to 5.3 (Michigan DNR, unpublished data).

Wolves establish and maintain territories (Ballard et al. 1987, Fuller 1989, Mech and Boitani 2003). Howling between packs and scent-marking along territory edges are the principal means of spacing in wild wolf populations. Territory size can vary greatly and depends upon the density of wolves and on the density and distribution of prey. Estimates of territory size also vary depending on the field and analytical methods used (e.g., number of telemetry relocations; Fritts and Mech 1981, Bekoff and Mech 1984, Mech et al. 1998; see also Kie et al. 2010, Noonan et al. 2019).

Sizes of individual wolf pack territories in the Upper Peninsula of Michigan have ranged from 22 mi^2 to 128 mi^2 (56-331 km^2) and in 2004, averaged 65 mi^2 (169 km^2) when using VHF telemetry data (Huntzinger et al. 2005). Advancements in collar GPS technology has greatly increased relocation telemetry data which has provided a more accurate estimation of territory sizes. Current estimates using GPS data suggest the average territory is 98 mi^2 (259 km^2) in the Upper Peninsula of Michigan (Michigan DNR, unpublished data).

3.4 Reproduction

Some wolves that were held in captivity were capable of breeding at 9-10 months of age (Medjo and Mech 1976), but wild wolves typically reach sexual maturity at 22 months of age (Mech 1970, Fuller 1989). Mating takes place in February, dens are dug in March, and pups are born in middle to late April (Peterson 1977, Fuller 1989).

Litter sizes can vary, but usually number 4- 6 pups (Mech 1970, Ferreras-Colino et al. 2021), but can be greater based on wolf density, with lower density populations having larger litter sizes (Sidorovich et al. 2007). Pups are born with their eyes and ears closed and lack the ability to properly regulate their body temperature (Mech 1970). Their eyes open when they are between 11 and 15 days old (Rutter and Pimlott 1968, Mech 1970). Pups emerge from their dens when they are approximately 3 weeks old (Young and Goldman 1944). At approximately 9 weeks of age, they are weaned and moved to a rendezvous site, an above-ground area where pups develop until they can travel with the pack. By the time pups are 4-6 months old, they are nearly as large as an adult wolf (Carbyn 1987).

3.5 Causes and Rates of Mortality

Wolves are subject to both natural and human-induced mortality. Natural mortality factors include accidents, malnutrition, starvation, parasites, diseases, and fatal encounters during territorial disputes between packs (Hill et al. 2022). No animal habitually preys on wolves, but pups may occasionally be taken by bears (*Ursus* spp.) or other predators. Both moose (*Alces alces*) and deer have injured or killed wolves (Nelson and Mech 1985, Mech and Nelson 1989).

Human-induced mortality can involve vehicle strikes and intentional killing (Hill et al. 2022; Michigan DNR, unpublished data).

Annual mortality of wolves from both natural and human-induced causes can fluctuate widely from year to year. Up to 60% of pups may die from disease and malnutrition during their first 6 months of life. Mortality rates approximate 45% from 6 months to 1 year, and 20% between years 1 and 2 (Pimlott et al. 1969, Mech 1970, Mech and Frenzel 1971, Van Ballenberghe et al. 1975, Fritts and Mech 1981). Adults may live past 11 years, but most die much sooner (Mech 1988; Michigan DNR, unpublished data). Reported adult wolf survival rates in the United States often range from about 75 to 79% (Adams et al. 2008, Wydeven et al. 2009, Smith et al. 2010, Cubaynes et al. 2014). Annual adult wolf survival in Wisconsin from 1979 to 2013 was 76%, with dominant mortality sources including illegal killing (9.4%), natural and unknown causes (9.5%), and other human-caused mortality (e.g., hunting, vehicle collisions, lethal control; 5.1%) (Stenglein et al. 2018). Huntzinger et al. (2005) estimated annual mortality rates of radio-collared wolves in the UP from 1999 to 2005. Estimates of annual mortality rates varied between 15% and 46% and annual mortality of wolves did not increase or decrease with time. O'Neil (2017) provided more current analyses of survival and cause-specific mortality of wolves in the Upper Peninsula of Michigan. Annual wolf mortality was about 25% during 1994-2013, with human-caused mortality the dominant source in Michigan wolves, representing 17% annually (O'Neil 2017). Across years (i.e., 1994-2013), wolf survival decreased overall with greater evidence corresponding with increased potential for conflicts with humans as opposed to natural (e.g., intraspecific aggression) causes of mortality (O'Neil 2017). O'Neil (2017) noted this density dependent survival was also landscape dependent, with mortality risk increasing in areas with greater proportions of agriculture.

Causes of wolf mortality are often at least partially compensatory (Mech 2001, Fuller et al. 2003, Borg et al. 2015, O'Neil 2017, Stenglein et al. 2018). For example, human-induced mortality can sometimes replace mortality that would otherwise occur due to natural factors, such as starvation, disease, or intraspecific aggression (Fuller et al. 2003, Rutledge et al. 2010, O'Neil 2017). However, whether mortality sources are compensatory or additive to other sources appears more complex and likely context dependent (Adams et al. 2010, Creel and Rotella 2010, Gude et al. 2012). In addition, the overall effects of some mortality sources such as poaching are difficult to quantify (Olson et al. 2016). Poaching can be an important source of mortality for wolves (e.g., Finland; Suutarinen and Kojola 2017) and has been reported to reduce wolf population growth (Liberg et al. 2012). In Michigan, illegal killing accounted for 39% of radio-collared wolf mortality from biological year (April 15th to April 14th) 2010 through 2020 (Michigan DNR, unpublished data). Compared to uncollared wolves, radio-collared wolves could be more or less likely to be killed illegally because radio-collars can be visible when wolves are sighted. If radio-collared wolves are less likely to be killed, then the actual proportion of mortality due to illegal activity could be higher. When vehicle strikes, depredation-control activities, harvest and other human-caused trauma are included, almost 61% of the radio-collared wolf mortality was directly attributable to humans (Michigan DNR, unpublished data).

3.6 Immigration and Emigration

Dispersal is highly variable among wolves, with attributes of dispersal including success dependent on environmental, social, and individual factors (Morales-González et al. 2022). Most wolves disperse because animals rarely assume a breeding position within their natal pack (Mech and Boitani 2003). In the western United States, males were more likely than females to disperse (Jiminez et al. 2017); however, earlier studies found no differences in rates of dispersal between males and females (Boyd and Pletscher 1999, Mech and Boitani 2003, Kojola et al. 2006). However, females are more likely to be successful, due in part to shorter dispersal distances (Morales-González et al. 2022). Dispersal rates may be greatest at lower and higher wolf densities, and wolves tend to avoid areas of greater human activity (Morales-González et al. 2022). Frequency of dispersal appears to increase with pack density and overall density of wolves (Gese and Mech 1991, Jiminez et al. 2017). Success of dispersals was reduced due to human-caused mortality, as well as distance of dispersal events (Morales-González et al. 2022). A global synthesis of wolf dispersal, including 21 studies found an average of about 77% of dispersing wolves became established in a new territory (Morales-González et al. 2022).

Wolves are capable of dispersing long distances; a few movements greater than 500 mi (800 km) have been reported (Fritts 1983, Ballard et al. 1983, Boyd et al. 1995). A male wolf captured and tagged in Gogebic County, Michigan in 1999 was later killed near Trenton, Missouri in October 2001. The straight-line distance between the two points is 457 mi (756 km). Another male wolf was incidentally captured by a coyote trapper in Mackinac County, Michigan in 2020. The wolf dispersed shortly after capture and was killed less than seven months later but not before travelling a minimum of almost 2,000 miles (3,219 km) to Manitoba, Canada. In a recent synthesis of wolf dispersal patterns, the greatest reported straight-line distance was 679 miles (1,092 km) (Morales-González et al 2022). Though methodologies varied markedly across studies, the range of reported minimum dispersal distances for wolves was 25 to 2,454 miles (41 to 3,950 km) (Morales-González et al 2022). Specific to the western Great Lakes region of the United States, movements of wolves among Minnesota, Wisconsin and Michigan have been confirmed through the recovery or observation of marked animals (ear-tagged and/or radio-collared) (Mech et al. 1995; Wisconsin DNR, unpublished data; Michigan DNR, unpublished data). There is also evidence of wolf movements between the eastern Upper Peninsula and Ontario across Whitefish Bay and the St. Mary's River (Jensen et al. 1986; Thiel and Hammill 1988; Michigan DNR, unpublished data). Movements and gene flow among these jurisdictions helps preserve or enhance genetic diversity within populations and helps mitigate the effects of detrimental demographic fluctuations due to environmental catastrophes (Simberloff and Cox 1987, Boitani 2000).

3.7 Wolf Food Habits

Wolves prey on a variety of wildlife species, and predation on those species often changes seasonally and geographically (Voigt et al. 1976, Fritts and Mech 1981, Potvin et al. 1988, Fuller 1989, Mech and Peterson 2003, Newsome et al. 2016). In general, prey abundance,

distribution, vulnerability and behavior influence a prey species' importance to wolves as a food source. In multiple prey systems, the more vulnerable species commonly predominates as the main food source for wolves (Van Ballenberghe et al. 1975, Fritts and Mech 1981).

Ungulates are the dominant prey of wolves worldwide (Newsome et al. 2016) and the Great Lakes region (DelGiudice et al. 2009). However, seasonal variation, or prey switching, can occur in wolf populations and is usually associated with changes in prey abundance or vulnerability (Newsome et al. 2016). For example, during spring and early summer months, beaver become an important food source (Van Ballenberghe et al. 1975, Voigt et al. 1976, Fritts and Mech 1981, Potvin et al. 1988, Fuller 1989, Gable et al. 2018). In June and July, wolves are thought to prey heavily on deer fawns and moose calves when they are more vulnerable and occur in relatively high densities (Voigt et al. 1976, Fritts and Mech 1981, Fuller 1989). In Minnesota, white-tailed deer, moose and beaver comprised the majority (>75%) of annual wolf diet (Van Ballenberghe et al. 1975). The predominance of deer remains in wolf scat indicates deer were the principal prey throughout the year despite relatively high densities of moose. Mandernack (1983) analyzed scats of Wisconsin wolves to determine the relative abundance of prey species in their diet. White-tailed deer (*Odocoileus virginianus*) comprised 55%, beaver (*Castor canadensis*) comprised 16%, snowshoe hare (*Lepus americanus*) comprised 10%, and other small mammals and miscellaneous items comprised 20% of wolf diet in that area. Beaver provided as much as 30% of a Wisconsin wolf's spring diet.

In the UP, white-tailed deer and moose constitute the ungulate prey available for wolves. However, wolves rarely prey on moose, probably due to the lack of overlap in distribution with wolf pack territories, the low abundance of moose in comparison to deer, and differences in vulnerability (D. E. Beyer, Michigan DNR, personal communication). Research in Michigan indicates deer are the primary prey item for wolves (e.g., Vucetich et al. 2012; Kautz et al. 2019, 2020; Petroelje et al. 2021), with small mammals such as beaver, snowshoe hare and ruffed grouse (*Bonasa umbellus*) making up lesser percentages of their diet (Huntzinger et al. 2004, Petroelje et al. 2021). Early studies in the Upper Peninsula found wolves ate shrews, snowshoe hares, red squirrels (*Tamiasciurus hudsonicus*), mice, ruffed grouse, crayfish, and grass in addition to white-tailed deer (Stebler 1944, 1951). More recently, prey identified at 164 wolf "cluster" sites (i.e., a group of locations from a GPS-collared wolf suggesting extended time spent in an area) during summer, was comprised primarily of white-tailed deer (76.8%; 12.2% adult, 64.6% fawn), followed by beaver (3%), muskrat (*Ondatra zibethicus*; 2.4%), raccoon (*Procyon lotor*; 2.4%), snowshoe hare (1.8%), coyote (1.2%), ruffed grouse (1.2%), Canada goose (*Branta canadensis*; 0.6%), wild turkey (*Meleagris gallopavo*; 0%), and unknown species (4.3%) (Michigan DNR, unpublished data). However, domestic livestock can potentially alter wolf diets. In a more recent Michigan study, diet analyzed from 152 scat samples collected during summer in an area of the south-central Upper Peninsula with livestock carcass dumps found 70% white-tailed deer (62% adult, 8% fawn), 22% cattle, and 6% cottontail rabbit (*Sylvilagus floridanus*) or snowshoe hare (Petroelje et al. 2019). In contrast, 328 summer wolf scats from an area in the western UP without livestock carcass dumps contained 78% white-tailed deer, (40% adult, 38% fawn), 0% cattle, 3% cottontail rabbit or snowshoe hare, and 19% rodents (Petroelje et al. 2019).

3.8 Ecological Function

Wolves are top predators and can have a major influence on the ecological systems in which they live (Mech and Boitani 2003, Wilmers et al. 2006). Primary effects of wolves can include the removal of less-fit individual prey, local influences on prey numbers, and increased availability of food for scavengers (Mech 1970, Stahler et al. 2006, Vucetich et al. 2004, Kautz et al. 2020). Wolves and other carnivores can provide ecosystem services of direct and indirect benefit to humans (see Lozano et al. 2019). Wolves may also limit populations of competitors such as coyotes (Crabtree and Sheldon 1999, Fowler et al. 2021, Fowler et al. 2022). These primary effects can also cause changes (indirect effects) in other elements of the ecosystem. These indirect effects have been termed 'trophic cascades' (Paine 1966) because changes at one trophic level (e.g., carnivores such as wolves) cause changes at another trophic level (e.g., herbivores such as elk [*Cervus elaphus*]). However, these relationships are complex and not well understood (see Eisenberg et al. 2013).

On Isle Royale, McLaren and Peterson (1994) documented a top-down trophic cascade among wolves, moose and balsam fir (*Abies balsamea*). In this system, wolves controlled moose numbers and moose controlled growth of balsam fir. However, this effect was reduced markedly following occurrence of canine parvovirus (Wilmers et al. 2006). A similar relationship may be occurring in Yellowstone National Park following the reintroduction of wolves. Some researchers have reported that wolf predation on elk is allowing several tree species, which were formerly limited by elk browsing, to recover (Ripple and Larsen 2000, Ripple et al. 2001, Ripple and Beschta 2003). The mechanism that starts the trophic cascade may be direct (wolves limit prey numbers; McLaren and Peterson 1994), or indirect (risk of wolf predation causes a change in ungulate browsing patterns; Ripple and Beschta 2004, Beschta et al. 2018). However, more recent work suggests a more limited effect of wolves facilitating this behaviorally-mediated trophic cascade, where effects of elk browsing on aspen were not reduced in areas where elk were at greater risk of wolf predation (Kauffman et al. 2010, Fleming 2019).

3.9 Wolf Habitat

Wolves are habitat generalists and have the potential to occupy habitat-diverse areas with an adequate abundance of hoofed prey (Fuller 1995, Singh and Kamara 2006, Wolf and Ripple 2016, O'Neil 2017, USFWS 2020, Marquard-Petersen, 2021). Given sufficient prey, the chance of an area being occupied and the number of wolves that could be supported is related to the proximity of source populations and the extent of human-caused mortality (Fuller 1995, Creel and Rotella 2010, Wolf and Ripple 2017).

Road density has been used as an index of wolf-human contact and appears to be related to illegal and accidental killing of wolves (Mladenoff et al. 1995, Mladenoff et al. 1999, Person and Russell 2010, Dennehy et al. 2021). A spatial habitat model based on road density has been

used to predict areas of wolf re-colonization in the northern portions of Minnesota, Wisconsin, and Michigan (Mladenoff et al. 1995). This model predicted a road-density threshold of 0.72 mi/mi^2 (0.45 km/km^2) where wolves were considered unlikely to occupy areas with road densities greater than this threshold. Although at this period of recolonization the model successfully predicted wolf occupancy in northern Wisconsin (Mladenoff et al. 1999), the results for the UP were questionable because areas of low prey (deer) density (Doepker et al. 1995) were identified as suitable habitat. Recognizing this problem, Potvin et al. (2005) developed a spatial habitat model for the UP which incorporated measures of road density and deer density. This model identified a road-density threshold of 1.1 mi/mi^2 (0.7 km/km^2) and a deer-density threshold of 6-15 deer/mi^2 (2.3-5.8 deer/km^2). The deer-density threshold is near the point where wolves become nutritionally stressed (Messier 1987) and wolf pack occurrence in the UP is strongly associated with areas of overwintering white-tailed deer (O'Neil 2017). The two models produced similar estimates of habitable area (Mladenoff et al. 1999: 11,331 mi^2 or 29,348 km^2; Potvin et al. (2005): 10,695 mi^2 or 27,700 km^2) but differed in how the suitable habitat was distributed. The Potvin et al. model predicted most occupiable habitat is in the southern portions of the UP. By contrast, the Mladenoff et al. (1995) model suggests many areas in the northern portion of the UP will be occupied. More recent estimates (2007-2013) predicted greater densities in the southern and eastern portions of the UP (O'Neil 2017), supporting the Potvin et al. (2005) model.

Potvin (2003) estimated the NLP contained about 3,089 mi2 (8,000 km^2) of suitable wolf habitat. Gehring and Potter (2005) applied the Mladenoff et al. (1995) model to the NLP and estimated 1,634 mi^2 (4,231 km^2) of suitable habitat was available. A more recent modelling effort using snow-tracking data (2017-2020) from Michigan, Wisconsin, and Minnesota estimated about 6,992 mi^2 (18,110 km^2) of the NLP was suitable for wolves (van den Bosch et al. 2022a). These modeling efforts suggest wolf habitat in the NLP is more fragmented than habitat in the UP. Previous estimates of suitable wolf habitat may be conservative because wolves exhibit behavioral plasticity and can select for areas previously considered unsuitable (Mladenoff et al., 2009).

4. Wolves in Michigan

4.1 History

Wolves have been part of the Great Lakes fauna since the melting of the last glacier and as such are native to the land area known as Michigan. Stebler (1951) indicated that pioneer documents and museum specimens show wolves were once present in all counties of Michigan.

