2020-2030

FURBEARER MANAGEMENT PLAN

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Maine Department of Inland Fisheries and Wildlife protects and manages Maine's fish and wildlife and their habitats, promotes Maine's outdoor heritage, and safely connects people with nature through responsible recreation, sport, and science.

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We are indebted to the donations of time and resources by Maine's Plan partners and citizens.

2020-2030

FURBEARER MANAGEMENT PLAN

1.0

INTRODUCTION

As part of its mission to preserve, protect, and enhance Maine's inland fisheries and wildlife resources, the Maine Department of Inland Fisheries and Wildlife also must ensure coordinated planning for the future use and preservation of these resources.

The Maine Department of Inland Fisheries and Wildlife (hereafter 'MDIFW' or 'the Department') began conducting comprehensive wildlife management planning in 1968, and since then has continually refined and expanded this work.

One major step was the 1989 rollout of a formal process for members of the public to help develop management goals and objectives for wildlife species of public interest (e.g., species that are hunted or have viewing interest). This process included convening a "Public Working Group" to represent the public's desires for the management of each species. Public Working Groups were charged with developing wildlife management goals and objectives and discussed their feasibility with Department biologists. During the same time period, the Department implemented a new management system approach to document how the Department would meet the goals and objectives that were derived by the Public Working Groups.

Over time, management plans have been developed for many wildlife species within the State. Plans were originally scheduled to be updated every 5 years, but this eventually transitioned to a 15-year planning horizon.

In 2014-15, MDIFW reviewed its planning process and determined that some adjustments would make the plans more responsive to public desires and more adaptable to emerging scientific information. In particular, advancements in the field of human dimensions science provided new ways to broadly engage the public during the development of species plans.

In 2019, MDIFW started working with Maine citizens to develop a new management plan for furbearers. The furbearer category includes mammals that have traditionally been trapped or hunted for their fur and range in size from weasels to bobcats. A diverse group of rodents and carnivores, furbearers live on land or in the water and play beneficial roles in the environment as predators, prey, seed dispersers, or keystone species. Furbearers are abundant and live in every corner of the state, from remote, rural areas in northern Maine to the outskirts of urban areas.

This plan divides 16 species into six groups based on their similar habitat use and ecology and consolidates their management priorities into a single document.

BEAVER + RIVER OTTER

4.0 

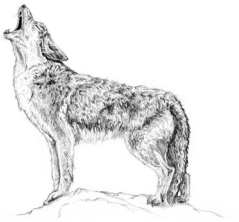
5.0 

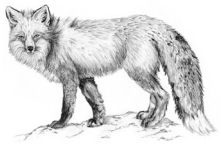
MINK + MUSKRAT

6.0 

7.0 

EASTERN COYOTE, RED FOX + GRAY FOX

8.0 

9.0 

BOBCAT

10.0 

MARTEN + FISHER

11.0 

12.0 

RACCOON, SKUNK, OPOSSUM, SHORT + LONG-TAILED WEASEL, RED SQUIRREL

13.0 

Canada lynx are also considered furbearers across most of their range in Alaska and Canada, but they are not included here because they are protected under the Endangered Species Act and have a separate management planning process.

Rather than relying on members of a Public Working Group to provide the sole public perspectives on the management of these species, MDIFW contracted with Responsive Management (Harrisburg, Virginia) to conduct a scientific study exploring public attitudes toward furbearers and furbearer management in Maine. This study included a formal survey, regional public meetings, focus group discussions, and Internet forums to gather input from the general public, landowners, hunters and trappers, as well as people opposed to trapping.

A steering committee provided guidance and advice to MDIFW during the development of the plan, and MDIFW convened a diverse subcommittee representative of different interests for each of the six species' groups. The subcommittees drafted goals, objectives, and management strategies based on the public survey results and the subcommittee members' professional expertise.

1.1 MDIFW Species Planning: Past & Present

THE TRADITIONAL METHOD

Historically, MDIFW species management plan development was a multi-step collaboration between Department staff and a Public Working Group.

STEP 1: SPECIES ASSESSMENT

First, a MDIFW wildlife biologist would develop a 'Species Assessment' summarizing the history and status of the species in Maine. This would include a thorough description of the species' ecology, management history, and use by the public. The assessments were often very detailed, and some exceeded 100 pages in length.

STEP 2: DRAFT OBJECTIVES & GOALS

Species Assessments were provided to a Public Working Group, which typically consisted of members of the general public and representatives from a wide range of stakeholder groups interested in, or impacted by, the management of the species. Using the Species Assessment as a guide, Public Working Group members recommended species management goals and objectives.

STEP 3: FEASIBILITY STATEMENTS

In response, Department staff prepared 'feasibility statements' describing the goals and objectives' desirability and feasibility.

STEP 4: REVISIONS

Groups considered modifications to the goals and objectives based on the Department's feedback.

STEP 5: MANAGEMENT SYSTEMS

Finally, using the goals and objectives as a guide, Department staff developed 'Management Systems,' which were road maps or decision-making matrixes describing the data inputs (e.g., harvest data, roadkill indices, habitat suitability), rules of thumb, and metrics staff would use to sustainably manage the species.

A NEW, MORE EFFICIENT WAY

In 2015, MDIFW reviewed its species planning process and determined that several adjustments could make the process more efficient, more responsive to public desires, and more apt to produce reader-friendly management plans. Process improvements included new ways of monitoring success, new means to address changes that could impact species, and a new plan format.

1) PUBLIC CONSULTATION

Thanks to advancements in human dimensions research and technology, it's now possible for a wider diversity of constituents to weigh in on Maine's wildlife management. Instead of relying solely on the discussions of a Public Working Group to represent the broad interests of Mainers, the Department now uses scientific public surveys to gather a representative summary of public attitudes on various issues. For this plan, researchers from Responsive Management determined the perspectives of different stakeholder groups on wildlife management issues by either surveying specific stakeholders (e.g., hunting and trapping license holders), or by using information collected during a survey (e.g., ages of survey participants) to categorize responses. In addition to surveys, researchers also conducted focus groups to obtain more detailed information and gauge how deeply participants understood certain topics. To ensure all members of the public had the opportunity present their viewpoints on wildlife management in a setting that was comfortable for them, the Department held public meetings and online forums.

2) ROLE OF WORKING GROUPS

Public Working Groups continue to form a key component of the Department's species planning process, though they have changed slightly in both name and function. Now called 'Steering Committees,' these groups provide input and advice throughout the planning process, including the public consultation efforts, identification of management issues, and development of plan content.

Bobcat Photo by Pam Wells

Instead of relying solely on the discussions of a Public Working Group to represent the broad interests of Mainers, the Department now uses scientific public surveys to gather a representative summary of public attitudes on various issues.

3) PLAN CONTENT

Historically, MDIFW species plans included detailed Species Assessments and goals and objectives to guide the management of the wildlife species over the life of the plan. Generally, goals and objectives focused on the number or density of animals that the Working Groups felt would provide a desired balance of habitat protection, recreational opportunities, and conflict avoidance. Now, MDIFW species plans include goals and objectives that address the full range of management issues for each species, including habitat conservation, research priorities, disease, and public education. Plans also include 'Management Strategies,' with specific tasks for the Department and its partners to consider as they work to achieve species goals and objectives. Overall, species management plans are now more streamlined, resulting in a more reader friendly document that does not go into extensive detail on the species' ecology, which is generally available from other sources.

4) GROUPING SPECIES

Where appropriate, MDIFW species management plans are now developed for groups of species. This more efficient approach allows Department staff to focus more of their efforts on plan implementation rather than plan development. Combining several species in a single plan also ensures that competing management issues are considered in a cohesive way.

5) MANAGEMENT SYSTEMS

Species management systems outline the detailed data inputs, analyses, and rules of thumb that MDIFW staff use to manage species. Historically, management systems were developed as an integral part of the planning process, and typically were not updated during the life of the plan. Now, management systems are developed separately from management plans, with systems updated on an as-needed basis throughout the life of a plan. This ensures that management systems reflect the latest scientific information and allows the Department to respond to emerging issues and challenges without altering management plans, which continue to guide the Department and serve as our roadmaps for species management.