Throughout the history of Native Americans living in present-day Michigan, wolves figured prominently in their culture and beliefs. For example, the wolf is a sacred clan animal among the Anishinaabe (Odawa, Ojibwe and Potawatomi) people. In the Anishinaabe creation story, Maahiingun (the wolf) is a brother to Nanaboozhoo (half man/half spirit); Gzhemnidoo (the Creator) instructed Maahiingun and Nanaboozhoo to travel together to name and visit all the

plants, animals and places on earth; later, Gzhemnidoo instructed them to walk their separate paths, but indicated each of their fates would be always tied to that of the other; they would be feared, respected and misunderstood by the people that would later join them on earth (see 6.8 for a more-detailed account of the story of Maahiingun and Nanaboozhoo). David (2009) also, provides additional background on the cultural importance of wolves to the Ojibwe in the western Great Lakes region. Some Tribes in Michigan have their own wolf management plans (e.g., Keweenaw Bay Indian Community [Nankervis 2013], Little Traverse Bay Bands of Odawa Indians [LTBB NRD 2009], Great Lakes Indian Fish and Wildlife Commission 1837/1842 Ceded Territory [David et al. 2022]) that provide additional information on history, cultural significance, and management priorities for tribal wildlife agencies. Also, Tribes in Michigan may use Traditional Ecological Knowledge (TEK), rather than or in addition to modern biology, as a way of knowing and managing wildlife. TEK refers to the evolving knowledge acquired by indigenous and local peoples over hundreds or thousands of years through direct contact with the environment (USFWS 2011b).

Settlers brought their wolf prejudices with them (Lopez 1978). European werewolf mythology, fairy tales, and religious beliefs, along with views that wolves were incompatible with human civilization, resulted in the persecution of wolves in Michigan as well as the rest of the United States. This practice led to the near extermination of wolves in the contiguous United States.

The United States Congress passed a wolf bounty in 1817 in the Northwest Territories, which included what is now Michigan. A wolf bounty was the ninth law passed by the first Michigan Legislature in 1838. A wolf bounty continued until 1922, when it was replaced by a State-paid trapper system. The bounty was reinstated in 1935 and repealed in 1960, only after wolves were nearly eliminated from the State. Michigan wolves were given legal protection in 1965 (Beyer et al. 2009).

By the time bounties were imposed in the 1800s, wolves were nearly extirpated from the SLP. They were absent from the entire LP by 1935, if not sooner (Stebler 1944). In the more sparsely settled UP, the decline was less precipitous. In 1956, the population was estimated at 100 individuals in seven major areas in the UP (Arnold and Schofield 1956). By 1973, the Michigan wolf population was estimated at only six animals in the UP. Sporadic breeding and occasional immigration of wolves from more-secure populations in Ontario and Minnesota were postulated as the factors that maintained the small number of wolves in the UP (Hendrickson et al. 1975). It is likely that a few animals persisted in remote areas of the UP and that wolves were never completely extirpated from the State.

In the early 1970s, the wolf population in Minnesota began to expand southward from its northern range. In 1975, a pack of wolves occupied a territory that spanned the Minnesota-Wisconsin border (Thiel 1993), signifying the beginning of re-colonization of former wolf range in Wisconsin. Since 1975, the wolf population in Wisconsin has grown to more than 1,100 animals occupying suitable habitat in northern and central portions of the state (Wisconsin Department of Natural Resources 2021). In the 1980s, wolves from Minnesota and Wisconsin began to re-colonize the western and central portions of the UP (Thiel 1988, Mech et al. 1995,

(Beyer et al. 2009)). In addition, wolves from Ontario may have crossed into the UP over ice at Whitefish Bay, along the St. Mary's River, and near northern Lake Huron islands (Jensen et al. 1986, Thiel and Hammill 1988). The beginning of wolf recovery in Michigan was first documented in 1989 when a pair established a territory in the central UP (Beyer et al. 2009).

Only one wolf reintroduction was attempted in Michigan. Four wolves from Minnesota were released in Marquette County in March 1974 and all died because of direct human activities between July and November 1974. These wolves did not reproduce and did not contribute to the current wolf population (Weise et al. 1975). The wild wolves that currently occur in the UP are the result of natural immigration and reproduction.

4.2 Upper Peninsula

The wolf population in the UP (excluding Isle Royale) showed mostly steady growth from 1989 to 2011 (Figure 4.1). From 1994 to 2007, the population grew at an average annual rate of 19%. From 2003 to 2007, the average annual growth rate was 12%. The growth rate was expected to decline as the population moved toward the maximum level the UP can sustain (Huntzinger et al. 2005). Since 2011 the wolf population has remained stable ranging from 618 to 695 with overlapping 95% confidence limits, suggesting wolves may have reached their carrying capacity in the Upper Peninsula. A minimum of 695 estimated wolves occurred on the UP mainland during the winter of 2020.

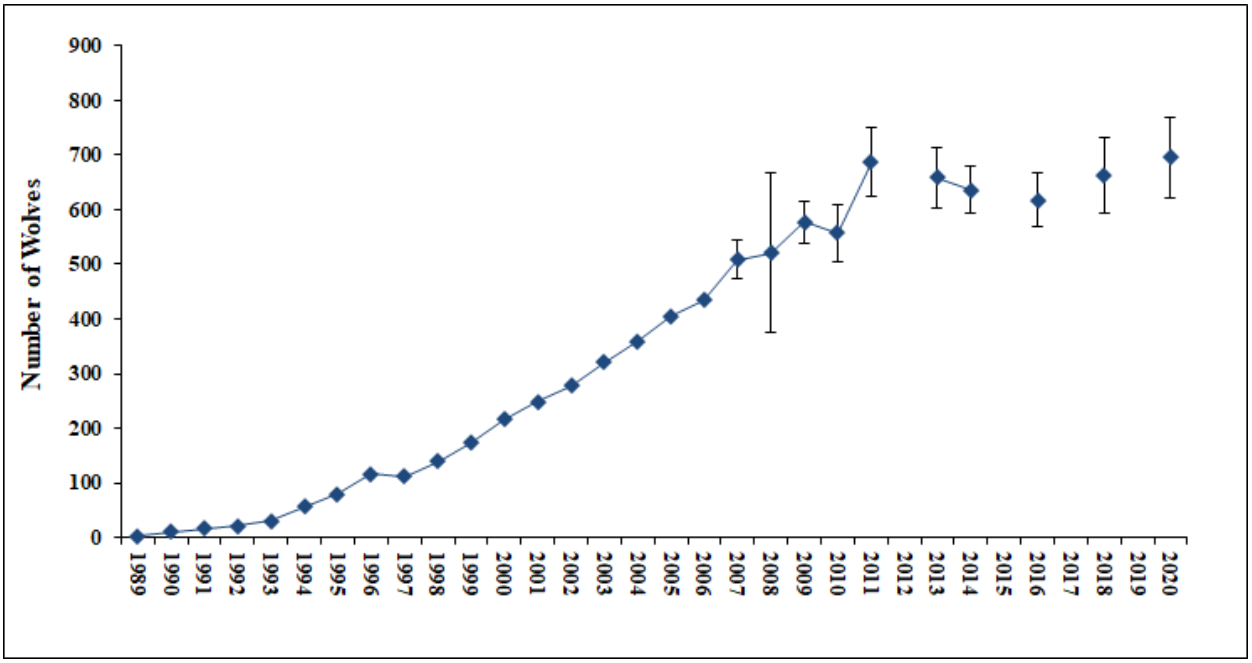

Figure 4.1. Minimum winter estimates of the number of wolves in Michigan's Upper Peninsula (excluding Isle Royale), 1989-2020. Prior to 2007, the entire Upper Peninsula was searched; starting in 2007, a stratified sampling plan was used. Error bars represent the 95% confidence limits on survey estimates from 2007-2020.

Wolves have been found in every county of the UP, but wolf density has been higher in the western UP (about 13-15 wolves/386 mi^2 [13-15 wolves/1000 km^2] in 2014) than in the eastern UP (about 10-11 wolves/386 mi^2 [10-11 wolves/1000 km^2]in 2014). However, during the 2020 survey this density difference between the eastern and western Upper Peninsula was no longer detected, and density across the UP was about 16 wolves/ 386 mi^2 (16 wolves/1000 km^2).

4.3 Lower Peninsula

In October 2004, a wolf that had been captured and radio-collared in the eastern UP was captured and killed by a coyote trapper in Presque Isle County of the NLP. This event represented the first verification of a wild wolf in the LP in at least 69 years. However, winter track surveys during 2005-2010 failed to indicate the presence of any wolves in the LP.

In 2010, 3 young of-the-year canids were captured in Cheboygan County of the NLP and initially identified as wolf pups based on dentition, size (especially length of legs and size of the feet and toes) and weight (Wheeldon et al. 2012). Genetic analyses indicated; however, the pups were coyotes rather than wolves. In addition, the analyses found evidence of maternal introgression from a Great Lakes wolf (hybrid heritage from gray wolves and eastern wolves) in their pedigree. The disagreement between the physical appearance of these animals and the genetic assignment indicates the Department should use genetic testing to validate classifications based on appearance or tracks until wolves have re-established themselves in the LP in significant numbers (Wheeldon et al. 2012).

During the 2011 winter track survey, and shortly after the 2015 survey period, tracks consistent with a wolf-like animal were observed in Cheboygan and Emmet Counties, respectively; while track surveys in 2013 failed to produce any evidence of wolves. In 2014, biologists from the Little Traverse Bay Bands of Odawa Indians captured what appeared to be a wolf on a trail camera and were able to collect a scat sample. DNA analysis of the scat confirmed that the animal was a wolf. DNA analysis also found that the wolf was a male and the mitochondrial DNA haplotype was an Old World (gray wolf) haplotype, which is only rarely observed in eastern wolves. Although it is possible that wolves currently occur in the LP, as of November 2022, no genetic verification exists since 2014.

4.4 Isle Royale

Wolves first appeared on Isle Royale in the late 1940s, when two to three wolves crossed the ice from either Minnesota or Ontario (Mech 1966, Peterson 1995). There is no physical evidence that wolves occurred on the island prior to this period, but research on that topic has been limited. Wolves arrived on the island to find a substantial moose population, which became their primary food source. Formal monitoring of the moose and wolf populations began in 1958.

The wolf and moose populations on the island followed a pattern of dynamic fluctuations, wherein high moose numbers (particularly older moose) were followed by high wolf numbers. Wolves influenced moose numbers predominantly through the direct killing of calves and have remained the only consistent source of moose mortality on the island. The moose-wolf population patterns held until a dramatic crash occurred in the wolf population in the early 1980s, during which wolf numbers dropped from 50 to 14. Circumstantial evidence suggests the decline in wolf numbers was related to the introduction of canine parvovirus (Peterson 1995a, Kreeger 2003). Wolf reproduction progressively declined during 1985-1992 and numbers dropped to their lowest level (12 animals). During the next decade, the wolf population increased slowly. It reached 30 animals in 2005 and included the same number in 2006 (Peterson and Vucetich 2006). In 2007, the wolf population declined to 21 animals, most likely due to lack of food. (Vucetich and Peterson 2007). The wolf population remained above 20 animals until 2010 when the population began declining reaching the lowest level ever recorded at 8 animals in 2013. Scientists studying the population believed the decline in wolf abundance was related to the effects of inbreeding and recommended introducing new wolves as a form of genetic rescue (Vucetich and Peterson 2014).

In 2015 the National Park Service began to formally determine how to manage wolves and assessed management alternatives which ultimately included the introduction of wolves to the island. During September 2018-2019, 19 wolves captured in Michigan, Minnesota, and Ontario were translocated to Isle Royale (Romanski et al. 2020). An estimated 14 wolves were present on Isle Royale on 14 April 2020. Though 8 wolves died following introduction, successful reproduction has occurred (Romanski et al. 2020).

5. Wolf Management Goals

The principal goals of this plan are fourfold: 1) maintain a viable Michigan wolf population above a level that would warrant its classification as threatened or endangered; 2) facilitate wolf-related benefits; 3) minimize wolf-related conflicts; and 4) conduct science-based wolf management with socially responsible methods.

To achieve those goals, the DNR must consider the complex interactions of many biological factors and implement measures that assure adequate protection and conservation of the species. At the same time, it must also address the many complex and often controversial social issues that accompany wolf management.

The public is highly polarized on wolf management, as evidenced by the tremendous amount of public input and litigation that has been associated with management decisions in the United States. Stakeholder groups often have disparate or opposing views and needs regarding wolf management, and this plan reflects efforts to identify an appropriate balance among the biological needs of the species, the benefits wolves provide to some segments of society, the costs they impose on others, and the acceptability and feasibility of specific management

methods. These elements reflected in the principal goals of this plan are discussed under the following headings.

5.1 Maintain a Viable Population

5.1.1 Definition of 'Viable Population'

The DNR is committed to maintaining a viable Michigan wolf population above a level that would warrant its classification as threatened or endangered at either the State or Federal level. Therefore, the Michigan wolf population must exceed criteria used to define a viable population in the *Recovery Plan for the Eastern Timber Wolf* (USFWS 1992) and the *Michigan Gray Wolf Recovery and Management Plan* (Michigan DNR 1997).

The *Recovery Plan for the Eastern Timber Wolf* established federal recovery criteria for gray wolves in the eastern United States (USFWS 1992). In addition to requiring that the Minnesota wolf population was stable or growing with its continued survival assured, a second population outside of Minnesota (or Isle Royale, Michigan) also had to be re-established before wolves could be removed from federal protections. This second population is considered viable if it has "at least 100 wolves in late winter if located within 100 miles of the Minnesota wolf population," or "at least 200 wolves if located beyond that distance," and is maintained for five consecutive years. Because wolves in Michigan are not isolated, a combined "Wisconsin-Michigan population of 100 wolves" is currently the criteria that must be exceeded to ensure federal recovery criteria are met.

The 1997 *Michigan Wolf Recovery and Management Plan* adopted the definition of a viable isolated population from *The Recovery Plan for the Eastern Timber Wolf* as a criterion for wolf recovery in Michigan (DNR 1997). Therefore, a winter wolf population of 200 animals for five consecutive years is the criteria that must be exceeded to ensure State recovery criteria are met.

Both plans focused on the biological needs of a small recovering population and were valuable tools for the recovery of wolves in Michigan. However, attempting to estimate the minimum population size necessary to avoid extinction, or extirpation, should be viewed with great caution because poorly understood genetic relationships, demographic stochasticity, climate change, negative changes to suitable habitat or conductivity to other populations, and unforeseen catastrophic events (e.g., disease) make it difficult to accurately estimate a minimum viable population for many species, including wolves (Fritts and Carbyn 1995, Reed 2003, Pierson et al. 2015, Wolf et al. 2015).

Reed et al. (2003) looked at over 100 different wild vertebrate species to model minimum viable population estimates and found that on average there needed to be enough habitat to support 7,000 adults to maintain long-term viable wild populations in isolation. However, few studies have attempted to identify minimum viable population sizes for populations in specific

jurisdictions that are extensions of much larger populations (Stokland 2016). This makes it very difficult to define a minimum viable population size for Michigan wolves, because they are interconnected to other wolf populations, forming a larger population of wolves in the Great Lakes Region. Wolf movements among Minnesota, Wisconsin, Canada and Michigan are not uncommon (Mech et al. 1995; Wisconsin DNR, unpublished data; Michigan DNR, unpublished data), and those movements enhance intra-population genetic diversity and mitigate adverse effects of demographic and environmental fluctuations.

The minimum criterion of 200 wolves does not reflect the maximum number of wolves the available habitat in Michigan can support. The winter population exceeded 200 wolves in 2000, and increased each year between 2000 and 2009, at an annual rate of 11% (see Figure 4.1). During the winter of 2020, a minimum estimate of 695 (+75) wolves lived in the UP. Estimates of biological carrying capacity for the Upper Peninsula are imprecise and range from 600 to 1,350 (Mladenoff et al. 1997, Miller et al. 2002, Potvin 2003, Van Deelen 2009).

Although the winter Michigan wolf population must exceed 200 animals to achieve the first stated goal of the plan, this minimum requirement is not necessarily sufficient to provide all the ecological and social benefits valued by the public (see 5.2). Accordingly, 200 wolves are not a target population size. Rather, the wolf population should be a self-sustaining and genetically diverse population with an abundance greater than 200 individuals, that maintains connectivity with wolf populations in neighboring states and Canada while fulfilling its ecological role. Management in Michigan will be conducted to maintain the wolf population above the minimum size requirement and facilitate those wolf-related benefits while minimizing and resolving conflicts where they occur (see 5.3). This plan does not identify a target population size, nor does it establish an upper limit for the number of wolves in the State. As a result, public preferences regarding levels of positive and negative wolf–human interactions will be an important consideration when managing wolf abundance and distribution, above the minimum requirements.

5.1.2 Need to Maintain a Viable Population

The DNR is committed to the conservation, protection, management, use and enjoyment of the State's natural resources for current and future generations. Since wolves have become re-established in Michigan, they have once again become an integral part of the natural resources of the State and are a component of naturally functioning Michigan ecosystems. In the context of the DNR's mission and its implicit public trust responsibilities for the State's wildlife, natural communities and ecosystems, the maintenance of a viable wolf population is an appropriate and necessary goal.

Long-term maintenance of a viable wolf population removes the need for Federal or State classification of the species as threatened or endangered. Anything that warrants subsequent reclassification would be detrimental to not only the wolf population; it would also have

negative consequences for the people of Michigan. A decline in the wolf population below a viable level would reduce opportunities for positive wolf-related interactions and other benefits derived by many residents. Moreover, regulatory restrictions associated with Federal reclassification would complicate and impede some efforts to address the needs of people who experience wolf-related conflicts. Therefore, maintenance of a viable population serves the best interest of wolves and the human residents of Michigan.

The most-recent public-attitude research shows most Michigan residents support the presence of a wolf population in the State. Most Michiganders (80.2%) believe wolves have an inherent right to exist. That belief is expressed across geographic regions in Michigan, although the percentage of people who express that view are greatest in the SLP (82.5%) and decreases somewhat in the NLP (78.0%) and UP (70.5%). Michigan residents were also asked about acceptability of various scenarios of wolf populations. Neither no wolves nor the greatest number sustainable were acceptable among most respondents. Across all regions, a scenario of moderate numbers of wolves appears to be most acceptable to the most people (53.2%). These results indicate that maintenance of a viable wolf population is supported by the vast majority of residents.

5.2 Facilitate Wolf-related Benefits

5.2.1 Benefits Valued by Michigan Residents

Many Michigan residents value the diverse benefits derived from the presence of wolves (Beyer et al. 2006, Lute et al. 2012, MI DNR 2022a). Many of those benefits fall within five general categories.