1.2 Development of the Furbearer Management Plan

STEERING COMMITTEE AND SPECIES SUBCOMMITTEES

MDIFW convened a Furbearer Steering Committee in May 2019 to guide the development of this plan. Membership was established by the Commissioner, based on relevant interest groups and included a past member of the Department's Advisory Council, a member of the Department's Legislative Committee, four Department staff, and representatives of several stakeholder groups with long histories of involvement in wildlife management issues in Maine (see Appendix I for a list of steering committee members and their affiliations). The Department also established a subcommittee of diverse stakeholders for each species group, chaired by a species specialist from the Department's Research and Assessment Section and Wildlife Special Projects Coordinator. Subcommittees also included one or two biologists from the MDIFW Wildlife Management Section, two MDIFW Game Wardens, and several members of the public involved with furbearer issues. The steering committee and subcommittees were provided with a project charter (Appendix II) to guide their activities. In general, the steering committee's role was to advise the Department on plan content and format and to make specific recommendations on difficult management issues, while the subcommittees were tasked with identifying specific public consultation needs for each species, developing draft goals, objectives, and management strategies, and responding to steering committee feedback on draft content.

PUBLIC CONSULTATION

MDIFW contracted with Responsive Management to conduct a scientific survey of Maine residents, landowners, trappers, and hunters, and to lead focus groups, facilitate public meetings, and develop an online town hall forum. MDIFW developed a draft list of issues for public consultation, and the steering committee worked closely with staff from Responsive Management to develop survey questions and discussion guides for the focus groups. Responsive Management divided the state into three regions and delivered public input via two reports: a comprehensive report describing the quantitative (scientific survey) and qualitative (focus groups, public meetings, and online forum comments) data, and a shorter report describing their methodology and summarizing the major findings. The steering committee and subcommittees carefully reviewed these reports and repeatedly referred to them throughout the development of species goals, objectives, and strategies. Detailed methodology and key results are provided in Section 2.0 and in the species chapters of this Plan.

SPECIES ASSESSMENTS

MDIFW wildlife management section staff developed the species assessment portions of this plan, which include information on species' status, historic and current management, current regulatory framework, and management issues and threats. The assessments were reviewed by the subcommittees and steering committee.

GOALS AND STRATEGIES

Species subcommittees identified significant management issues for each species by referring to the species assessments, public consultation results, and professional expertise of Department staff and subcommittee members. Next, they drafted goals and strategies to address those issues.

In many cases, strategies identified by the subcommittees were already underway and part of the Department's core management programs. Other strategies were new; and in these cases, the subcommittees discussed their feasibility and desirability before adding them to the plan. For all species, a wide range of topics were discussed amongst the subcommittees and sometimes there were divergent opinions. In some cases, the management issue surrounding a strategy was controversial, had personal impacts, or was politically charged and the subcommittee could not reach agreement. In those cases, the subcommittees used a 'modified consensus' approach to develop plan content. Where consensus could not be achieved, the differing viewpoints were shared with the Steering Committee, which then made a final recommendation to the Commissioner.

1.3 Plan Format

This Plan is organized into a general introduction, a section summarizing statewide issues and management strategies that applies to all furbearer species, and separate chapters for Beaver/Otter, Mink/Muskrat, Coyote/Red Fox/Gray Fox, Bobcat, Marten/Fisher, and Raccoon/Skunk/Opossum/Weasel/Red Squirrel. Species chapters include sections describing 'History and Population Status', 'Current Regulatory Authority', 'Current Management Issues and Threats', 'Goals and Strategies', and 'Expected Outcomes'.

1.4 Process for Updates and Revisions

This plan will be monitored, revised, and updated as necessary throughout its life. The Department may make minor revisions in response to emerging scientific information or changes in wildlife populations or habitat. Prior to making major revisions (e.g., modifying goals or objectives) to the plan, the Department will reconvene the Steering Committee and/or Species subcommittee(s) to provide advice and recommendations on proposed changes.

1.5 Species Management Systems

The Department will continue to use Species Management Systems to guide day-to-day wildlife management decisions. Management systems describe the data and analytical approaches that are used to achieve the goals and objectives outlined in the Management Plan. Following publication of this plan, the Management Systems for all furbearer species will be revisited and where appropriate, will be revised. Management systems will be continuously updated to reflect emerging scientific information, changes in the availability of biological data, and analytical techniques. Revision of Management Systems will be led by Department biologists, who may solicit input and advice from other wildlife professionals on an as-needed basis.

2.0

PUBLIC SURVEY RESULTS: METHODS & KEY FINDINGS

Prior to the development of this plan, the Department scientifically surveyed Maine residents and landowners as well as resident and non-resident hunters and trappers to gauge their opinions of and attitudes towards furbearer management.

The survey was carefully designed by Responsive Management, in collaboration with Department staff, the furbearer steering committee, and the aquatic subcommittees to ensure that results were accurate and representative of each stakeholder group across the state. Large sample sizes **(Table 2.1)** were selected to achieve a high level of precision and confidence. A random selection of survey participants were contacted by postal mail, phone, and/or email, and were given the option to complete the survey by phone or on the internet. The survey posed a wide variety of questions, including some that focused on wildlife and trapping and others about population levels and management options for different furbearer species.

TABLE 2.1 SAMPLE SIZES AND SAMPLING ERROR (95% CONFIDENCE INTERVAL) FOR THE 2019 FURBEARER MANAGEMENT PLAN PUBLIC SURVEY CONDUCTED BY RESPONSIVE MANAGEMENT.

SAMPLE TYPE	SAMPLE SIZE	SAMPLING ERROR
RESIDENTS	621	3.93%
LICENSED HUNTERS	1,245	2.77%
LICENSED TRAPPERS	541	3.91%
PRIVATE LANDOWNERS	305	N/A
INDUSTRIAL LANDOWNERS	7	N/A

Of the **Maine residents** surveyed, 75% approved of regulated trapping, while 17% disapproved and 8% were neutral. Support of regulated trapping to manage wildlife was highest for coyote (71%) and lowest for bobcat (48%). Maine residents indicated that they knew more about skunk, coyote, and raccoon, and knew least about muskrat and marten. Regarding furbearer population levels, more residents felt that populations were too high than too low for coyote, skunk, raccoon, and fisher; conversely, more residents felt that populations were too low than too high for otter, bobcat, fox, marten, muskrat, and beaver. More residents enjoyed having fox around their home, whereas coyotes tended to be viewed as dangerous or a nuisance. More than a third of residents experienced conflicts with wildlife in the past two years, with raccoon, skunk, fox, and coyote being the most conflict-prone furbearer species. The Department received high ratings for its management of trapping, with 56% of residents rating the Department as excellent or good.

When combined with the focus groups, public meetings, online forum, and related public survey projects, we now have the most comprehensive evaluation of stakeholder opinions on Maine furbearers that has ever been available.

Landowners had similar attitudes towards furbearers and showed similar support for trapping as Maine residents in general, though they did report more wildlife conflicts and had more concerns about beavers. Of the furbearer species, they were most tolerant of fox, beaver, bobcat, marten, otter, and muskrat, and least tolerant of coyote, skunk, raccoon, and fisher. Most landowners in each region had wildlife conflicts (53-60%), with the Central and South regions experiencing the most problems. They listed coyote, raccoon, fox, and beaver as the furbearer species causing the most problems, which were primarily damage to crops/gardens and threat/harm to livestock.

Land managers from seven of Maine's 12 large industrial landowner companies (100,000+ acres) participated in the survey, and all indicated strong support for trapping. All seven allow furbearer hunting and trapping on the properties they own or manage, and most (six) indicated strong support for trapping as a method to manage beaver. All responded that the beaver population was too high, to the point that five regarded beaver as a nuisance. Luckily, none of these large landowners have experienced any issues or conflicts with trappers.

The survey provided a wealth of information about motivations and barriers for **hunters and trappers.** Most hunters (82%) were satisfied with their hunting experiences in Maine, with lack of game being a top reason for dissatisfaction. Most trappers (71%) were satisfied with their trapping experiences in Maine, with lynx exclusion devices being a top source of dissatisfaction. Lack of time was the biggest constraint for hunter and trapper participation. Hunters who have never trapped were asked why, and 51% responded that they simply had no interest. The main reasons that trappers participated in trapping were for recreation/challenge/being outdoors (65%) and to help control animal populations (37%).

The public survey was carefully considered during the development of the furbearer management plan. When combined with the focus groups, public meetings, online forum, and related public survey projects, we now have the most comprehensive evaluation of stakeholder opinions on Maine furbearers that has ever been available. These opinions were the foundation of the plan's goals and objectives, and they also give us a reference point from which we will be able to gauge success.

3.0

STATEWIDE FURBEARER MANAGEMENT CONSIDERATIONS & STRATEGIES

Maine is fortunate to have one of the most intact forest environments in the country.