Ecology

As top predators, wolves fill an important ecological niche and at times can have a major influence on the ecological system in which they live (Mech and Boitani 2003; Wilmers et al. 2006). Primary effects of wolves include the removal of less-fit individual prey, control of prey numbers, and increased availability of food for scavengers (Mech 1970; Stahler et al. 2006, Vucetich et al. 2004, Kautz et al. 2020). In addition, they can help control populations of secondary predators and thus have indirect effects on many trophic levels (Paine 1966, Crabtree and Sheldon 1999). Fowler et al. (2021) found some support for wolves limiting coyote occurrence in the UP. Densities of wolves and coyotes in the UP were inversely related, with coyote diet, space use, and daily activity less variable in areas of lower wolf densities as an apparent means to allow their coexistence (Fowler et al. 2022). These primary effects can also cause changes (indirect effects) in other elements of the ecosystem. These indirect effects have been termed 'trophic cascades' (Paine 1966) because changes at one trophic level (e.g., carnivores such as wolves) cause changes at another trophic level (e.g., herbivores such as elk). A study conducted in the UP concluded that wolves likely altered deer behavior which benefited maple growth and species richness of rare forbs (Flagel 2014). However, all of these

relationships are complex and not well understood (see Eisenberg et al. 2013). Finally, wolves and other carnivores can provide ecosystem services of direct and indirect benefit to humans (see Lozano et al. 2019). Results from the 2021 public-attitude survey suggest that most Michiganders (82.7%) agree that wolves are an important part of ecosystems.

Cultural and religious values

Wolves are a species of great significance to many Native Americans. Today, many Native American communities in Michigan value the return of Maahiingun (the wolf) as an intrinsic spiritual component in the reaffirmation and continued viability of their own cultural well-being. See 6.8 for additional detail regarding the significance of wolves in tribal culture. Many other people value wolves for reasons that are based on personal or religious convictions. An estimated 62% of residents express at least some agreement with the statement: "Wolves are an important part of human culture."

Interaction with nature

The presence of wolves in Michigan provides a unique opportunity for people to interact with and experience a particular component of the natural world. The opportunity to personally observe, photograph or study wolves in the wild may be restricted to a relatively small proportion of residents, but the option for those residents to have those experiences is highly valued by society. Results from the 2021 public-attitude survey suggest that most Michiganders (64.2%) agree that they want to see or hear wolves in the wild. In addition, seeing wolf tracks, scat, or other sign that wolves occupy an area may be valued by residents as well.

Personal appreciation

Independent of cultural or religious convictions, many people feel wolves have an 'existence value' and they value the knowledge that they exist as a healthy, thriving, wild population in the State. This benefit can be realized whether or not people are able to see or hear those animals. An estimated 80% of Michiganders have some agreement with the statement "Wolves have an inherent right to exist." And while only an estimated 18.2% of Michiganders have seen a wolf in the wild once or twice, and only 8.6% have seen a wolf in the wild multiple times, 34.9% have least some agreement with the statement: "The presence of wolves improves my quality of life."

Tourism and recreation

Residents and nonresidents travel to Michigan wolf range to interact with wolves, whether listening for howls, taking photographs, or looking for tracks and scat. However, only 32% of residents at least somewhat agree with the statement that "Wolves contribute to the Michigan economy." See 6.8 for additional details regarding the facilitation of positive wolf-human interactions, which in turn could increase tourism. Potential consumptive use of wolves for

hunting, trapping and fur harvest may bring additional tourism to local communities within wolf range. However, less than a third (29.0%) of residents agreed that potential game status of wolves was a reason to have wolves in Michigan. Any promotion of tourism and recreational opportunities associated with wolves might attract a greater number of people to local communities within wolf range and thus increase the economic benefits derived from the species.

In addition to economic benefits derived from tourism, a public wolf harvest could provide resources such as fur, meat, teeth, and claws, economic benefits from the sale of furs, and recreation for hunters and trappers. See 6.12.2 for additional details regarding implementation of a policy for a public wolf harvest for reasons other than managing wolf-related conflicts. Results of the most recent public-attitude survey indicate that 49.2% of residents support and 30.4% oppose a legal, recreational hunting season for wolves, if biologists and the DNR believed the wolf population could sustain it. Michiganders were more likely to oppose (42.6%) a recreational trapping season than support it (36.0%). When asked to identify reasons that influenced their beliefs about the acceptability of recreational hunting and trapping seasons in Michigan, 44.0% selected "I do not support hunting wolves if the purpose is for recreation" and 44.2% selected "I do not support trapping wolves if the purpose is for recreation."

5.2.2 Providing Benefits through Management

Public support is critical for the long-term viability of a wolf population (USFWS 1992, Wisconsin DNR 1999, Bangs et al. 1995, Minnesota DNR 2001, Boitani 2003, Fritts et al. 2003). The depth and extent of that support is partially influenced by the physical, spiritual, psychological, and economic benefits provided by the population (Slovic 1987). Thus, management that enhances opportunities for positive wolf-related experiences fosters public support for the population and thus serves the best interests of both wolves and the human residents of Michigan.

This plan identifies and supports measures to promote positive wolf-related interactions. Many benefits will be provided through the maintenance of a viable wolf population. Other benefits may be achieved through efforts to develop and promote opportunities for people to experience and appreciate wolves.

5.3 Minimize Wolf-related Conflicts

5.3.1 Need to Minimize Conflicts

Although the wolf population offers benefits as described above, it also poses significant costs and concerns for some Michigan residents (Beyer et al. 2006). These costs include losses of domestic animals, anxieties over the presence of wolves near residential or recreational areas, and concerns over the impact wolves may be having on populations of game species. Given the unequal distribution of wolves in the State and the nature of certain types of conflicts, all segments of society do not bear these costs equally; the presence of wolves represents a greater challenge for some groups of Michigan residents than others.

Left unaddressed, sources of conflict can foster the development of negative public attitudes toward wolves, and those negative attitudes can lead to adverse impacts on wolf distribution and abundance. Indeed, negative public perception of wolves was the primary reason they were historically threatened with extinction in many areas (Mech 1970, Beaufort 1987, Thiel 1993). Negative perceptions, manifesting themselves in the form of widespread killing, nearly eliminated the species from the contiguous United States.

As stated previously, public support is critical for the long-term viability of a wolf population (USFWS 1992, Wisconsin DNR 1999, Bangs et al. 1995, Minnesota DNR 2001, Boitani 2003, Fritts et al. 2003). The risk and frequency of conflicts still influences human views and tolerance of wolves (e.g., Huber et al. 1992, Mishra 1997), and public support for a population of any large predator depends, in part, on confidence that conflicts will be resolved in a timely and effective manner (Frost 1985, Wolstenholme 1996, Beyer et al. 2006). Many researchers have suggested resolution of conflicts would allow people to tolerate greater abundance and distribution of wolves on the landscape (Bangs et al. 1995, Mech 1995, Boitani 2003, Fritts et al. 2003, Mech and Boitani 2003). By contrast, a failure to address conflicts could foster negative attitudes that lead to adverse impacts on wolf distribution and abundance. Thus, effective management of wolf-related conflicts assists affected stakeholders and the wolf population as a whole.

Most Michigan residents recognize the importance of addressing wolf-related conflicts (MI DNR 2022a). Respondents to the public-attitude survey were also asked to express their support or opposition to several management options when applied to different scenarios of wolf issues: 1) a wolf seen in a residential area; 2) a wolf killing someone's pet; 3) a wolf killing a free-ranging hunting dog; 4) a wolf killing livestock; and 5) a wolf attacking a human. The only interaction that elicited acceptability by the majority of respondents for killing wolves was attacks on humans. Passive management, or a "do nothing" alternative was the least acceptable action for every situation.

More than 90% of residents indicated that wolves pose at least some risk to pets, hunting dogs, and livestock, with the highest amount of risk associated with livestock, with only 2% indicating that wolves posed no risk to livestock. However, the majority did not support killing wolves in the event of a wolf killing a pet (59.1%), hunting dog (68.5%), or livestock (56.9%). A plurality were unsupportive of reducing the wolf population in the case of a wolf killing a pet (49.1%), and a majority did not support reducing the wolf population in the event of the death of a hunting dog (55.6%). Residents were more split with respect to the acceptability of reducing the size of the wolf population in response to livestock depredation, with 40.5% indicating this response was somewhat, moderately, or highly acceptable; 47.3% reporting unacceptable; and 12.2% indicating population reduction was neither acceptable nor unacceptable.

5.3.2 Effective Conflict Management

Setting numeric goals for wolf abundance at large geographic scales (e.g., the entire State, the entire UP) may not be necessary or effective for addressing most wolf-related conflicts. Broadly based abundance goals may not reflect the unequal distribution of wolf habitat, human activity, and the potential for positive and negative interactions in local areas. Moreover, wolf numbers alone do not necessarily predict the frequency of certain types of interactions. In an area of abundant natural prey and few human residences, for example, many wolves could cause a relatively low level of negative interactions. Conversely, few wolves could create an unacceptably high level of negative interactions in local areas where natural prey is scarce or where human population density is high. Management driven by broad numeric abundance goals would not necessarily reduce negative interactions, could unacceptably restrict positive interactions desired by the public, and could promote an inaccurate public perception regarding the relationship between wolf numbers and the risk of conflict.

Previous management experience indicates most wolf-related conflicts can be best handled on an individual basis. Conflicts in local areas are often caused by the behavior of a few individual wolves, and management at small scales can often address problems effectively. Therefore, this plan does not set broad numeric abundance goals for the purpose of managing most conflicts. To the extent it is expected to be effective and logistically feasible, management under this plan will be conducted to prevent and minimize conflicts on a local rather than landscape level.

5.4 Conduct Science-based and Socially Responsible Management

Science allows managers to predict consequences of specific management actions. It is a tool of primary importance for identifying those actions that could effectively achieve wildlife management goals. The importance of using sound science when making wildlife management decisions is formalized in part 401 of NREPA.

Science can identify probable outcomes of management approaches, but as an objective process, it does not prescribe subjective values to those outcomes. Rather, the desirability or acceptability of any outcome depends on the values of affected stakeholders. Moreover, when disagreements originate from differences in values rather than questions of fact, consideration of the available science alone will not be sufficient to resolve conflict. Consequently, a process of social deliberation is often necessary to determine which science-based management approaches are acceptable to individual stakeholder groups and society at large.

This plan outlines approaches for managing many wolf-related issues. These approaches were chosen, in part, based on scientific evaluation of their potential impacts to the wolf population, their feasibility, and their probability of success. In addition, they were chosen because they appear to be responsible approaches considering the benefits and conflicts of having wolves in Michigan and the attitudes of Michigan residents. They are not expected to satisfy everyone;

indeed, satisfying everyone with any single wolf management approach is not possible. However, the approaches outlined in this plan directly consider the attitudes and preferences suggested by the results of the 2021 public-attitude survey, as well as the guidance collectively offered by the diverse interests represented on the Michigan Wolf Management Roundtable, Michigan Wolf Management Forum, and Michigan Wolf Management Advisory Committee.

6. Wolf Management Strategies

The following wolf management strategies will be implemented to achieve the principal goals of this plan. They provide guidance for the management of several wolf-related issues at the strategic level; they do not outline operational details of wolf management in Michigan. Operational details are specified within guidance documents, protocols, and regulation memos, in which specific management methods are routinely evaluated, adjusted and updated in an adaptive management process as local conditions, research, technology, and feasibility of individual management techniques change (e.g., MI DNR 2022b, 2022c, 2022d). In addition, this management plan will be updated at 10-year intervals to account for changes in management context (see 7.0 for additional details).

The ensuing headings indicate strategic goals (in bold, e.g., **6.1**), objectives (underlined, e.g., 6.1.1) and actions. They partition broad needs into manageable segments, and thus provide a structure for addressing individual management issues.

6.1 Increase Public Awareness and Understanding of Wolves and Wolf-related Issues.

Researchers, managers, and stakeholder groups generally agree an informed public is important for successful wolf conservation and management (Fritts et al. 2003). State and Federal wolf plans (e.g., USFWS 1992, Michigan DNR 1997, Wisconsin DNR 1999) frequently identify education and outreach as a high priority. Although the need for an effective wolf-based education program is widely recognized, development of such a program is not a simple task. Strong public opinions, the controversial nature of many issues, and other barriers present agencies and other education partners with several challenges.

Wolves, perhaps more than any other wildlife species, tend to elicit strong emotions among stakeholder groups and the public (Meadow et al. 2005, Vaske et al. 2021), and personal views of wolves are often based on core beliefs, which are resistant to change (Fulton et al. 1996). Therefore, the presentation of information alone is not always effective at influencing personal perceptions and opinions (Meadow et al. 2005). Moreover, individuals tend to selectively accept and recall information that is consistent with their existing attitudes (Olson and Zanna 1993, Petty et al. 1997). Similarly, people may interpret new information in ways that support their existing attitudes (Petty et al. 1997).

Another challenge of a wolf-based education program is to present information that is not biased toward a particular point of view. Fritts et al. (2003) cautioned that "there are important and critical differences between objective wolf education and wolf advocacy or activism." Different groups may find difficulty agreeing on the focus of an education program, or even on the facts to be presented, because ethical and subjective values are often involved. However, the presentation of accurate, unbiased information is especially important when education is used as a tool to help resolve wolf-related conflicts among stakeholders.

A third challenge involves popular presentations of wolf-related issues. Controversy tends to receive attention, and the public may receive imbalanced impressions of the extent of wolf-related conflicts (Mech 1995, Bangs and Fritts 1996). Framing of wolf management issues may also vary with respect to local outlets versus larger, national outlets (Killion et al. 2018). For example, in a content analysis study characterizing media coverage surrounding the 2014 wolf referenda in Michigan, Gore (2016) found that policy frames were focused mostly on "power and control and not wolf biology or management." In addition, media coverage surrounding wolves tends to focus more on the negative impacts of wolves, with coverage generally being one-sided (Niemec et al. 2020; Houston, Bruskotter, and Fan 2010). A challenge for an education program is to achieve a balanced, accurate and objective public perspective that reflects the diversity of positive and negative impacts of wolves.

The following objectives have been identified to help overcome many of the challenges identified above. To the extent the objectives are achieved, public awareness and understanding of wolves and wolf-related issues are expected to increase.

6.1.1 Coordinate with management partners to develop and implement a wolf-based information and education program.

Coordinating an education program in cooperation with management partners (e.g., local, state, federal, and tribal agencies, and private organizations) is the most effective way to overcome many challenges and barriers. Coordination can help identify target audiences, information needs, and the educational approaches that may be most effective. Partnership with multiple organizations and stakeholder groups can also lend credibility to educational materials and help ensure those materials present unbiased, accurate information. A coordinated program that involves the media can foster the presentation of accurate information to broad audiences.

Coordination also facilitates the involvement of partners who possess the expertise and resources necessary to develop and implement an effective program. Therefore, it can accelerate the development and distribution of educational materials that address the specific needs and interests of different target audiences. It can also facilitate the organization of wolf-based events and programs, and thus expand opportunities for people to personally experience and appreciate wolves. In these ways, a coordinated education program can maximize the available tools and opportunities for increasing public awareness and understanding.

Actions:

1. Work with management partners to identify target audiences and information and educational needs.
2. Work with management partners to develop and distribute materials that address the needs and interests of target audiences.
3. Work with management partners to develop and deliver presentations that address the needs and interests of target audiences.
4. Work with management partners to coordinate wolf-based programs and events.
5. Work with media to present accurate information to broad audiences.
6. Invite public and media participation in wolf-related projects.
7. Prioritize supporting efforts of management partners to provide positive wolf-related experiences.

6.1.2 Provide timely and professional responses to information requests.

Providing prompt and professional responses to information requests is one way to increase individual understanding, dispel misconceptions, and generate support for wolf management efforts. A clear process for responding to information requests will facilitate efforts to achieve this objective.

Actions:

1. Increase public awareness regarding where to find and request fact-based information regarding wolves.
2. Refine procedures for responding to a broad range of information requests.
3. Train staff on response procedures.

6.1.3 Support training opportunities for staff and management partners involved in the wolf-based information and education program.

Agencies and other management partners can provide the public with accurate information only to the extent they understand wolf-related issues themselves. Therefore, opportunities for personnel to attend regional wolf research and management meetings and conferences, to participate in training, and to review relevant scientific publications are important for an effective education program.

Actions:

1. Provide staff with the training and information resources necessary for effective participation in the information and education program.
2. Share information with management partners to facilitate understanding of current wolf-related issues.

6.1.4 Evaluate the effectiveness of the wolf-based information and education program.

During recent decades, much attention has been given to wolves through a variety of media. Publication of wolf-related research in scientific literature has become increasingly common (Fritts et al. 2003). Conservation organizations and centers have focused on educating the public about wolves. In addition, numerous websites, books, documentaries, magazines, and other media reports have provided the public with information on wolves. The DNR has engaged and continues to engage in several wolf education and outreach activities (Beyer et al. 2006, MI DNR 2022a).

Despite the great availability of information, the public still holds many misconceptions about wolves. Mertig (2004) found that Michigan survey respondents generally had poor knowledge of wolves, noting that public understanding had not improved significantly during the 12-year period following re-establishment of the wolf population in the UP. The persistence of misconceptions and lack of knowledge in the face of abundant information underscores the need to evaluate the effectiveness of any education program.

Action:

1. Work with partners to develop and implement methods to evaluate the information and education program.

6.2 Maintain Active Research and Monitoring Programs to Support Science-based Wolf Management.

As wide-ranging and often controversial components of a large and complex Great Lakes ecosystem, wolves present many complicated management challenges. As a result, the role of science is especially important in the management of the species. Management decisions can have serious biological and social consequences and are often scrutinized by affected stakeholders. To conduct responsible management and earn credibility among the public, agencies must make decisions that are scientifically defensible.

Wolf management in Michigan has regularly benefited from research and management experience from other parts of the world. However, wildlife managers in Michigan cannot always rely on work conducted elsewhere due to differences among local biological and social

environments. For example, the experiences of managing wolves in Alaska, Canada or Italy are not always readily applicable to Michigan on account of differences in human population density, infrastructure, habitat, wildlife communities, regulations, and public attitudes. In addition, the management environment changes constantly, and scientific information must be regularly updated to reflect current conditions.

In many instances, the 2006 Michigan Wolf Management Roundtable felt the available science was inadequate to guide its recommendations for wolf management. For example, the Roundtable identified needs for more research regarding the interactions between wolves and humans, the dynamics of wolf-ungulate systems, management options to address wolf-related conflicts, and the relationship between wolf population size and wolf-related conflicts. As a result, the Roundtable recommended that the DNR place a high priority on wolf-related research. These research topics have been and continue to be priority research topics since the 2006 Wolf Management Roundtable recommendations (Appendix 1).

The following objectives and actions address the need to maintain active wolf research and monitoring programs in Michigan. These programs will investigate and integrate the biological and social questions associated with wolf management and thus improve the ability of wolf managers to make decisions that are based on sound science.