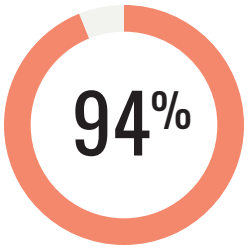
3.1 Furbearer Habitat Availability & Trends

Maine has the largest undeveloped area east of the Mississippi River, with 82% of our surface area covered in forest (the most of any state in the nation) and 8% in inland waters. Only 10% of Maine's land is developed or farmed, though we still boast some of New England's largest grassland and agricultural areas. Maine also has the lowest human population in the east at 43 people/mi^2. These patterns have been relatively stable for the past 60 years (McCaskill et al. 2016).

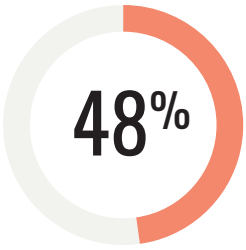
Not only is Maine unique among eastern states for its heavily forested and relatively undeveloped landscape, but it also has an extremely diverse climate with significant implications for wildlife. Although Maine spans only four degrees latitude, it includes three climate divisions with vastly different temperature and precipitation regimes. Northern hardwood and conifer forests are distributed statewide and comprise 40% of Maine's landscape, with significant areas of boreal upland forest in northern and Downeast Maine (Faber-Langendoen 2012). The vegetation and snowfall patterns in northern Maine are most conducive to species like marten and lynx that are adapted to severe winters. Southern and coastal portions of the state, with their milder winters, are more hospitable to a wide range of species including bobcat and raccoon. Opossum and gray fox also have expanded their range into central and western parts of Maine.

Maine has a long history of landscape changes that have shaped wildlife habitat over time. Historically, Maine was heavily forested with few natural clearings or early successional forest habitat. With European colonization, much of southern and central Maine was converted to farmland, and timber harvests occurred statewide. By the early 1800s, it was estimated that over 80% of the land in New England had been cleared. Beginning in the late 1880s, farmland no longer used for agricultural purposes began reverting back to forest. The diverse mosaic of forest, shrub, and old field habitats that this created in southern and coastal Maine was ideal for many wildlife species. Across much of northern Maine, a massive spruce budworm outbreak in the 1970s and 80s resulted in extensive salvage logging, creating large stands of even-aged forests and driving northern Maine forest stand development to this day. In 1989, in response to public concerns about clearcutting, the Maine Forest Practices Act was passed, resulting in far fewer clearcuts and more partial harvesting and pre-commercial thinning. A concurrent shift to mechanized harvesting, improved road networks, changing markets for forest products, and changes in silvicultural techniques all contributed to an increased prevalence of 'young forests' in much of the state's industrial forest land base.

Maine's pattern of private land ownership also has significant implications for wildlife habitat in the state. Approximately 94% of the state is privately owned with the majority held by corporations that manage the land for timber production, especially in northern and Downeast Maine (McCaskill et al. 2016). Family landowners also own a significant portion of the state, especially in southern and central Maine, where parcel sizes are typically small (<1,000 acres). Most family landowners in Maine own land for a variety of reasons, including enjoyment of wildlife (McCaskill et al. 2016). Family-owned parcels are generally small, averaging only 64 acres. While timber production is not typically a main objective of family forest owners, a quarter of them have had a commercial timber harvest in the past five years. In fact, 48% of landowners self-reported that they actively manage their land for wildlife (Responsive Management 2016). Although these management practices occur within the state's regulatory framework (including the Maine Forest Practices Act and Natural Resources Protection Act), management of wildlife habitats is generally at the landowner's discretion.



OF THE STATE IS PRIVATELY OWNED



OF LANDOWNERS ACTIVELY MANAGE THEIR LAND FOR WILDLIFE

Currently, Maine's climate, forest management practices, diverse landscapes, and patterns of human settlement create excellent habitat conditions statewide for furbearers, especially for raccoon, skunk, coyote, bobcat, fisher, and red fox. The abundance of inland and coastal waters also contributes to outstanding habitat for semi-aquatic furbearers like beaver, muskrat, mink, and otter. It is unclear how climate change will impact wildlife habitat, distribution, and disease in the future. Maine's climate is warming, winters are becoming shorter, and snowpack has become more variable (MCC STS 2020). Species that are already near the edge of their geographic range will likely be impacted the most. In some cases, species that are tied to a colder climate (such as marten) may contract their range and shift further north, while other species like gray fox and opossum may continue to expand their range into places they have never occurred. However, the Department expects that habitat conditions for the state's furbearer species will remain relatively stable over the life of this plan (10 years). Maine's human population growth through the year 2034 is expected to be relatively stable, which will help minimize development and habitat conversion that could negatively impact some wildlife species.

3.2 Economic Impact of Wildlife

Wildlife is an important natural resource in Maine contributing to a ~$6 billion tourism industry that brings over 35 million visitors to the state each year (Maine Office of Tourism, unpublished data). According to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, wildlife watchers and hunters spend >$1 billion per year in Maine, with about 1.1 million total participants spending >12 million days/year hunting, fishing, and viewing wildlife (U.S. Department of Interior 2011). The number of participants engaging with wildlife is increasing, especially with people viewing wildlife near their homes (U.S. Department of Interior 2016). Deer, moose, and turkey are the three most commonly viewed species in Maine, and are also among the most sought after species by hunters (Responsive Management 2016).

Although the larger game species are more visible for viewing and popular for hunting, smaller game species like coyote, bobcat, fox, and raccoon also contribute to the economy and diversify the hunting experience. In 2013, approximately 50,000 resident and non-resident hunters spent $32 million while hunting small game in Maine, supporting over 490 full and part time jobs that provided $16.9 million in labor income (Southwick Associates 2014). With over 5,000 Registered Maine Guides in the state, as well as dozens of sporting lodges and hotels that cater to hunters, small game hunters provide a much-needed source of seasonal income for many businesses, particularly in rural parts of the state. Trappers also contribute to the state's economy, with each trapper spending, on average, over $3,000 each year on equipment, travel, lodging, food, and other expenses related to trapping activities (Responsive Management 2015).

3.3 Hunting and Trapping Access

Use of hunting and trapping as management tools hinges on the ability of hunters/ trappers to access lands. In Maine, 53% of trappers trap exclusively on private land, 37% trap on private and public land, and just 8% trap on public land only (Responsive Management 2015). Eight percent of trappers responded that access problems contributed to their dissatisfaction with trapping, with access being a bigger constraint in southern Maine (Responsive Management 2020). With only 6% of Maine in public ownership, hunting and trapping access ultimately depends on the willingness of private landowners to allow use of their properties. Maine has a unique tradition of 'implied access', where unless posted otherwise, the public can legally access private land, though Maine law still requires trappers (with some exceptions) to have written permission from the landowner before setting traps. With the exception of some large industrial landowners that charge road-use and/or camping fees, access to private land is generally free. This open-land tradition is a key component of Maine's hunting and trapping heritage, but the tradition is slowly changing (Acheson 2006). While the data may not be directly comparable because methodologies differed, surveys conducted in 1991 and 2016 demonstrated a dramatic increase in the share of small landowners posting their land, from 14.9% in 1991 to as much as 72% in 2016 (Acheson 2006, Responsive Management 2016). A number of factors may be contributing to changing patterns in public access to private land, including increases in motorized recreation (ATVs), demographic shifts by landowners, and cultural attitudes towards hunting (Acheson 2006). These changes are not limited to small landowners, and changes in ownership of large northern Maine parcels have also resulted in some hunting and trapping access loss.

Although Maine's open-land tradition may be changing, particularly on smaller parcels, there are also several positive trends that have emerged in recent years. Conservation easements have increasingly been used to guarantee public access to private lands, often while prohibiting or limiting development. Land trusts have also acquired significant acreage in the state, particularly in central and coastal regions, and typically allow access for hunting and trapping. Use of 'Access by Permission Only' signage (including purple boundary paint) has also increased, allowing landowners to control public access without necessarily prohibiting it. Finally, MDIFW's landowner relations program provides targeted resources to address landowner/land-user conflicts and encourage ongoing public access to private land. Continued efforts to maintain positive relationships between hunters, trappers, and landowners will be critical to the effective management of furbearers in Maine.

3.4 Public Support for Trapping

Maine residents are generally highly supportive of legal, regulated trapping, particularly when used as a tool to manage wildlife (Responsive Management 2020). Nonetheless, with increasing urbanization, national declines in hunter and trapper participation rates, and public referenda on management methods, wildlife agencies will need to take proactive steps to ensure that support for trapping does not erode over time (American Sportfishing Association et al. 2013, U.S. Department of the Interior 2011). Successful management of Maine's furbearer species requires implementation of science-based hunting and/or trapping regulations, which have unique challenges in parts of the state with the highest or lowest human density. Therefore, it is essential that Maine residents not only support trapping, but understand it's role in maintaining healthy wildlife populations in both suburban and rural areas.