6.2.1 Monitor the abundance of wolves in Michigan.

To determine whether the population remains viable and above the Federal recovery goal, the USFWS uses data collected by State agencies and other partners to closely evaluate the status of wolves in Michigan. In 1990, the Michigan DNR implemented a winter track survey that produced a minimum population estimate for the UP wolf population. The entire UP was searched each time a survey was conducted from 1990 to 2006. As the number of packs increased and proximity between packs decreased, it became less practicable to search the entire UP during every survey. In 2007, the DNR implemented a geographically stratified sampling system to produce unbiased, precise estimates of wolf abundance (Potvin et al. 2005, T. Drummer, Michigan Technological University, unpublished data). Annual estimates of wolf abundance occurred from 1990 through 2011. In 2011, the DNR determined that biennial abundance estimates were adequate to meet monitoring needs and, in addition, would result in staff time and monetary savings. Following Federal delisting, estimates of wolf abundance facilitate the Fish and Wildlife Service's evaluations of wolves during at least a 5-year period post-delisting monitoring period (U.S. Fish and Wildlife Service 2008). All previous Federal delisting attempts have been withdrawn or vacated after less than five years, but if wolves were to be delisted for longer than five years, the frequency and/or necessary precision of wolf abundance estimates may change depending on the type of management actions implemented and the size of the wolf population.

Wolves have been documented twice in the NLP in recent history; once in Presque Isle County in 2004, and once in Emmet County in 2014. Wolves in the NLP, if present, are at such low densities that it makes the methodology used in the UP winter track survey impractical for

documenting wolf presence in the NLP. Additionally, the discovery of three coyote pups in Cheboygan County in 2010 with evidence of wolf introgression indicates that the DNR should use genetic testing to validate wolf presence until wolves have re-established themselves in the NLP in significant numbers (Wheeldon et al. 2012).

Actions:

1. Estimate wolf abundance biennially for at least 5 years after Federal de-listing.
2. After wolves in Michigan have been Federally de-listed for 5 years, assess the frequency and intensity of wolf abundance monitoring necessary to support the wolf management program.
3. Conduct monitoring to assess wolf presence in the NLP using genetic testing.

6.2.2 Monitor the health of wolves in Michigan.

In Michigan, wolves have been or could be affected by several diseases and parasites (see 6.6 for additional information). Exposure to some diseases and parasites is continuous, and the wolf population has had the opportunity to develop individual or collective immunity to some of the more-common agents over time (Gillespie and Timoney 1981). Other diseases and parasites can be significant sources of mortality for wolves, but they are generally not considered to be limiting at the population level. Although a study in Minnesota provided circumstantial evidence that canine parvovirus may effect rates of wolf population growth and colonization via increased pup mortality (Mech et al. 2008), diseases and parasites are generally not expected to threaten the long-term viability of the wolf population (Kreeger 2003). However, the DNR will continue to monitor their prevalence and impacts on Michigan wolves. Approaches for monitoring wolf health are outlined under 6.6.1.

6.2.3 Investigate biological and social factors relevant to wolf management.

Wolf research has often focused on factors associated with the biological recovery of the species. As a result, many important biological and social questions regarding wolf management after recovery remain unanswered. The Michigan DNR has spent a considerable amount of time and resources investigating these questions in recent years but will need to continue to do so as management context changes over time. An active wolf research program in Michigan should focus on two broad areas: 1) wolf ecology and the biological impacts of specific management approaches; and 2) attitudes of Michigan residents toward wolves and their management.

Actions:

1. Determine wolf population responses to selected management options.
2. Investigate the relationships between wolf and prey populations.

3. Periodically monitor public attitudes towards wolves and investigate factors that influence public tolerance for wolves.
4. Assess public responses to selected wolf management practices (e.g., information and education activities, depredation-control measures).

6.2.4 Coordinate with partners to support a wolf research and monitoring program.

In Michigan, an established network of research partners works in a coordinated manner to investigate questions regarding wolves and their management. Although these partners effectively conduct many types of research, the expertise required to investigate specific questions may sometimes be found in agencies, organizations, and institutions outside the established network. Accordingly, the network will continue to expand to ensure the best possible expertise is applied to research questions. Additionally, wolf monitoring takes a lot of staff time and resources to conduct. The DNR currently collaborates with USDA Wildlife Services to conduct its winter wolf track survey and is currently exploring opportunities to work with tribal wildlife agencies as well. The current population survey methodology is not compatible with the use of volunteers, but the DNR is currently investigating alternative methodologies that may be more compatible.

Coordination with partners to conduct research and monitoring increases the funding and staff that are potentially available to support wolf management. Funding and staff available to the DNR alone are not sufficient to study all the important questions related to wolves. Additionally, aspects of monitoring wolf populations can require significant funding. Thus, collaboration with a greater number of partners could accelerate the rate at which research questions are answered and support wolf monitoring efforts.

Actions:

1. Expand and maintain cooperative relationships with state, federal, and tribal agencies, organizations, and institutions interested in monitoring wolf populations and investigating biological, ecological, and social questions regarding wolves and their management.
2. Where appropriate and compatible with methodologies, the DNR may consider the use of volunteers to monitor wolf populations.
3. Seek funding from additional sources to complement agency contributions to research and monitoring.

6.3 Enact and Enforce Regulations Necessary to Maintain a Viable Wolf Population.

Legal protection under Federal and State regulations was a key component in the biological recovery of wolves in Michigan and other areas of the Midwest. Although protection of Michigan wolves under the Federal Endangered Species Act is no longer warranted (USFWS 2007, 2011), legal protection remains necessary to help ensure the long-term persistence of a viable population. The following objectives focus on providing adequate legal protection, informing the public on regulations, and investigating and penalizing wolf-related violations.

6.3.1 Ensure adequate legal protection for wolves.

Options for general protection of a species under State regulations involve designation as endangered, threatened, game, or protected animals. All of these designations prohibit a person from taking (which includes killing or otherwise harming), selling or purchasing individuals of a designated species, except under permit, license, or certain specified conditions. The NREPA defines each of those designations as follows.

'Endangered species means any species of fish, plant life, or wildlife that is in danger of extinction throughout all or a significant part of its range, other than a species of insecta determined by the [Michigan DNR] or the secretary of the United States [D]epartment of the [I]nterior to constitute a pest whose protection . . . would present an overwhelming and overriding risk to humans.'

'Threatened species means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.'

'Game' is defined as a list of species that currently hold that designation. The definition does not reference permissible and restricted activities associated with such a designation. Game-animal status allows but does not require the establishment of a regulated harvest season.

'Protected animal means an animal or kind of animal designated by the [Michigan DNR] as an animal that shall not be taken.'

Wolves in Michigan have surpassed State and Federal population recovery goals for 22 years, and no longer warrant Threatened or Endangered Status in Michigan. In April 2009, wolves were removed from the State Threatened and Endangered Species list and given protected animal status. On two separate occasions, once in 2012 and once again in 2013, wolves were classified as game animals in Michigan. The laws that allowed these classifications were repealed by public referendum in November of 2014. However, in August of 2014, different citizen-initiated legislation also classified wolves as game animals. Known as the Scientific Fish and Wildlife Conservation Act, this Act was also challenged and overturned by a three-judge

appellate panel in November of 2016. Then in December of 2016, Public Act 382 was signed into law reenacting the Scientific Fish and Wildlife Conservation Act. This legislation added the authority to classify species as game animals to the NRC's already existing authority to decide if a game species will be hunted, and the parameters around a regulated harvest.

Taking into account the current Federal and State legal status, regulations will be reviewed, modified or enacted as necessary to provide the wolf population with appropriate levels of protection.

Actions:

1. Re-classify wolves as endangered or threatened under State regulations if population size declines to 200 or fewer wolves.
2. Review, modify, recommend, and/or enact regulations, as necessary, to ensure appropriate levels of protection for the wolf population.
3. If necessary to avoid a lapse in legal protection, amend the Wildlife Conservation Order to designate wolves as a protected animal.

6.3.2 Inform the public on regulations pertaining to wolves.

The Federal and State legal classifications of wolves have changed several times during the last decade. Wolf legal status may continue to change beyond the finalization of this plan. Frequent regulation changes can create public confusion regarding permissible and prohibited activities. Public education on prevailing regulations could help reduce such confusion and prevent inadvertent violations.

Actions:

1. Provide the public with information on wolf regulations as part of a wolf-based information and education program (see 6.1.1).

6.3.3 Investigate and penalize violations of wolf regulations.

To help deter wolf-related crimes, the DNR will make its best efforts to investigate violations and to pursue the appropriate penalties based on available evidence. Achieving this objective will require an efficient system for receiving and directing reports of violations, clear investigation procedures, and adequate training of staff. It is also important for the DNR to coordinate with other law enforcement agencies to effectively address wolf-related crimes, including at the local, state, and federal level, as well as with tribal conservation enforcement programs.

Actions:

1. Increase public awareness regarding where to report suspected violations of wolf regulations.
2. As necessary, update and refine procedures for investigating violations of wolf regulations.
3. Train field staff on investigation procedures.
4. As appropriate, issue and pursue penalties for violations of wolf regulations.
5. Recommend modification of law, at the State level, to make penalties for illegally killing a wolf commensurate with other highly valued species with similar legal status (endangered, threatened, game, or protected animals).
6. Coordinate with other law enforcement agencies to address wolf-related crimes.

6.4 Maintain Sustainable Populations of Wolf Prey.

Wolves prey on a variety of wildlife species (see 3.7 for additional information), and the importance of particular species as wolf food sources often varies seasonally and geographically (Voigt et al. 1976, Fritts and Mech 1981, Potvin et al. 1988, Fuller 1989, Mech and Peterson 2003, Newsome et al. 2016). In Michigan, the primary prey for wolves during winter is white-tailed deer (Huntzinger et al. 2004 Vucetich et al. 2012; Kautz et al. 2019, 2020; Petroelje et al. 2021), and adequate deer densities are necessary for the long-term persistence of a viable wolf population. Other prey, such as beaver, snowshoe hare and other small animals, are an important complement to deer in the diet of Michigan wolves (Huntzinger et al. 2004, Petroelje et al. 2019).

Many Michigan residents view the natural dynamics of wolf-prey relationships in a positive way (Beyer et al. 2006, MI DNR 2022a). The 2021 public attitude survey evaluated the importance of 10 possible reasons for having wolves in Michigan. One of the proposed reasons was that wolves are an important part of ecosystems. About 70.2% of the general public strongly or moderately agreed that wolves are an important part of ecosystems, with differences reported across regions. UP residents were less likely to agree with this statement (51.9% strongly or moderately agreeing), and SLP residents were mostly likely (75.3% strongly or moderately agreeing)

Despite general appreciation for the ecological role of wolves, some Michigan residents are concerned about the impacts of wolves on populations of deer and other wildlife (Beyer et al. 2006, MI DNR 2022a). Compared to the general public, deer hunters indicated that wolves are a higher risk to populations of white-tailed deer, with 77.3% indicating wolves present a large or moderate risk. In comparison, 66.9% of the general public indicated wolves present a large

or moderate risk to deer. However, differences were reported across regions in the general public survey as well. UP residents assess risk even more seriously than deer hunters, with 83.5% indicating wolves present a large or moderate risk to populations of white-tailed deer.

The following objective addresses the need to ensure the persistence of healthy wildlife populations, especially white-tailed deer, to simultaneously provide for abundant hunting opportunities, and the associated economic activity with hunting-based tourism, and adequate prey for wolves.

6.4.1 Maintain prey populations required to provide for sustainable human uses and a viable wolf population.

Ungulates are the primary prey of wolves (Newsome et al. 2016), and the most common ungulate in Michigan is white-tailed deer (e.g., Kautz et al. 2020). Several studies have estimated the average number of deer killed per year by individual wolves. Some research indicates an individual wolf may kill roughly 15–19 deer per year (Mech 1971, Keith 1983, Fuller 1989), whereas other research indicates a single wolf may kill as many as 37–50 deer per year (Pimlott 1967, Huntzinger et al. 2004). However, these estimates are generally biased because the associated studies were only conducted during winter. Kill rates in winter may not be equivalent to those in other seasons and can vary throughout the winter (e.g., Vucetich et al. 2012) and in response to prey abundance (Zimmerman et al. 2015). Summer kill rates of deer have not been assessed, but information from Michigan suggests other studies may overestimate seasonal average kill rates by 50% (Vucetich et al. 2012). Additional research is necessary to refine estimates of the numbers of deer killed by wolves in Michigan.

In some situations, wolves may significantly reduce local prey populations, whereas in others, the impact may be negligible (Mech and Peterson 2003). The wolf–prey relationship is complex and is influenced by many factors, including the number of prey species in a system, the relative densities of wolves and prey, the responses of both wolves and prey to fluctuations in prey densities, and the effects of environmental influences (e.g., winter severity and disease) on wolves and prey (Vucetich et al. 2002; Mech and Peterson 2003; Sand et al. 2012; Kautz et al. 2019, 2020). Disease (e.g., chronic wasting disease) can also potentially increase prey vulnerability to wolf predation (e.g., Brandell et al. 2022) but this has not been rigorously tested in a wolf-prey system. Each of these factors varies geographically and temporally; thus, there is no general answer to the question of how wolves affect prey densities. Prey and predators coevolved. As a result, prey possesses physical and behavioral adaptations for avoiding predation (Mech and Peterson 2003), the efficacy of such adaptations generally allows prey populations to be sustained, even in areas with robust predator populations.

Moreover, wolf predation may be compensatory to other sources of mortality. In other words, mortality caused by predation may replace mortality that would have otherwise occurred. Evidence that wolves tend to kill weak, sick, or otherwise vulnerable individuals supports the notion that wolf predation is at least partially compensatory (Mech and Frenzel 1971**,** Fritts and Mech 1981, Huntzinger et al. 2004, Kautz et al. 2020), but the extent of such compensation in

wolf-deer systems is unknown. Additional research is necessary to assess the compensatory nature of predator-induced deer mortality in Michigan.

Deer populations in Michigan are managed for a variety of social values including providing an adequate number of deer to meet the demand for recreational hunting. Regardless of whether the average deer kill rate by wolves occurs at or even somewhat above the high end of the existing estimates, the number of deer required on the landscape to meet these societal values means the number of deer has not been, and is not predicted to be, a limiting factor in maintaining a viable wolf population in Michigan. Nor is wolf predation alone expected to significantly reduce the number of deer and other prey available for public harvest or other human uses across the landscape. Furthermore, deer populations in Michigan, and especially the UP, are heavily influenced by the severity of winter weather (Kautz et al. 2020) and there will be times that the number of deer will fluctuate significantly as a result, and wolf numbers are also expected to fluctuate.

Management activities that maintain deer and other prey at numbers similar to those that occurred in the UP during the past decade would continue to sustain opportunities for recreational hunting, and the associated economic activity it provides, while ensuring a prey base that is more than adequate to maintain a viable wolf population. These management activities will be planned and implemented at several geographic scales (e.g., statewide, forest management unit, and deer management unit). In addition, the DNR will work with partners to educate the public about the ecological role of wolves and to further research the dynamics of wolf-prey interactions.

Action:

1. Ensure the management of deer and other prey populations at multiple geographic scales addresses the need to provide sufficient food for wolves.
2. Manage white-tailed deer in a sustainable manner to yield healthy fawns, does, and bucks without negatively impacting habitat, other wildlife species, or creating undue hardship to private interests.
3. Conduct management activities to provide for public harvest of deer and other prey species.
4. Increase understanding of beaver distribution and abundance in the UP and the role they play as prey for wolves.
5. Provide the public with information on wolf-prey interactions and the impacts of wolves on prey populations as part of a wolf-based information and education program (see 6.1.1).
6. Support research to investigate wolf-prey interactions and the impacts of wolves on prey populations (see 6.2.3).

6.5 Maintain Habitat Necessary to Sustain a Viable Wolf Population.

Wolves are habitat generalists and have the potential to occupy habitat-diverse areas with an adequate abundance of hoofed prey (Fuller 1995, Singh and Kamara 2006, Wolf and Ripple 2016, O'Neil 2017, USFWS 2020, Marquard-Petersen, 2021). Given sufficient prey, the chance of an area being occupied and the number of wolves that could occupy the area is related in part to the proximity of source populations and the extent of human-caused mortality (Fuller 1995, Creel and Rotella 2010, Wolf and Ripple 2017) (see 3.9 for additional information).

Road density has been used as an index of wolf-human contact and appears to be related to illegal and accidental killing of wolves (Mladenoff et al. 1995). Using models that incorporated measures of deer density and/or road density, researchers estimated that approximately 11,000 square miles of suitable wolf habitat occurred in the UP (Mladenoff et al. 1995, Potvin et al. 2005) and between 1,600 and 3,000 square miles of suitable habitat occurred in the LP (Gehring and Potter 2005, Potvin 2003). More recent estimates predicted as much as 7,000 square miles of suitable habitat for wolves in the LP (van den Bosch et al. 2022a). Previous estimates were likely conservative given the ability of wolves to exhibit behavioral plasticity and select for areas previously considered unsuitable (Mladenoff et al. 2009).

The current amount of available wolf habitat is expected to be sufficient to allow the long-term persistence of a viable wolf population. Moreover, the amount of suitable habitat is expected to remain adequate into the foreseeable future (van den Bosch et al. 2022b). Based on an assessment of climate and land use changes over the next century, van den Bosch et al. (2022b) predicted Minnesota, Wisconsin, and Michigan would retain or increase suitable habitat for wolves.

To ensure the continued availability of sufficient habitat, management will focus on three areas: 1) maintaining habitat necessary to sustain adequate levels of wolf prey; 2) maintaining wolf habitat linkages; and 3) minimizing disturbance at known active wolf den sites.

6.5.1 Maintain habitat necessary to sustain adequate levels of wolf prey.

As stated previously, prey availability strongly influences the suitability of an area for wolves. Therefore, many wolf habitat needs will be met through the maintenance of habitat for sufficient levels of wolf prey, primarily white-tailed deer. Approaches for managing prey populations are outlined in Objective 6.4.

6.5.2 Maintain habitat linkages to allow wolf dispersal.

Wolf recovery in the UP began with immigration of wolves from Minnesota, Wisconsin, and Ontario (Thiel 1988, Mech et al. 1995). Migration and gene flow among these areas helps to preserve or enhance genetic diversity within populations and to mitigate the detrimental effects of random demographic fluctuations and environmental catastrophes (Simberloff and

Cox 1987, Boitani 2000). Thus, continued movement of wolves within and among jurisdictions is important for the long-term viability of the wolf population (e.g., Beyer et al. 2006).

Wolves are effective dispersers (Forbes and Boyd 1997, Boyd and Pletscher 1999, Treves et al. 2009, Jiminez et al. 2017, Moralez-González et al. 2022), and existing habitat linkages among the UP, Wisconsin and Minnesota appear to be adequate to allow long-distance movements (van den Bosch et al. 2022a). Since the early 1990s, movements of numerous wolves between the UP and either Minnesota or Wisconsin have been documented (Mech et al. 1995, Michigan DNR, unpublished data). In addition, there is evidence that wolves have moved between the eastern UP and Canada (Jensen et al. 1986, Thiel and Hammill 1988, Michigan DNR unpublished data).

The types of landscape features that represent barriers to wolf movements are poorly understood. Long-distance movements of wolves through human-dominated landscapes in Minnesota and Wisconsin suggest highways and roads are not barriers (Mech et al. 1995, Merrill and Mech 2000, Kohn et al. 2009). However, wolf survival declines overall with longer-distance dispersals (Moralez-González et al. 2022). Wolves are capable of traveling through crop and range land (Licht and Fritts 1994, Wydeven et al. 1998). They can also cross ice-covered lakes and rivers (Mech 1966, Orning et al. 2020) as well as unfrozen rivers during the summer (Van Camp and Gluckie 1979). However, a series of linear obstacles, such as a river flanked by roads, railways, and disturbed habitat, may act synergistically and be more of a barrier to wolf movements (Blanco et al. 2005). Further, areas of greater human activities can also limit wolf movements and dispersal (Moralez-González et. al. 2022, van den Bosch et al. 2022a). Jensen et al. (1986) suggested areas of human settlement along the St. Mary's River were barriers to dispersing wolves, but some wolves have been able to pass through or around those areas (Mech et al. 1995).

Although few natural or artificial landscape features may absolutely prevent wolf dispersal, maintenance of habitat linkages across the landscape may facilitate regular exchange of individuals and genetic material among areas. The amount and distribution of government-controlled wild lands in Minnesota, Wisconsin, Michigan and Ontario suggest habitat linkages in the region can be effectively conserved (van den Bosch et al. 2022a).

Action:

1. Prioritize cooperation with federal, state, and tribal agencies and private landowners to identify and protect wolf habitat linkage zones.

6.5.3 Minimize disturbance at known active wolf den sites.

Wolves dig or otherwise establish sheltered dens to provide early protection for young pups. Early studies (Joslin 1967, Stephenson 1974, Allen 1979) suggested human disturbance can cause den abandonment or movements to new dens. Wydeven and Schultz (1993)

documented possible abandonment of dens in Wisconsin as a result of nearby road construction and logging activity. However, some wolves have been tolerant of human disturbances, even denning near logging sites, open-pit mines, garbage dumps, moss harvesters, and military firing ranges (Thiel et al. 1998).

The 1997 *Michigan Gray Wolf Recovery and Management Plan* recommended the seasonal protection of den sites. However, den sites are dynamic, often changing from year to year and even during the same year (Mech and Boitani 2003). As a result, the detection of these areas is difficult, and only a small percentage of den sites have been identified in any given year. Although identified den sites have been protected during active use, most sites were not identified and did not receive active protection. The general lack of protection at most sites did not appear to hinder the recovery of the wolf population, and disturbance at den sites is not considered to be a significant threat.

The DNR does not plan to conduct systematic searches for wolf den sites. However, it will minimize management-related disturbance near active den sites (i.e., sites currently used by wolf pups) that are identified on the land it manages. The agency will also work with management partners to help minimize disturbance near sites on other properties.

Actions:

1. Consider known active den sites during compartment reviews and other DNR management efforts.
2. Minimize management-related disturbance near known active den sites on land managed by the DNR.
3. Work with management partners to help minimize disturbance near known active den sites on other properties.

6.6 Monitor and Manage Adverse Effects of Diseases and Parasites on the Viability of the Wolf Population.

Michigan wolves have been or could be affected by a variety of diseases, including those caused by viruses (e.g., canine distemper, canine parvovirus, rabies), bacteria (e.g., Lyme disease, leptospirosis, tularemia) and fungi (e.g., blastomycosis), as well as both internal (e.g., canine heartworm and intestinal worms of various species, echinococcosis) and external (e.g., sarcoptic mange, lice, ticks) parasites.

Given their taxonomic and physiologic similarities, wolves and domestic dogs are susceptible to many of the same diseases. Moreover, in all but the most-remote areas of Michigan, wolves face virtually continuous exposure to some of these diseases (e.g., distemper, parvovirus) which cycle through the dog population. Others are enzootic in the wolf population itself (e.g., sarcoptic mange, echinococcosis), in prey (e.g., tularemia), or in the environment (e.g.,

Blastomyces). Consequently, the wolf population has had the opportunity to develop individual and collective immunity to some of the more-common agents over time, which in some cases can be lifelong and conferred to offspring through maternal antibodies (Gillespie and Timoney 1981). Although these established diseases can be significant sources of mortality for wolves, they are generally not considered to be limiting at the population level. Despite evidence of ubiquitous exposure, affected wolf populations demonstrate good recruitment, suggesting long-term stability of a robust Michigan population is likely to remain unaltered by these diseases (Kreeger 2003).

The following objectives and actions focus on monitoring the prevalence and effects of wolf diseases and parasites and on assessing the most-appropriate approach for managing their impacts.

6.6.1 Monitor the health of wolves in Michigan.

Wolf health will be monitored through necropsies of dead wolves and analysis of biological samples from captured live wolves. Necropsies provide information on condition, age, reproductive status, food habits, and cause of death, as well as the geographic distribution and prevalence of diseases and parasites. Analysis of biological samples such as blood, feces, and skin scrapings provide similar information on diseases and parasites. The DNR will continue to conduct these analyses at its Wildlife Disease Laboratory. In addition, the DNR will collaborate with researchers interested in studying wolf diseases and parasites.

Actions:

1. As necessary, update and refine procedures for collecting, submitting, and storing information on carcasses and biological samples.
2. Train field staff on collection and submission procedures.
3. Conduct necropsies and analyses of dead wolves and biological samples, respectively.
4. Work with management partners to develop and conduct studies of wolf diseases and parasites.

6.6.2 Assess the need to manage diseases and parasites in the wolf population.

In most cases, treatment of diseases and parasites in free-ranging wolves is not practical. Prior to 2004, wolves captured in Michigan for research purposes were administered vaccinations for canine distemper and parvovirus and were treated for sarcoptic mange. These procedures may have reduced the amount of natural mortality that would have otherwise occurred in the Michigan sample (although objective assessment of any such effect was essentially impossible). Discontinuing vaccination and treatment as part of handling procedures has eliminated this source of bias and has recently allowed more-accurate estimations of natural mortality.

At present, diseases and parasites do not pose a significant threat to the Michigan wolf population. Except for euthanizing wolves observed to be suffering from serious detrimental effects of infection, active management of diseases and parasites in the wolf population is not currently warranted or recommended. Thus, vaccinations are not expected to resume. However, if wolf-health monitoring indicates that diseases and parasites someday pose a significant threat to the wolf population, managers will evaluate options for more-active management.

6.7 Achieve Compatibility between Wolf Distribution and Abundance and Public Preferences.

A principal goal of this plan is to maintain a viable Michigan wolf population above a level that would warrant its classification as threatened or endangered. Therefore, the Michigan wolf population must exceed criteria that have been used to define biological recovery (USFWS 1992, MI DNR 1997). However, the minimum requirement to preclude listing is not necessarily sufficient to provide all the ecological and social benefits valued by the public. Accordingly, management will be conducted to maintain the wolf population above the minimum size requirement and facilitate those wolf-related benefits while minimizing and resolving conflicts where they occur. This plan does not identify a target population size, nor does it establish an upper limit for the number of wolves in the State. As a result, public preferences regarding levels of positive and negative wolf-human interactions will strongly influence the extent to which wolf abundance and distribution exceed the minimum requirements for a viable population.

The attitudes and actions of society historically influenced the abundance and distribution of wolves on the landscape (Mech 1970, Beaufort 1987, Thiel 1993). Indeed, public intolerance of wolves led to the virtual extirpation of the species from the State. During recent decades, policies that reflected significant increases in public support for wolves facilitated the recovery of the Michigan population. Public attitudes still have the power to influence wolf population levels. People can take measures to either sustain or threaten the population. These measures can be direct (e.g., maintenance of adequate prey, illegal killing) or indirect (e.g., litigation, legislation).

The effects from wildlife-human interactions or management actions that are prioritized by the public can also be thought of as *impacts* (Riley et al., 2003). Impacts are about more than a position relative to a particular management action, and often reflect an underlying interest that may derive from a person's identity or values. For example, a livestock producer may fear wolf depredation on their sheep, which is an impact, but reflects an underlying interest in sustaining their livelihood. A livestock producer may subsequently support lethal control efforts for wolves, which is a position reflective of their interests and associated wolf-related impacts. Understanding the diversity of impacts around a given wildlife issue can help ensure management is reflective of public needs, interest, and concerns. Riley et al. (2003) defines

wildlife management as the guidance of "decision-making processes and implementation of practices to purposefully influence interactions among and between people, wildlife and habitats to achieve impacts valued by stakeholders" (p. 586). As Decker et al. (2009) write, wildlife management "…is not a value-free technical process dictated by biological or social science," it is about managing impacts the public cares about (p. 324). This adaptive approach to wildlife management requires defining objectives that address a diversity of citizen-defined impacts, which may be ecological, cultural, health and safety, psychological, social, or economic. Adaptive impact management also requires tracking progress towards management objectives, engaging in continual learning, and modifying management actions accordingly (Decker et al. 2014).

Effective adaptive impact management also requires an understanding of the socio-political factors or constraints that create the context for decision making. Goals for wolf management are often determined within a social context where stakeholder values and priorities must be addressed. Wolf management is contentious, as different publics, holding distinct wildlife value orientations, often disagree on acceptable management activities (Dietsch et al. 2018, Lute et al. 2014). Wildlife value orientations refer to patterns in beliefs, derived from ideologies that give meaning to values and influence attitudes and behaviors towards wildlife (Manfredo et al. 2004). People can be sorted according to a spectrum from a domination (or utilitarian) value orientation (wildlife should be used to benefit humans) to mutualist value orientation (wildlife should have rights like humans) to wildlife. While historically domination was the main value orientation in the US, we have witnessed an increasing trend towards mutualism, a trend likely related to several factors such as urbanization, demographic changes, changes in our relationship to wildlife, and overall less contact with wildlife (Manfredo et al. 2004, Patterson et al. 2003). Understanding value orientations is important because they can be predictors of attitudes towards management activities. With respect to wolves, research has shown that social or stakeholder identity can influence perceived impacts of wolves, which can influence attitudes towards various management activities (Bruskotter et al. 2009, Lute and Gore 2014). Different stakeholder groups also may vary in their wildlife value orientations, which may reflect underlying ideological conflict relative to wolf management and decision making (Manfredo et al. 2017, Schroeder et al. 2021).

Results of public surveys, anecdotal conversations with stakeholders, and other forms of public participation indicate many Michigan residents perceive risks from wolves that include a reduction in deer distribution or abundance, safety of livestock or humans, and effects on the general way of life in some areas of Michigan, especially the Upper Peninsula. Nevertheless, many Michigan residents also greatly value the presence of wolves for the role they play in ecosystem functioning, recreational or aesthetic benefits, and existence values now and in the future.

Survey-respondent preferences regarding the levels of wolves within each region varied according to region of residence and stakeholder group (MI DNR 2022a). For example, the preferred level of wolves in both the UP and NLP was highest among residents of the SLP and lowest among UP residents. Only an estimated 15.3% of UP residents expressed desire for an

increase in wolf abundance while the percentage of residents in the NLP and SLP who desire an increase are 46.0% and 56.6% respectively. Statewide, the estimated percentage of people who desire a reduced wolf population was 24.0% while 49.9% desire an increase. Compared to non-hunters, hunters tended to be less tolerant of wolves. As a group, livestock producers were less tolerant of wolves than was the general public.

Given the disagreement in preferences among different segments of the public, the following objectives were designed to help achieve compatibility between wolf abundance and distribution and public preferences.

6.7.1 Promote consistent public understanding and appreciation of the benefits and costs associated with particular levels of wolf abundance.

People can hold preferences and tolerances regarding wolf abundance and distribution without a complete understanding of all the relevant issues. For example, a person who is not willing to tolerate any wolves on the landscape may not be aware of the benefits wolves provide to many residents. Intolerance can also be affected by the perception of the problems wolves cause, regardless of the accuracy of those perceptions. Conversely, a person who demands the highest number of wolves the available habitat can support may hold inaccurate beliefs regarding the costs and risks such a level would impose on certain members of society. In fact, tolerance of wolves may be influenced by perceived risks, which may or may not align with actual risks. Affect or emotion is also a strong driver of tolerance of wolves, and in some studies has been shown to be a stronger driver than cognitions or beliefs (Jacobs et al. 2014, Slage et al. 2012). In addition, tolerance may be affected more strongly by perceived benefits of wolf populations, influenced in part by trust in the managing agency (Ghasemi et al. 2021, Slage et al. 2022). Finally, the degree of control that individuals may sense relative to mitigating the risk of wolves may also influence tolerance (Bruskotter and Wilson 2014). However, communication and messaging that focuses solely on mitigating risks may reduce tolerance (Bruskotter & Wilson 2014).

Public education, coupled with effective public engagement process aimed at fostering social trust, could help foster a realistic understanding of the positive and negative consequences associated with varying levels of wolf abundance. This education could allow some Michigan residents to place a higher value on wolves, alleviate concerns held by some Michigan residents, and thus increase general tolerance for the wolf population, especially if focused on emphasizing benefits of having wolves present and increasing behavioral control over risks (Sponarski et al. 2016). It could also help other residents understand the real costs and risks associated with wolves and help them appreciate the potential adverse consequences of particular levels of wolf abundance for affected residents.

To some extent, personal preferences and tolerances will continue to reflect personal values, which are resistant to change (Fulton et al. 1996). However, education efforts may encourage attitude shifts that are based on consistent, accurate information and are designed in a manner that is responsive to underlying value orientations and perceived risks towards wolves.

Actions:

1. Increase public awareness regarding where to obtain information on the consequences of particular levels of wolf abundance.
2. Provide the public with accurate information on the benefits and costs associated with particular levels of wolf abundance as part of a wolf-based information and education program (see 6.1.1).

6.7.2 Manage wolf-related interactions to increase public tolerance for wolves.

Social tolerance for a population of any large predator depends on the benefits attributed to the population, confidence that conflicts will be resolved effectively, and trust in the managing agency (Slovic 1987, Frost 1985, Wolstenholme 1996, Beyer et al. 2006, Bruskotter and Wilson 2014). Therefore, facilitation of wolf-related benefits and effective conflict resolution could do more than serve the interests of Michigan residents. Those actions could also reduce levels of intolerance among some stakeholders by addressing the impacts that some stakeholders experience and value.

Section 5.2 describes the many types of benefits people can derive from the presence of wolves. In brief, many of these benefits fall within five general categories: 1) ecology, as wolves fill an important ecological niche and improve ecosystem function; 2) cultural and religious values, as people derive spiritual satisfaction or fulfillment from the presence of wolves; 3) interaction with nature, as the presence of wolves provides unique opportunities to interact with, study, and appreciate a particular component of the natural world; 4) personal appreciation, as people may value the knowledge that wolves exist ; and 5) tourism and recreation, as the presence of wolves could draw a greater number of people to local communities and provide recreational opportunity. The approaches that will be used to foster these types of wolf-related benefits are outlined under 6.8 and 6.12.

Conflicts associated with wolves can involve human-safety concerns regarding the presence of wolves near residential or recreational areas, depredation of domestic animals, and concerns regarding the impact wolves may be having on populations of other wildlife species. The approaches that will be used to manage specific types of wolf-related conflicts are outlined under 6.9, 6.10, 6.11 and 6.12.

6.7.3 Manage wolf distribution and abundance as necessary to maintain positive and negative wolf-related interactions at socially responsible levels.

As stated previously (see 5.3.2), broadly based abundance and distribution goals may not be necessary or effective for managing most negative wolf-related interactions. Wolf-related conflicts in local areas are often caused by the behavior of a few individual wolves, and management at small scales can often address problems effectively. Accordingly, management

of wolf-human conflicts under this plan will be conducted at the level of individual wolves or packs to the extent that it is expected to be effective and logistically feasible.

Some situations may warrant consideration of reducing wolf numbers in localized areas to reduce the risk of negative interactions. Such consideration could be necessary if a high density of wolves in an area, rather than the behavior of individual wolves, was determined to be responsible for problems that could not otherwise be addressed through non-lethal or individually directed lethal methods.

Many Michigan residents would support local reduction of wolf numbers if it would reduce human health and safety impacts caused by wolves (Beyer et al. 2006, MI DNR 2022a). The results of the most recent public-attitude survey indicate that the percentage of residents that support reducing the wolf population is highest with regard to human safety concerns (52.1%); for all other impacts acceptability of reducing the size of the wolf population was below 50%. Forty percent expressed some acceptability of population reduction in response to livestock depredation; 32.6% with regard to hunting dog depredation; and 36.2% in regard to pet depredation (MI DNR 2022a).

The severity, immediacy and frequency of conflicts will determine whether active management of wolf abundance or distribution in local areas is necessary. More conservative management methods will be applied when the risk of problems is relatively small and non-immediate, whereas increasingly aggressive methods may be applied as the severity, immediacy and frequency of problems increase.

According to the results of the most recent public-attitude survey, the public generally desires some presence of wolves in the NLP (MI DNR 2022a). Indeed, an estimated 66.0% of residents would find wolves establishing a population in the NLP to be at least somewhat acceptable, with little difference between residents from the UP and NLP.

Wolves will not be prevented from colonizing the LP. However, their presence in that area is not necessary to maintain a viable population in Michigan. Additionally, if a wolf population becomes established in the LP, the higher density of human residences and livestock operations in that area relative to the UP (see 6.10 for additional information) would create a higher potential for wolf-related conflicts. The severity, immediacy and frequency of conflicts would guide management responses in the LP, but given the preceding considerations, relatively aggressive responses may be warranted in many cases.

The presence of wolves in the LP would be unlikely to: 1) exacerbate the prevalence of tuberculosis in the deer herd, 2) spread the disease geographically, or 3) increase the risk of tuberculosis transmission to cattle. Indeed, the presence of a natural predator might be expected to reduce tuberculosis prevalence in the deer herd; by preying upon individuals weakened by tuberculosis, a predator would remove the deer most likely to spread the disease. Although all mammals, including wolves and other canids, can be infected with bovine tuberculosis in certain circumstances, canids are generally resistant to infection. Moreover,

there is no evidence that wolves or other wild canids transmit the disease to each other or to other species. In Canada, where tuberculosis is present in free-ranging bison (*Bison bison*) in Wood Buffalo National Park and in free-ranging elk in Riding Mountain National Park, there is no evidence that the wolf populations in those areas have contributed to the spread of the disease (Carbyn 1982, Tessaro 1986).

Actions:

1. Effectively manage wolf-related conflicts at the smallest possible scale.
2. Allow wolves to colonize and remain in the LP to the extent that the accompanying negative interactions can be managed at socially responsible levels.
3. Evaluate the outcomes of active management on wolf abundance and distribution.