MDIFW has high credibility among Maine residents, and the public generally trusts the Department to make the best decisions for the state's wildlife (Responsive Management 2015). There is high public awareness that the Department regulates trapping, but most people are unsure how to rate these efforts. The public is largely uninformed about most aspects of trapping, including its benefits, licensing and educational requirements, seasons, species, tagging requirements, trap technologies, and strictly enforced regulations. In order to maintain its 'social license' to use hunting and trapping as tools to manage wildlife, MDIFW must continue, and where possible expand, its efforts to communicate with the non-hunting and non-trapping public. In particular, the Department must increase public awareness on the benefits of regulated hunting and trapping to wildlife and people, including how these activities maintain healthy wildlife populations, provide funding for wildlife conservation and public land acquisition, protect rare species, and reduce human-wildlife conflicts.

3.5 Best Management Practices (BMPs) for Trapping

Common reasons for opposing trapping are the perception that trapping is inhumane and concern over the capture of non-target animals (Responsive Management 2020). It is not well known that improvements have been (and continue to be) made to traps to make them more humane and selective.

Since 1997, state and federal agencies have been working together with trappers, veterinarians, and other wildlife professionals to develop the most humane, safe, selective, efficient, and practical trapping devices. The ongoing Trapping Best Management Practices (BMP) program provides science-based recommendations on the best traps and methods for each furbearer species in the United States (White et al. 2020). By 2018, the program had reviewed over 600 traps and developed BMPs for 22 furbearer species. Swivels on foothold traps and clear catch circles are examples of BMP modifications that prevent injuries. Trap manufacturers have embraced these recommendations, evolving their designs to meet the new BMP standards. In Maine, 79% of trappers support BMPs because they believe these guidelines make traps more humane (Responsive Management 2015).

Trapping is a highly regulated activity, with certain restrictions in Maine to protect the federally threatened Canada lynx. Although trappers support BMPs, additional restrictions do affect their motivations to trap. The Department will continue to support and communicate the value of trapping BMPs to the general public, to longtime trappers, and to new trappers through trapper education programs.

3.6 Trapper Recruitment

Half of Maine residents have known a trapper, but only 6% have ever trapped. This stands in contrast to the third of Maine residents who have hunted at some point in their lives. The number of people that hunted or trapped recently is even lower. During the 2018/19 season, less than 0.5% of Maine residents trapped, while 13% hunted and 20% fished (Responsive Management 2020).