6.8 Facilitate Positive Wolf-Human Interactions and Other Wolf-Related Benefits.

A principal goal of this plan states the need to facilitate wolf-related benefits. Those benefits serve the interests of affected stakeholders, and they foster the public support that is necessary for the long-term viability of the wolf population (USFWS 1992, Wisconsin DNR 1999, Bangs et al. 1995, Minnesota DNR 2001, Boitani 2003, Fritts et al. 2003). Many Michigan residents value the diverse benefits derived from the presence of wolves (Beyer et al. 2006, Lute et al. 2012, MI DNR 2022a). Many of those benefits fall within five general categories: ecology, cultural and religious values, interaction with nature, personal appreciation, and tourism and recreation. For more information on the wide range of benefits provided by a viable wolf population, see 5.2.

The cultural values and religious beliefs regarding wolves can be very diverse. Wolves can play major or minor roles or be viewed positively or negatively within particular cultures and religions. As only one example among many different perspectives, the cultural and religious values regarding wolves are particularly important to many Native Americans. To help illustrate those values held by many Native Americans in Michigan, the representatives of the Chippewa Ottawa Resource Authority and the Great Lakes Indian Fish and Wildlife Commission on the 2006 Michigan Wolf Management Roundtable provided the following account of the story of Maahiingun and Nanaboozhoo:

> *"Nanaboozhoo, (half man/half spirit) was placed on the Earth at the beginning of time and given instructions by Gzhemnidoo (The Creator) and told to walk the Earth to name the plants, animals, insects and the entirety of everything that comprised the world of his time.*

"Throughout his travels, Nanaboozhoo began to notice that the animals he was tasked to name came in pairs and also had the ability to repopulate their species. Seeing the various animal families throughout all of creation, Nanaboozhoo became lonely and so he spoke of his feelings to Gzhemnidoo and asked "Why is there no other like me?" Gzhemnidoo answered, "I will bring you someone to walk, talk and play with" and in his infinite wisdom, Gzhemnidoo sent Maahiingun (the wolf) to be with Nanaboozhoo and together they set out to complete the task that Gzhemnidoo had asked.

"In their journey, they became very close to each other, like brothers. It was through this closeness that they soon came to realize that they were also brothers to all of Creation.

"Once they had finally completed the task that Gzhemnidoo asked of them, they talked with the Creator once again. Gzhemnidoo was pleased with what he heard but this time Creator curiously replied, "From this day on, you are to separate and go different ways. What happens to one of you will also happen to the other. You will be feared by some, respected by others, but misunderstood by all of the people who will come to inhabit these lands."

"Reluctantly, Maahiingun and Nanaboozhoo set off on their different journeys. Their shared sadness is evident by Maahiingun's cry that can still be heard wherever the wolf still roams the Earth on his separate journey.

"The teachings of Nanaboozhoo and Maahiingun serve as an important reminder for Indian People to this day. All of what Gzhemnidoo said to Nanaboozhoo and Maahiingun has come true. Indian and Maahiingun have come to experience the same things, both good and bad, that life has to offer. Both take a mate for life, have a Clan System, and also are part of a Tribe. Both have been stripped of their land and hunted for their skin. Both have been pushed to the brink of extinction yet somehow miraculously survive to this day.

"It is our belief as Indian people that our ability to foretell our future is evident by looking at the wolf, who remains one of the most significant cultural indicators to our continued existence."

The following objectives focus on increasing public awareness regarding the benefits provided by wolves, ensuring an adequate distribution and abundance of wolves, and providing specific opportunities for people to experience and appreciate wolves.

6.8.1 Inform the public on benefits derived from the presence of wolves.

The benefits of wolves may not be apparent to many Michigan residents. Public education and outreach could help residents understand and appreciate those benefits.

Action:

1. Prioritize providing the public with information on the benefits of wolves as part of a wolf-based information and education program (see 6.1.1).

6.8.2 Maintain a distribution and abundance of wolves adequate to provide benefits at publicly responsible levels.

The size of some benefits depends on the abundance and distribution of wolves on the landscape. For example, an informed individual can derive personal satisfaction from the presence of a healthy wolf population only if such a population actually exists.

Maintenance of a viable wolf population will allow the level of positive wolf-related interactions desired and appreciated by many Michigan residents (MI DNR 2022a). As suggested by the most recent public-attitude survey, when presented with scenarios of varying populations of wolves, ranging from no wolves to the greatest number of wolves that can be sustained, the most acceptable scenario to most people is a moderate number of wolves. However, some people prefer higher levels of interactions than others, and some people prefer the level of interactions associated with the largest number of wolves the available habitat can sustain (MI DNR 2022a).

Both positive and negative interactions can increase as wolf abundance or distribution expands. Although some individuals may prefer the level of benefits associated with a maximum level of wolves, the corresponding level of negative interactions may not be responsible when considering the impacts to other segments of society. Therefore, wolf-related benefits will be maximized to the extent that the accompanying levels of negative interactions can be managed effectively.

Actions:

1. Facilitate the ecological, cultural, economic, and personal benefits derived from the presence of wolves by maintaining a viable wolf population.
2. Facilitate the maximum level of positive wolf-related interactions that is possible while maintaining negative interactions at publicly responsible levels.

6.8.3 Promote opportunities for people to experience and appreciate wolves.

Wolf-based programs and events can increase opportunities for people to appreciate the benefits of wolves. Such programs and events can provide participants with positive, unique experiences, increase public knowledge of the positive values of wolves, and generate support for the wolf population.

Actions:

1. Work with management partners to coordinate wolf-based programs and events.
2. When prudent, invite public and media participation in wolf-related projects.
3. Support efforts of management partners to provide positive wolf-related experiences.

6.9 Manage Actual and Perceived Threats to Human Safety Posed by Wolves.

Most Michigan residents place a high priority on wolf management that addresses public concerns for human safety (Beyer et al. 2006, MI DNR 2022a). Eighty-seven percent of interested respondents to the previous public-attitude survey indicated human-safety issues should be an important factor when considering whether to reduce the number of wolves in a particular area (Beyer et al. 2006). In the most recent survey, an estimated 64.0% of residents would support some type of active wolf management to address human-safety risks posed by wolves (MI DNR 2022a).

The following objectives for the management of human-safety issues fall into three general categories. The first category focuses on educating the public on the actual safety risks posed by wolves and ways to reduce those risks. The second category focuses on managing the factors that influence the probability of wolf-related problems, including rabies and habituation of wolves to humans. The third category focuses on eliminating actual safety threats.

6.9.1 Promote accurate public perceptions of the human-safety risks posed by wolves.

Most wildlife has the potential to be dangerous to humans in certain situations. In most cases, people can take simple, sensible measures to avoid those situations and protect themselves against harm. Other cases may warrant higher levels of concern and professional assistance. Accurate perceptions of the human-safety risks posed by wildlife can facilitate appropriate levels of concern and responses to specific situations.

Segments of the public can overestimate or underestimate the actual human-safety risks posed by wolves. Some people may feel the mere presence of a wolf population poses a serious safety threat, whereas others may not recognize that wolves could be dangerous to people in certain situations. Perceptions and attitudes regarding safety risks can vary by geographic region and stakeholder group (MI DNR 2022a). For example, the most-recent public-attitude study showed that residents in the SLP perceived a higher degree of risk of wolves to human safety than did residents in the UP. Compared to the general public, livestock producers as a group were more concerned about wolf-related safety risks (MI DNR 2022a).

In Michigan, wolves are not likely to attack any person who does not deliberately invite aggression (i.e., by provoking or feeding wolves). As of this writing, a wolf attack on a human has never been documented in Michigan. However, wolves have attacked people in other areas of North America (McNay 2002a, b; Linnell et al. 2021), and concerns for public safety are warranted in some situations. Regardless of the extent to which wolves pose a threat to human safety, anxieties over a perceived threat can impact the quality of life of affected residents as well as public tolerance for the wolf population.

Public education may help foster a realistic understanding of the human-safety risks associated with Michigan wolves. Education aimed at addressing perceived risks should seek to enhance positive beliefs about wolves through not only dispelling inaccuracies but including messages regarding how individuals can address conflict (Vaske 2021, Sponarski et al. 2016). This education could help alleviate concerns held by some Michigan residents, and thus increase general tolerance, if not support, for the wolf population. It could also help other residents understand that some wolf-related human-safety concerns are legitimate, and thus help them appreciate the consequences of those concerns for affected residents.

Actions:

1. Increase public awareness regarding where to obtain information on wolf-related threats to human safety.
2. Provide the public with accurate and relatable information on the human-safety risks posed by wolves as part of a wolf-based information and education program (see 6.1.1).
3. Provide prompt responses to requests for information regarding wolves and human safety.

6.9.2 Provide timely and professional responses to reports of human-safety risks posed by wolves.

The protection of human safety is a top priority, and the DNR, USDA Wildlife Services, and other management partners will make their best efforts to respond to reports of habituated, sick, or injured wolves in a timely and professional manner. Achieving this objective will require an efficient system for receiving and directing reports, clear investigation procedures, and adequate training of staff.

Actions:

1. Increase public awareness regarding where to report wolf-related threats to human safety.

2. As necessary, update and refine procedures for the investigation of reported threats to human safety.
3. Train field staff on investigation procedures.

6.9.3 Minimize the incidence of rabies in wild and domestic populations.

Worldwide, most documented wolf attacks on humans during the past century involved rabid wolves. For example, from 1900 through 2002, rabid wolves were involved in more than 80% of documented attacks in Europe and 70% of documented attacks in areas of Asia (Linnell et al. 2002, U.S. National Park Service 2003).

The role of rabies in wolf attacks has been smaller in North America than in other parts of the world. In a summary of wolf attacks in Canada and Alaska since 1900, McNay (2002a, b) reported that only 12 of 80 (15%) reviewed attacks involved rabid wolves. This comparatively low incidence may reflect the implementation of programs designed to minimize the incidence of rabies in domestic and wild animals (Centers for Disease Control and Prevention 1999,2008; USDA Wildlife Services 2002). Rabies has not been documented in Michigan wolves, and the potential for the disease to affect wolves in the State is small.

Actions:

1. Support programs to assess and minimize the incidence of rabies in wild and domestic animal populations.
2. Euthanize wolves and other animals suspected to be infected with rabies.

6.9.4 Promote accurate public perceptions of the human-safety risks posed by echinococcosis

Echinococcus spp. is a tapeworm which parasitizes wild carnivores, particularly members of the canid family, in its adult form. However, its life cycle has intermediate hosts such as livestock, wildlife species and on rare occasion, humans. In Michigan there are two species of *Echinococcus* (*E. granulosus* and *E. multilocularis*) which can be found in coyotes, fox, and wolves (Storandt and Kazacos 1995, Eckert et al. 2000, Michigan DNR, unpublished data).

This parasite can cause a life threating disease in humans known as cystic or alveolar echinococcosis (Pawłowski et al. 2001). People at a higher risk include trappers, biologists, veterinarians, or others who have contact with wild canids and are exposed to *Echinococcus* spp. eggs by "hand-to-mouth" transfer. Fortunately, in North America the transmission of wild strains of *Echinococcus* spp. to humans has been very low (Rausch 2003, Foreyt 2009). Since the 1980s, in the lower 48 states reports on the presence and prevalence of *Echinococcus* spp. tapeworms in domestic and wild animals has also been low (Cerda et al. 2018).

Actions:

1. Work with management partners and the media to provide accurate information on the risks of echinococcosis to humans.
2. Monitoring the prevalence of *Echinococcus* spp. in Michigan's wild canids.

6.9.5 Prevent or minimize the habituation of wolves.

The most important factor contributing to wolf attacks in Canada and Alaska appears to be habituation to humans. Of the 80 wolf attacks reviewed by McNay (2002 a, b), 29 cases (36%) involved habituated wolves. Linnell et al. (2021) summarized additional wolf attacks in North America. During this period, two people died (one each from the US and Canada) and seven people were injured (two from the US and five from Canada) (Linnell et al. 2021). One of the human fatalities and six of the seven human injuries involved habituated wolves (Linnell et al. 2021). Wolves can become habituated and lose their fear of humans by having frequent and increasingly closer contact with humans, and by receiving food rewards for their boldness.

Several human behaviors can attract wolves and contribute to habituation. Directly feeding wolves is the most obvious way to cause habituation. Drawing deer into residential areas by feeding them also can attract wolves and other predators. Feeding pets outside and leaving pets outside unattended also may attract wolves. Avoiding these behaviors can reduce the chance a wolf will become habituated and lose its fear of humans.

In addition to avoiding the behaviors listed above, people can take other, active measures to prevent wolf habituation. Wolves can be deterred by strange odors, sights, or sounds (USDA 2002), and devices designed to scare wolves may help prevent problems. Some examples of scare devices include lighting systems, sirens and other noisemaking devices, flagging (fladry), and movement-activated guard devices (MI DNR 2022a).

Public education on ways to avoid attracting wolves and technical assistance on the appropriate use of scare devices may help prevent the habituation of wolves and help reduce associated risks to human safety.

Actions:

1. Provide the public with information on ways to help prevent wolf habituation as part of a wolf-based information and education program (see 6.1.1).
2. Provide property owners and residents with technical assistance on methods to help prevent wolf habituation.

3. As warranted, recommend modifications in law, policy or enforcement that could more-effectively discourage human activities that lead to the habituation of wolves.

6.9.6 Eliminate actual human-safety threats where they occur.

A habituated, sick, or injured wolf in or near areas of human activity can represent an actual threat to human safety. Where actual threats are identified, the DNR, USDA Wildlife Services and other management partners will take the steps necessary to eliminate those threats (MI DNR 2022b).

The severity, immediacy and frequency of safety threats will guide management responses. More-conservative management methods will be applied when the risk of physical harm to humans is relatively small and non-immediate, whereas increasingly aggressive methods may be applied as the severity, immediacy or frequency of threats increase (MI DNR 2022b).

This strategy places a high priority on developing, evaluating, and applying non-lethal management methods to reduce human-safety threats. Non-lethal methods will be applied wherever they are expected to be effective and where the severity and immediacy of a threat do not warrant more aggressive action. Non-lethal methods can include elimination of wolf attractants, use of scare devices, and aversive conditioning. Aversive conditioning involves a stimulus (e.g., rubber bullets) that causes discomfort, pain, or an otherwise negative experience without permanently injuring or killing a wolf.

To the extent non-lethal methods are effective at eliminating actual threats to human safety, lethal control of wolves will not be necessary. However, when such practices prove to be ineffective, are not expected to be effective, or are infeasible, lethal control may be necessary to prevent problems. Reserving lethal control as a management option allows the potential use of all the tools that might be required to help ensure the protection of human safety. Results of the most-recent public-attitude survey indicate that an estimated 78.0% of Michigan residents believe that wolves pose at least some risk to the personal safety of themselves or other people. When asked about the acceptability of various management actions in the event a wolf attacked a human, 64.0% indicated that lethal control was somewhat, moderately, or highly acceptable, with a third of respondents indicating it was a highly acceptable action. The DNR and its management partners will apply lethal control methods as necessary to eliminate demonstrable threats to human safety.

Additionally, current regulations (*Public Act 451, Part 365, Section 324.36505 (5)*) allow a person to remove, capture or kill a wolf when it poses an immediate threat to human life, and they require reporting of any such action to the USFWS within five days. A situation of this type has not occurred in Michigan, nor is one expected. However, the Department would like to maintain the 24-hour reporting provision, that was required when the wolf was State listed as endangered, regardless of the future legal classification of wolves. A 24-hour reporting

requirement would allow the DNR and its management partners to investigate and document such an incident in a timely manner.

Relocation of wolves is often proposed by the public as a method to reduce wolf-related conflicts. However, eliminating a threat to human safety through wolf relocation is not reasonably possible. Data from radio-collared wolves indicate relocated wolves rarely settle in the areas where they are released and relocated wolves may return to their original territories (Michigan DNR, unpublished data). Even if habituated wolves were relocated and did not return to the areas of capture, they would still be fearless of humans and would probably continue to cause human-safety threats elsewhere. Relocating wolves is problematic for additional reasons. Given the current widespread distribution of wolves across the UP, unoccupied, suitable release areas are no longer available, and any relocated wolves may be killed by resident packs. Also, residents have expressed opposition to the release of wolves near their communities.

Actions:

1. Remove habituated wolves that present a threat to human safety.
2. Support the development, evaluation, and appropriate use of non-lethal and lethal management methods to reduce human-safety threats.
3. As necessary, update and refine management responses according to the severity, immediacy, and frequency of human-safety threats.
4. Train field staff on response procedures.
5. Develop regulations to require individuals who capture, remove, or kill a wolf in response to a human-safety threat, to report the incident to the DNR within 24 hours, regardless of legal status.

6.10 Manage Wolf Depredation of Domestic Animals.

A depredation event occurs when a predator kills or injures one or more animals at a given time. Wolves normally select wild ungulates including deer (*Odocoileus* spp.) and elk, and secondarily smaller prey such as beaver, but sometimes kill or injure domestic animals (Newsome et al. 2016). Although its frequency is currently lower in Michigan than in Minnesota or Wisconsin, wolf depredation of domestic animals is an important management issue in Michigan.

In the United States, farmers and ranchers as an overall group still hold strong negative views of wolves (Fuller et al. 2003, Nie 2003). Indeed, the most-recent Michigan public-attitude study indicated that livestock producers were less supportive of having wolves in the State than was the general public. Whereas 80.2% of the general public are estimated to strongly, moderately, or somewhat agree that wolves have an inherent right to exist, 55.0% of livestock producer

survey respondents indicated such agreement. Whereas only an estimated 24.0% of the general public desire a decrease in the wolf population in the next five years, 63.1% of livestock producers desire a decrease. These results indicate a strong need to address livestock producer concerns and thus foster greater tolerance for wolves. Without relief from depredation problems, intolerant stakeholders may adopt indiscriminate anti-wolf behaviors that could have adverse impacts on the population (Fuller et al. 2003). For example, a study in Wisconsin found that illegal killing of radio-collared wolves increased during periods when the state did not have authority to use lethal control (Olson et al. 2014). This study suggests that a depredation management program may reduce illegal killing.

More than 1,000 livestock farms (cattle, sheep, and goats) occur in the UP (USDA 2017). From 1998 through 2021, the DNR and USDA Wildlife Services verified 320 wolf-livestock depredation events on 105 (10%) of those farms. However, the previous public-attitude study found that 31% of interested livestock producers in the UP suspected wolves had been responsible for recent livestock losses on their farms in at least 1 out of 5 years (Beyer et al. 2006). Prior to 2016, there was an association between verified wolf livestock depredation events and wolf abundance (Edge et al. 2011; Michigan DNR, unpublished data). However, the distribution of farms and associated livestock depredations are not uniform across the UP and are likely influenced more by the behavior of a small number of individual wolves or packs than by wolf population size.

There are approximately 2,100 livestock farms that occur in the northernmost 21 counties of the LP (USDA 2017). There is an average of one farm per 5.4 square miles in this area versus an average of one farm per 15.7 square miles in the UP. To date, no wolf depredation events have been verified in the LP. However, if a wolf population becomes established in the NLP, the higher density of livestock farms in this region suggests the number of wolf depredations could be higher than what has been experienced in the UP.

In addition to livestock, wolves sometimes attack domestic dogs. These attacks may be caused by inter-specific aggression or by perception of dogs as potential prey (Fritts and Paul 1989). Between 1996 and 2021, the DNR and USDA Wildlife Services verified 94 wolf depredation events on domestic dogs in Michigan. Sixty-four percent of those attacks involved hunting hounds (i.e., for pursuit of black bear (*Ursus americanus*), bobcat (*Lynx rufus*) and snowshoe hare) in the field. In addition, some dogs were attacked in close proximity to their owners' residences.

Many Michigan residents place a high priority on wolf management that addresses depredation of domestic animals (Beyer et al. 2006). Eighty-four percent of interested respondents to the previous public-attitude survey indicated that "the number of farm animals actually lost to wolves" should be an important factor when considering whether to reduce the number of wolves in a particular area (Beyer et al. 2006). Sixty-one percent and 85% of interested survey respondents, respectively, indicated that "the number of hunting dogs lost to wolves in the field" and "the number of pets actually attacked by wolves near the pets' homes" should be 'somewhat' or 'very' important factors in a decision to reduce wolf numbers in a particular

area. Results of the most-recent public-attitude survey indicate that an estimated 35.1% of Michigan residents support lethal control to address wolf depredation of livestock, 24.2% support lethal control to address wolf depredation on hunting dogs; and 34.6% support lethal control to address wolf depredation on pets. This reflects a shift from the 2005 public attitudes survey, where 75% of interested respondents supported some form of lethal control to address wolf depredation of domestic animals. Note, these questions were asked differently on the 2005 and 2021 survey; the 2021 survey asked respondents to identify whether a particular management action was somewhat, moderately, or highly acceptable or unacceptable. For the 2021 survey, which we derive from weighted and imputed data, we characterize support as a response of somewhat, moderately, or highly acceptable. The 2005 survey asked respondents to identify whether they strongly or somewhat support or oppose a particular management action.

The following objectives for the management of depredation of domestic animals fall into three general categories. The first category focuses on educating the public and providing technical assistance on ways to reduce the risk of wolf depredation. The second category focuses on managing ongoing depredation problems. The third category focuses on compensation for losses of livestock caused by wolves.

As a document that offers guidance at the strategic level, this plan does not describe the operational methods of preventing and eliminating wolf depredation problems. A description of those methods can be found in our nuisance wolf management and depredation guideline documents which are updated as regulations, technology, and other aspects of management context change (MI DNR 2022b, 2022c).

6.10.1 Provide timely and professional responses to reports of suspected wolf depredation of domestic animals.

The causes of depredation are not always apparent and other causes of death or injury can often be mistaken for wolf depredation. For example, from 2003-2021, coyotes caused 40% of verified livestock depredation events in the UP. At times, livestock producers suspect a wolf has killed livestock, but after investigation its determined that the animal was stillborn, killed by a different predator, killed by something other than a predator, or the cause of death cannot be determined (B. Roell, Michigan DNR, personal communication).

Given multiple potential causes and the need to assess the available evidence, professional investigation of a depredation event is necessary to determine whether a wolf caused it. On-site investigations also provide responding agencies with opportunities to provide affected stakeholders with information and technical assistance that may help them reduce future depredations.

To the extent possible, the DNR, USDA Wildlife Services, and other management partners will respond to reports of suspected wolf depredation in a timely and professional manner.

Achieving this objective will require an efficient system for receiving and directing reports, clear investigation procedures, and adequate training of staff.

Actions:

1. Increase public awareness regarding where to report wolf depredation of domestic animals, the need to report depredation events rapidly, and how to preserve evidence at depredation sites.
2. As necessary, update and refine procedures for the investigation of suspected wolf depredation of domestic animals.
3. Train field staff on investigation procedures, methods to reduce depredation risk, and laws regarding carcass disposal.

6.10.2 Minimize the risk of wolf depredation of domestic animals.

Certain human behaviors and practices can attract wolves and thus increase the risk of depredation of domestic animals. Directly feeding wolves is the most obvious way to invite depredation problems. Baiting and feeding other wildlife can attract and concentrate natural prey and thus attract wolves and other predators. Feeding pets outside and leaving pets outside unattended also may attract wolves. Avoiding these behaviors and practices can help reduce the risk of depredation.

In addition to avoiding the behaviors and practices describe above, livestock producers can help prevent depredation of livestock through certain animal husbandry practices. For example, prompt and proper disposal of livestock carcasses may eliminate attractants that could draw wolves to particular farms (Petroelje et al. 2019). Barrier fencing, monitoring, and pasturing of livestock based on their vulnerability, lighting systems, sirens and other noisemaking devices, flagging (fladry), movement-activated guard devices, and livestock-guarding animals are a few of the other tools and techniques that may help reduce the risk of depredation of livestock (MI DNR 2022a).

There is an inherent risk to dogs allowed to range in areas frequented by wolves, but individuals who hunt with dogs can take measures to reduce the risk of an attack on their animals (Wisconsin DNR 2004, MI DNR 2022a). Avoiding specific areas that are currently being used by wolves or where problems have occurred previously may be the most effective way to reduce the risk of a wolf-dog conflict. The DNR will provide information on its website (www.michigan.gov/wolves) and at local DNR offices to help hunters identify and avoid areas of probable or previous conflicts. Staying close to dogs, using collars with bells or beepers, and avoiding bait sites recently visited by wolves are other techniques that may reduce the chance of a wolf attack on a hunting dog.

The DNR cannot compel residents to adopt any of the practices or techniques described above. However, public education, information sharing, and technical assistance could provide valuable information, encourage the use of beneficial practices and techniques, and thus help reduce the risk of wolf depredation of domestic animals.

Actions:

1. Provide the public with information on ways to help reduce the risks of wolf depredation as part of a wolf-based information and education program (see 6.1.1).
2. Provide livestock producers, individuals who hunt with dogs, property owners, and other residents with technical assistance on methods to help prevent or minimize wolf depredation.
3. Share information on areas of probable or previous conflicts between wolves and dogs and advise avoidance of those areas.
4. As warranted, recommend modifications in law, policy, or enforcement that could more effectively discourage human activities that increase the risk of wolf depredation.
5. As warranted, recommend modifications in law, policy, enforcement, or practice that could reduce wolf visitation to bear bait sites.

6.10.3 Eliminate or minimize ongoing wolf depredation of domestic animals.

Many techniques can effectively prevent or deter depredation. However, the effectiveness of some techniques may be temporary, and some techniques may fail to work altogether in certain situations. Where depredation occurs despite reasonable efforts to prevent it, the DNR, USDA Wildlife Services and other management partners will take appropriate steps to eliminate or minimize ongoing problems.

The severity, immediacy and frequency of depredation problems will guide management responses. More conservative management methods will be applied when the risk of depredation is relatively small and non-immediate, whereas increasingly aggressive methods may be applied as the severity, immediacy, and frequency of problems increase (MI DNR 2022c).

This strategy places a high priority on developing, evaluating, and applying non-lethal management methods to reduce depredation problems. Non-lethal methods will be applied wherever they are expected to be effective and where the severity and immediacy of a problem do not warrant more aggressive action. Non-lethal methods can include the elimination of wolf attractants, the use of improved husbandry practices and scare devices (see 6.10.2), as well as aversive conditioning. Aversive conditioning involves a stimulus (e.g., rubber bullets) that

causes discomfort, pain, or an otherwise negative experience without permanently injuring or killing a wolf.

To the extent non-lethal methods are effective at eliminating or minimizing depredation problems, lethal control of wolves will not be necessary. However, when such practices prove to be ineffective, are not expected to be effective, or are infeasible, lethal control may be necessary to prevent problems. Reserving lethal control as a management option allows the potential use of all the tools that might be required to help prevent depredation problems. Results of the most-recent public-attitude survey indicate that an estimated 35.1% of Michigan residents support lethal control to address wolf depredation of livestock, 24.2% support lethal control to address wolf depredation on hunting dogs; and 34.6% support lethal control to address wolf depredation on pets (MI DNR 2022a). This reflects a shift from the 2005 public attitudes survey, where 75% of interested respondents supported some form of lethal control to address wolf depredation of domestic animals (Beyer et al. 2006). Note, these questions were asked differently on the 2005 and 2021 survey; the 2021 survey asked respondents to identify whether a particular management action was somewhat, moderately, or highly acceptable or unacceptable. For the 2021 survey, which we derive from weighted and imputed data, we characterize support as a response of somewhat, moderately, or highly acceptable. The 2005 survey asked respondents to identify whether they strongly or somewhat support or oppose a particular management action.

Patterns in responses varied markedly by stakeholder group and by region; a greater proportion of residents in the Upper Peninsula were supportive of lethal control, with 60.2% expressing support in the event of wolf depredation on livestock. In addition, the perspective of those directly impacted by depredation differs dramatically from the general public. Seventy-seven percent of fur harvesters who responded to the 2021 survey expressed support for lethal control in the event of wolf depredation on pets and 64.7% expressed support for lethal control to address wolf depredation on a hunting dog. Similar patterns hold for livestock producers, with 76.1% of respondents to the 2021 survey expressing support for lethal control to address wolf depredation on livestock.

In 2008, Public Acts 290 and 318 were passed into law. These Acts allow anyone under certain circumstances to use lethal control on wolves when they are in the act of preying upon livestock or domestic dogs when wolves are not listed as a Federally endangered species (MI DNR 2022e). Lethal control will be a management option in situations where loss of livestock has been documented or where a wolf is in the act of depredating livestock; it will not be used as a preventative measure in areas where livestock depredation has not yet occurred. Similarly, lethal control will be a management option in specific areas where wolf attacks on free-ranging hunting dogs have been documented, but it will not be used as a preventative measure where attacks have not yet occurred. In addition, lethal control will be a management option in specific areas where wolf attacks on dogs and other pets have occurred near human residences.

Relocation of wolves is often proposed by the public as a method to reduce wolf-related conflicts. However, reducing depredation problems through relocation has become

increasingly problematic and is no longer recommended as a management tool in Michigan. Data from radio-collared wolves indicate relocated wolves rarely settle in the areas where they are released and relocated wolves may return to their original territories (Michigan DNR, unpublished data). Even if depredating wolves were relocated and did not return to the areas of capture, they may cause depredation problems elsewhere.

Actions:

1. Provide for the selective lethal removal of wolves that are a threat to livestock or other private property.
2. Support the development, evaluation, and appropriate use of non-lethal and lethal management methods to prevent or minimize wolf depredation of domestic animals.
3. As necessary, update, and refine management responses according to the severity, immediacy, and frequency of depredation problems.
4. Train field staff on depredation response procedures.

6.10.4 Develop a program to allow livestock producers to control depredating wolves on their property.

The level of personal control with regard to depredation problems appears to be the most-important factor that influences livestock-producer tolerance for wolves (Beyer et al. 2006). Eighty-five percent of interested livestock producers surveyed in 2005 indicated that being prevented from controlling or removing wolves that posed a threat to their livestock had 'greatly decreased' their willingness to have wolves in their farming area. Seventy-eight percent of surveyed livestock producers indicated they would be 'very' or 'somewhat' satisfied with a management program that, among other things, empowered them to remove problem wolves from their own property. By contrast, only 20% of respondents indicated they would be 'very' or 'somewhat' satisfied with a management program that lacked such a provision. When surveyed again in 2021, 76.1% of livestock producer respondents expressed support for lethal control to address wolf depredation on livestock (MI DNR 2022a).

Given this information, a carefully regulated program that allows livestock producers to control depredating wolves would address a major concern of livestock producers (MI DNR 2022a). At the same time, it could assist efforts to maintain a viable wolf population. Although such a program could cause the deaths of a small number of wolves, it could help prevent an increase in the prevalence and intensity of the negative attitudes that led historically to widespread indiscriminate killing by intolerant stakeholders. Indeed, a program that allowed responsible and effective personal control could allow livestock producers to tolerate a greater abundance and distribution of wolves on the landscape.

Personal control of depredating wolves by livestock producers could involve non-lethal (see 6.10.3) and lethal methods. Lethal control would not be authorized when problems could be addressed through other, non-lethal methods. However, a livestock producer could be authorized to kill problem wolves when reasonable efforts to deter depredation have failed or when other feasible options are unavailable. Only the minimum level of lethal control necessary to resolve an ongoing depredation problem would be authorized (MI DNR 2022d).

Any program allowing personal control of depredating wolves by livestock producers would be administered to ensure it does not have adverse consequences for the long-term viability of the wolf population. Monitoring, reporting, and enforcement would be conducted to help ensure compliance with program requirements.

Actions:

1. Develop a permitting process to allow livestock producers to control wolves on their property, as necessary, following a verified wolf depredation event.
2. Develop a system to allow livestock owners to kill wolves in the act of livestock depredation.
3. Monitor and enforce compliance with program requirements.

6.10.5 Facilitate financial compensation for livestock losses caused by wolves.

In the United States and other countries, compensation programs have been designed to assist livestock producers by reimbursing them for losses attributable to wolves, with the intention of increasing overall public acceptance for wolf populations (Fritts et al. 2003). An expectation that compensation will increase tolerance for wolves is often based on an assumption that livestock producers primarily perceive wolf depredation as an economic problem. Recent research has shown that other, non-economic factors more strongly influence livestock producer attitudes toward wolves, and that compensation programs have not substantially improved tolerance among this group (Naughton-Treves et al. 2003, R. B. Peyton, MSU, personal communication).

Current Michigan law requires the State to compensate livestock owners for livestock killed by wolves, regardless of the extent to which efforts have been made to reduce depredation risks. The Michigan Animal Industry Act (Public Act 466 of 1988) defines livestock as "those species of animals used for human food and fiber or those species of animals used for service to humans. Livestock includes, but is not limited to, cattle, sheep, new world camelids, goats, bison, privately owned cervids, ratites, swine, equine, poultry, aquaculture, and rabbits. Livestock does not include dogs and cats." The Michigan Wildlife Depredations Indemnification Act (Public Act 487 of 2012) provides payment to livestock owners, but it may do so only if the DNR or its designated agent (USDA Wildlife Services) verifies the depredation was caused by wolves, coyotes, or cougars (*Puma concolor*) or is a missing animal claim.

Currently, compensation payments shall be made for each animal included in the claim at 100% of the fair market value not to exceed $4,000.00 for each animal. Funding for this program shall be from the MDARD budget, unless otherwise determined by statute or the appropriations process. If DNR funds are appropriated or otherwise authorized for reimbursement, the DNR funds shall not be used for reimbursement for missing animals. Reimbursement for missing animals from farms with previous verified wolf depredation was authorized in 2013. Funding for depredation payments and missing animal claims has changed over time, currently it is covered under a general fund appropriation. Through the end of 2021, the State paid $156,852 and Defenders of Wildlife paid $10,053 to compensate for wolf-related livestock losses in Michigan. Funding for the supplemental payments from Defenders of Wildlife ended in 2010. Missing livestock claims accounted for another $31,388 in payments.

Livestock producers in Michigan strongly desire financial compensation as part of a depredation management program, and they overwhelmingly support the use of tax dollars for this purpose (MI DNR 2022a). Seventy-three percent of livestock producers who responded to the most recent public-attitude survey expressed support for the use of tax dollars to compensate livestock owners who experience depredation by wolves. Results of the most recent survey also indicate that an estimated half (48.5%) of residents find the use of tax dollars as compensation for lost livestock to be somewhat, moderately, or highly acceptable (MI DNR 2022a).

Current Michigan law does not require or allow the State to compensate owners for dogs killed by wolves. The lack of State compensation for wolf depredation of dogs is consistent with the public preference on this issue (MI DNR 2022a). Opposition (60.7% indicating this response was at least somewhat unacceptable) was greater than support (24.3% indicating this response was at least somewhat acceptable) for the use of tax dollars to compensate for hunting dogs lost to wolves. Patterns in responses for the use of tax dollars to compensate for other pets were virtually identical; opposition (54.0% indicating this response was at least somewhat unacceptable) was greater than support (28.5% indicating this response was at least somewhat acceptable) for the use of tax dollars to compensate for pets lost to wolves.

Actions:

1. Investigate the causes of depredation to facilitate compensation to livestock producers for livestock losses caused by wolves.

6.10.6 Work with partners to reduce the likelihood of privately owned cervids lost to wolves.

Cervids (i.e., deer, elk, and other members of the Cervidae family) are the natural prey of wolves. Enclosures that contain privately owned cervids, often at unnaturally high densities, are expected to attract wolves. A wolf that gains entry to such an enclosure would be expected to exhibit natural predatory behavior.

The public generally does not support compensation for privately owned cervids lost to wolf depredation (Beyer et al. 2006). Thirty-three percent and 45% of interested respondents to the 2005 public-attitude survey respectively supported and opposed the use of tax dollars for that purpose. The 2021 survey did not ask about compensation for privately own cervids lost to wolf depredation, and instead asked about compensation for livestock owners, specifying livestock as "cattle, sheep, goats, or poultry." However, privately owned cervids are defined as livestock under the Michigan Animal Industry Act (Public Act 466 of 1988) and current Michigan law requires the State to provide compensation for livestock lost to wolves. Results of the most-recent public-attitude survey indicate that an estimated half (48.5%) of residents are accepting of the use of tax dollars to compensate livestock owners who have lost livestock to wolf depredation.

Actions:

1. Work with partners and the privately owned cervid industry to develop voluntary standards to reduce the likelihood of wolves getting into enclosures.

6.11 Minimize the Negative Impacts of Captive Wolves and Wolf-Dog Hybrids.

Captive wolves and wolf-dog hybrids that are released or escape pose a threat to both people and the wild wolf population. These animals could pose risks to human safety, cause adverse biological impacts, and reduce social acceptance for the wild population because the public is unlikely to distinguish between problems caused by released captive or hybrid wolves and those caused by wild wolves. The following objectives focus on reducing the risks posed by these animals.

6.11.1 Minimize and deter the possession of captive wolves in Michigan.

Well-designed wolf exhibits at zoos open to the public may serve an educational function, but possession of captive wolves by private individuals will not help save the species in the wild, regardless of intentions. Conservation of the species is better achieved through management of the wild population rather than efforts to save or breed individual animals. Given the risks posed by captive wolves, minimizing their possession in Michigan will help protect human safety and the wild wolf population.

The capture of wild wolves for possession in captivity is illegal in Michigan (Wildlife Conservation Order 1989). However, regulations in place as of this writing do not prohibit the importation and possession of wolves that were legally obtained in other states and countries. The Department is not the regulatory agency that permits the possession of captive wolves (Captive Game Order 1990) In some cases, captive wolves may be possessed by licensed and accredited zoological facilities. These organizations are typically regulated by the Michigan Department of Agriculture and Rural Development and U.S. Department of Agriculture. In

addition, amendment of the Michigan Large Carnivore Act (Public Act 274 of 2000) to include wolves would provide expanded regulatory opportunities regarding the possession of wolves in captivity. This regulatory authority could be described to mirror the language applied to members of the Felidae family, therefore including wolves whether wild or captive bred, including a hybrid cross. The administering agency for the Large Carnivore Act is the Michigan Department of Agriculture and Rural Development.

When a severely injured wolf (e.g., hit by a vehicle) is encountered, euthanizing the animal is often more humane and prudent than subjecting it to long-term captive treatment and rehabilitation. Severe injuries often result in permanent damage to an animal, making it unfit for release into the wild. Captivity is a traumatic experience for any wild animal, and whether a wolf would be readily accepted into a pack after extended confinement is unknown. The DNR does not advocate rehabilitation of sick or injured wolves.

Actions:

1. Support prohibitions and penalties associated with the possession of wolves in captivity, except under permit, as outlined in the Michigan Wildlife Conservation Order.
2. Prioritize supporting the inclusion of wolves as animals covered by the Michigan Large Carnivore Act.

6.11.2 Minimize and deter the possession of wolf-dog hybrids in Michigan.

Wolf-dog hybrids are produced when a wolf interbreeds with a domestic dog or another wolf-dog hybrid. Ownership and proliferation of these animals in Michigan could threaten public safety. Most wolf-dog hybrids are poorly adapted as pets and are difficult to train (Jenkins 1991, Warrick 1991, Sikarskie 1993). Hybrids are frequently destructive of their owners' property, attack people and domestic animals, and are generally too wary of people to be effective guard animals. In one instance in the UP, wolf-dog hybrids killed the pet dog of their owner and bit another person. Those animals were subsequently killed for rabies testing, but other hybrids have either escaped or been released by their owners into the wild (B. Roell, Michigan DNR, personal communication).

Ownership and proliferation of wolf-dog hybrids could also threaten the viability of the Michigan wolf population in multiple ways. First, escaped or released hybrids may breed with wild wolves and thereby introduce dog genes into the wolf population. The DNR has documented the assimilation of at least one hybrid wolf into a pack of wild wolves in the UP (B. Roell, Michigan DNR, personal communication). This behavior can jeopardize the genetic integrity of the population and cause population-wide changes in morphological and behavioral characteristics. Second, a desire to breed and raise wolf hybrids may prompt some people to capture wild Michigan wolves illegally. Third, problems caused by released or escaped hybrids

are often incorrectly attributed to wolves and thus reduce social acceptance for a wolf population.

The Michigan Wolf-Dog Cross Act (Public Act 246 of 2000) currently prohibits the ownership and possession of wolf-dog hybrids, except under permit. Maintaining the prohibitions and penalties under that law would help deter possession of hybrids and thus reduce the risks associated with them.

In many cases, wolf-dog hybrids can be difficult to identify. Although the DNR does not have regulatory authority for the management of such animals, it can offer expertise to other agencies, law-enforcement officials, and local animal-control agents for the purpose of identifying and managing hybrids.

Actions:

1. Support prohibitions and penalties associated with the possession of wolf-dog hybrids, as outlined under the Michigan Wolf-Dog Cross Act.
2. Train staff on the identification of wolf-dog hybrids.
3. Assist other agencies, law-enforcement officials, and local animal-control agents in efforts to identify and manage wolf-dog hybrids.

6.12 Develop Socially and Biologically Responsible Management Recommendations Regarding Public Harvest of Wolves.

Harvest (i.e., hunting and trapping) of wolves by the public is both: a potentially important tool to reduce conflict from, and realize benefits of, a healthy wolf population; and a controversial issue that often polarizes stakeholder groups. Indeed, "the issue of hunting and trapping wolves—a public take—is only possible after they become Federally delisted and is perhaps the most divisive and potentially explosive issue in the entire wolf debate" (Nie 2003). Public harvest of wolves is also biologically complex. The effects of harvest on a wolf population are determined by a suite of factors, including population size, age and sex structure, immigration and emigration rates, birth rates, and natural and human-induced mortality rates (MI DNR 2022a).

For a public wolf harvest to occur, wolves must be Federally delisted and classified as game animals in Michigan. Due to a February 2022 court order, wolves are once again protected under the Endangered Species Act as endangered in Michigan. Public Act 382 of 2016 reenacted the Scientific Fish and Wildlife Conservation Act which had previously been overturned by a three-judge appellate panel. This Act classifies wolves as game animals and delegates the NRC the authority to classify species as game animals. In addition, the NRC can authorize a harvest season. With wolves classified as game animals, the Michigan NRC has the exclusive authority to enact regulations pertaining to the methods and manner of public

harvest. Although authority regarding establishment of a harvest season lies with the NRC, this strategy offers relevant guidance to make socially and biologically responsible recommendations to the NRC regarding the public harvest of wolves. Additionally, the State of Michigan will engage all federally recognized Tribal governments in Michigan, as well as provide Consultation with those Tribes in the 1836 Treaty Ceded Territory that are party to the 2007 Inland Consent Decree, prior to any potential wolf harvest. Stakeholder input will also be considered when any potential public harvest is evaluated.

The following objectives separate the issue of a public wolf harvest into two categories. The first category deals with harvest that addresses a need to reduce wolf-related conflicts. Wolf-related conflicts include depredation and other nuisance behaviors. The second category deals with harvest for reasons other than managing wolf-related conflicts, which would be forms of recreational harvest. There are various reasons why people harvest wildlife recreationally (e.g., nature appreciation, meeting utilitarian needs [e.g., fur, meat], spending time with friends and family, harvesting a unique animal, supporting DNR objectives, improving or testing skills and abilities, etc.) (Manfredo, Driver and Tarrant 1996; Siemer, Decker and Stedman 2012). Recreational harvest is a catchall term for all those different reasons. However, public support for a harvest is often found to differ according to the primary purposes (Decker et al. 2015; Manfredo et al. 1999; Riley et al. 2022).

6.12.1 Develop recommendations regarding public wolf harvest for the purpose of managing wolf-related conflicts.

Wolf-related conflicts are generally associated with livestock or hunting dog depredation. However, conflicts such as pet depredation, human safety issues, limiting wild ungulate abundance, and other nuisance behaviors are also forms of wolf-related conflicts. Wolf-related conflicts with livestock, hunting dogs, pets and human safety are often caused by the behavior of a few individual wolves, and localized management can often address problems effectively. To the extent that it is expected to be effective and logistically feasible, conflict management under this plan will be conducted at the level of individual wolves or packs. Currently, the best available science does not suggest or support that wolves are negatively limiting ungulate abundance in the U.P. (Kautz et al. 2019, Kautz et al. 2020, Sitar and Roell 2021).

If it is determined that the number of conflicts are correlated to wolf abundance, or the spatial extent of the conflicts indicate it involves multiple pack territories, it may warrant the consideration of reducing wolf numbers in areas that span multiple pack territories to reduce the risk of future conflicts. Such consideration could be necessary if a high density of wolves in an area, rather than the behavior of individual wolves, is determined to be responsible for problems that could not otherwise be addressed through non-lethal or individually directed lethal methods.

Michigan residents may support reduction of wolf numbers in localized areas if it reduces certain problems caused by wolves (MI DNR 2022a). The extent of public support appears to depend on the nature of the problem to be addressed. The most recent public-attitude survey

presented five scenarios of increasing expected intensity of human-wolf interactions and asked about the acceptability of six management actions, also of varying intensity: (1) a wolf seen in residential areas; (2) a wolf killing someone's pet; (3) a wolf killing a free-ranging hunting dog; (4) a wolf killing livestock; and (5) a wolf attacking a human. The management options offered were to: (1) do nothing; (2) monitor the situation; (3) frighten the wolf; (4) capture and move the wolf; (5) kill the wolf; (6) reduce the size of the population; and in the livestock depredation scenario, use tax dollars to compensate the producers. The only interaction that elicited acceptability for lethal control (i.e., reducing the population or killing the responsible wolf) by most respondents was the fifth scenario, a wolf attacking a human. For this scenario, 64.0% indicated killing the wolf is at least somewhat acceptable and 52.1% indicated reducing the size of the wolf population is at least somewhat acceptable. Passive management, or a "do nothing" alternative was the least acceptable action for all five scenarios.

Current public attitudes also vary according to the management technique applied. If one or more wolves had to be removed from an area for some reason, the most acceptable method among four choices was "provide a limited number of permits to licensed hunters to shoot wolves during a controlled hunt" (68.3% statewide indicated that this option was at least somewhat acceptable). This method of removal was favored more strongly in the UP (76.7%) than the SLP (66.6%). The least acceptable means of removal was to "kill wolves that are trapped by trained, paid professionals" state-wide and among all regions, with only 34.8% indicating this was at least somewhat acceptable.

The efficacy of using licensed hunters and trappers to reduce local wolf numbers would depend on the behavioral and reproductive responses of wolves and the method and manner of take. Wolves are prolific and can also quickly re-colonize areas through immigration (Fuller et al. 2003). As a result, wolf populations can remain stable or increase despite relatively high mortality rates (Fuller 1989, Mech 2001, Adams et al. 2008, Creel and Rotella 2010). Recent public wolf harvests in Alaska, Canada and other parts of the world did not cause long-term reductions in wolf populations (Boitani 2003, MI DNR 2022a); however, population reduction was not necessarily a goal of those harvests. Where efforts to reduce wolf population sizes have been successful, the methods that were used (poisoning, bounties, gas, smoke, explosives, baited hooks, aerial shooting and unregulated harvest) are generally considered to be politically and socially unacceptable (National Research Council 1997, Boitani 2003). Public harvest with those methods should not be authorized in Michigan. Any legal public harvest in Michigan should be conducted with socially responsible and biologically sustainable methods.

This strategy provides the option to evaluate and apply, as appropriate, the use of hunters and trappers as a management tool for addressing conflicts that cannot otherwise be resolved. There is scientific uncertainty relative to the use of wolf harvest as a conflict management tool because most wildlife managers do not have experience with this approach for wolves. However, there are examples where human-wildlife conflicts have been directly reduced by decreasing population density via hunting (see citations in MDNR 2022a). There is also a growing body of evidence that animal behavior is influenced by the perception of the risk of predation (e.g., Lima and Bednekoff 1999, Ferrari et al. 2009).

This strategy recommends evaluating local situations on a case-by-case basis, and then applying the assistance of hunters and trappers, as prudent, to reduce wolf-related risks to responsible levels. If such action is deemed necessary, it will be planned based on the best available research and its effects will be evaluated to ensure it does not threaten the long-term viability of the Michigan wolf population.

Actions:

1. Evaluate conflict situations to determine whether localized reduction of wolf numbers is necessary to manage wolf-related conflicts.
2. Evaluate the potential impacts of using licensed hunters and trappers to manage local levels of wolf-related conflicts on the local and regional wolf population.
3. If prudent, develop recommendations to the NRC to recruit and use licensed hunters and trappers to manage levels of wolf-related conflicts at the appropriate scale.

6.12.2 Develop recommendations regarding public wolf harvest for reasons other than managing wolf-related conflicts.

Although the public generally supports the use of licensed hunters and trappers to reduce wolf-related conflicts, it is more ambivalent on the issue of a public wolf harvest specifically for recreational purposes (MI DNR 2022a). Many species of wildlife in Michigan are sustainably harvested for reasons other than conflict management (as defined previously; recreational opportunity) (e.g., ruffed grouse, snowshoe hare, North American river otter (*Lontra canadensis*), bobcat, red fox). Recreational harvest of wolves is a controversial issue that is often socially complex. It is also biologically complex; the amount of harvest a wolf population can sustain is determined by many factors. However, there is adequate peer-reviewed scientific literature and examples of successful implementation to sustainably harvest wolf populations (see citations in MDNR 2022a). Results of the most recent public-attitudes survey indicate that approximately half (49.2%) of residents statewide support a legal, recreational hunting season for wolves, if biologists and the DNR believed the wolf population could sustain it, with 30.4% opposed. Residents were more likely to oppose (42.6%) a recreational trapping season than support it (36.0%). When those that responded that a hunting or trapping season was unacceptable were asked to identify reasons that influenced their beliefs, 82% agreed with the statement “I do not support hunting wolves if the purpose is for recreation” and 73% agreed with the statement “I do not support trapping wolves if the purpose is for recreation.”

Although members of the 2006 Michigan Wolf Management Roundtable reached consensus on every other issue, they did not come to agreement on whether a regulated wolf harvest season should be provided in the absence of any need to reduce wolf-related conflicts. Some Roundtable members supported such a hunting and trapping season because many Michigan

residents would place an important value on and derive benefits from the opportunity to harvest wolves. Other members opposed a hunting and trapping season in the absence of a specific need to reduce local wolf abundance because it would conflict with the cultural and personal values of many other Michigan residents. After substantial deliberation, the group concluded consensus on any guiding principles regarding the issue was not possible because the disagreement focused primarily on important differences in fundamental values. These same fundamental value differences were found in the 2021/22 Wolf Management Advisory Council.

A meta-analysis of wolf population growth rates in North America suggested that rates of human-caused mortality (including harvest) less than 29% did not importantly influence growth rates (Adams et al. 2008). In the event a public wolf harvest is authorized in Michigan, the effects of particular levels of take on the wolf population would depend on a variety of factors, including local conditions and population characteristics. Analyses of those factors would be important for the regulation of a sustainable harvest that does not threaten population viability.

Given the continued legal battle to remove wolves from the Federal List of Endangered Species, an absence of a strong public preference, the lack of specific guidance from the 2006 Michigan Wolf Management Roundtable, and the need to assess the biological effects of different levels of take, the following actions focus on the need to gather and evaluate biological and social information regarding a wolf harvest for recreational purposes.

Actions:

1. Evaluate the potential biological effects of a public wolf harvest specifically for recreational purposes.
2. Evaluate the demand for, and public attitudes toward, a public wolf harvest specifically for recreational purposes.
3. If biologically sustainable, legally feasible, and socially responsible, develop recommendations to the NRC to offer opportunities for the public to harvest wolves for recreational purposes.

7. Plan Monitoring and Review

Regular communication among agencies, stakeholder groups and the general public allows interested parties to monitor progress made toward implementation of this plan. It also provides opportunities for management agencies to receive input on specific management issues. One of the ways to facilitate these benefits is through engagement with a wolf management stakeholder group. The DNR engaged with a Wolf Management Forum for the 2015 update to this plan. However, current State law dictated that a Wolf Management

Advisory Council, with specific requirements for membership, meeting format, and recommendation development, be used for stakeholder engagement (Section 43540e of NREPA). When wolves are not on the Federal List of Threatened and Endangered Species, this group will convene at least annually, to discuss management goals, educational opportunities, conflict resolutions, plan implementation, and other topics. Membership of this group is structured to represent the diversity of wolf-related interests and management responsibilities in Michigan. The role of the Wolf Management Advisory Council is different from that of the Michigan Wolf Management Roundtable, which fulfilled its charge and was disbanded following its review of the 2008 version of this plan.

Wolf abundance and distribution, attitudes of Michigan residents, and wolf legal status may continue to change through time. To address ecological, social, and regulatory shifts in a timely manner, the DNR will review and update this plan at 10-year intervals. The original Michigan Wolf Management Roundtable recommended that the plan be updated at 5-year intervals, but after multiple revisions the DNR feels that 10-year intervals are more appropriate due to the rate at which the body of scientific literature and management context changes. A 10-year interval is also consistent with other DNR species management plans (e.g., bear, deer, elk). This 10-year interval would not preclude the DNR from initiating an update sooner if warranted. The plan revision process will include review of the best available scientific information, consultation with tribal governments, and substantial involvement by affected stakeholder groups and the general public.

8. Funding

Costs of wolf management are associated with salaries, wages, contracts, travel, equipment, facilities, livestock compensation, and information and education materials. These costs have been significant for many of the agencies and partners involved in wolf management. Given persistent management needs, they are expected to remain significant into the foreseeable future.

At all ten wolf-focused public meetings hosted by the DNR in May 2005, and more recently at many of the 2021-2022 Wolf Advisory Council meetings the public expressed diverse concerns pertaining to funding for wolf management. Some people were concerned about the large expense of population monitoring and other management activities. Others desired assurance that sufficient funds would be available to maintain adequate staffing levels and allow timely agency responses to depredation complaints and other concerns. Others objected to a funding approach that has traditionally caused some stakeholder groups (i.e., hunters and trappers) to disproportionately bear the financial costs of wolf management.

Most funding for wildlife management has traditionally been derived from revenues generated by sportspersons. For example, the Michigan Game & Fish Fund is generated by State hunting and fishing license revenues, and the Federal Aid in Wildlife Restoration Act (a.k.a. Pittman-

Robertson Fund) provides funds derived from an excise tax on purchases of firearms and sporting goods. In the absence of many other funding alternatives, the DNR wolf management program has been supported primarily by these two funding sources. As a result, sportspersons have played a critical role in the recovery, conservation, and management of Michigan wolves.

Other agencies, tribes and private organizations also have played an important role by addressing education, conservation, and research needs. The financial and staff resources applied by these groups have complemented traditional funding sources in ways that have broadened the wolf management program.

Sportspersons and other management partners have provided most of the funding for wolf management, but they currently represent only a small proportion of all Michigan residents. Regardless of the inequities that may be associated with such a system, a funding approach that relies on the disproportionate contributions of these groups may become inadequate, especially if the prevalence of sportspersons within the general population continues to decline.

Successful efforts to obtain funding from alternative sources could spread the financial support for wolf management among a greater variety of stakeholder groups than traditional funding sources currently allow. Such an approach could help sustain the required levels of funding, and it could provide the general public with a greater stake and interest in wolf management.

The DNR will work with management partners to explore opportunities to identify new funding sources and to distribute the financial support for wolf management more-evenly among a greater diversity of stakeholders. It will also assist its management partners in their efforts to maintain the funding required for their wolf management activities. Finally, the DNR will take other prudent steps to ensure sufficient funding will be available to address management needs and to ensure funding is used in a responsible, efficient manner.

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