2018-19 TRAPPING & HUNTING SEASON

>0.5%

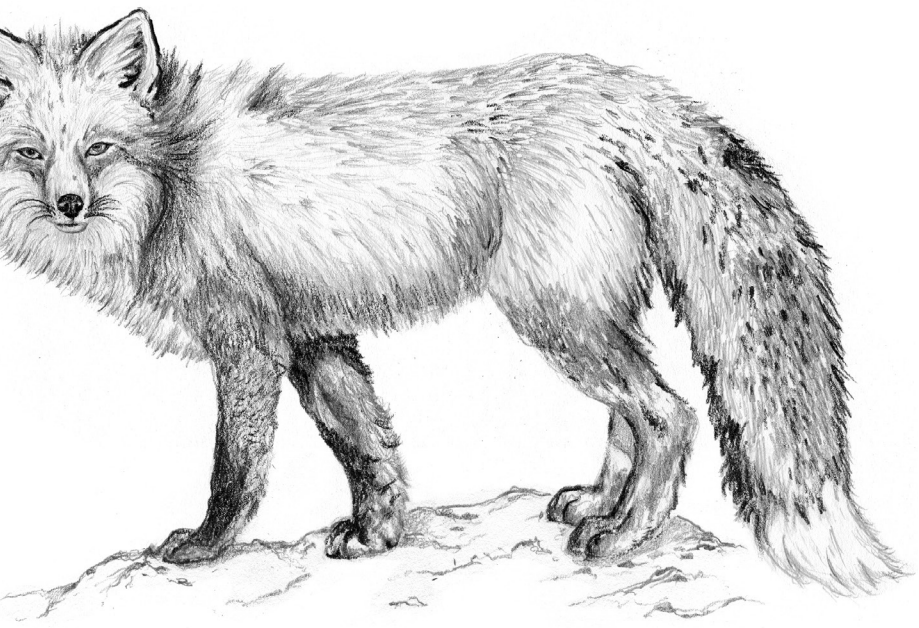
MAINE RESIDENTS TRAPPED

13%

MAINE RESIDENTS HUNTED

20%

MAINE RESIDENTS FISHED



Trappers are getting older, and fewer people are being recruited into trapping. The number of junior Maine trapping licenses in 2019 (103) was 32% lower than the previous five-year average of 152. The number of annual trapping licenses has also declined, but lifetime trapping licenses have increased since 2000 and now make up half of all trapping licenses. Overall, the number of Maine trappers has steadily dropped, with a 37% decline in total trapping licenses from the 1980s to the 2010s **(Figure 3.61)**.

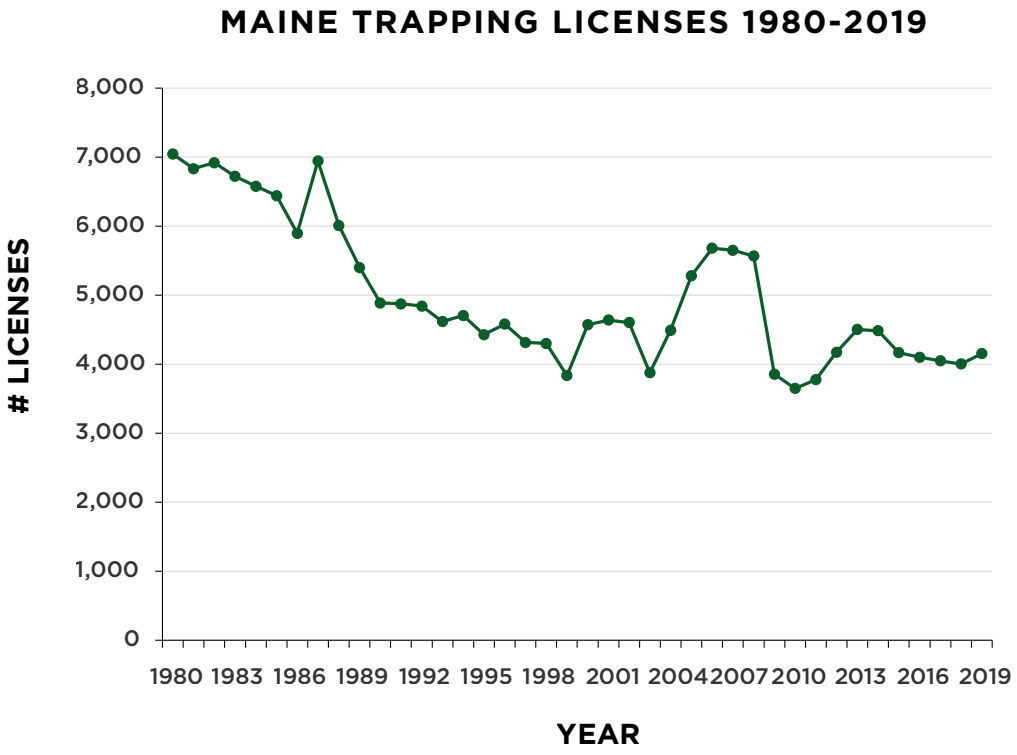


FIGURE 3.61 THE NUMBER OF MAINE TRAPPING LICENSES ISSUED FROM 1980-2019. TRAPPING LICENSES INCLUDE ANNUAL LICENSE SALES AND LIFETIME TRAPPING LICENSES. NOTE THAT THESE DATA EXCLUDE ANYONE OLDER THAN 83 YEARS (THE CUTOFF USED TO DETERMINE LICENSED HUNTERS AND ANGLERS BY USFWS).

In 2018, the Department joined in a nationwide effort called R3 (recruit, retain, and reactivate), which seeks to combat declining participation in outdoor activities. As part of R3, the Department (along with its outdoor partners) is working to identify areas where we can effectively recruit, retain, and reactivate trapping participants. While traditional furbearer hunting and trapping participants seem to be declining, there appears to be a whole new segment of the U.S. population eager to participate in outdoor activities that allow them to be more self-reliant and environmentally conscious. The challenge is to effectively stay engaged with our more traditional audience while also providing education, training, and mentoring opportunities to new audiences (including women, families, young adults, and youth) for whom trapping may have previously seemed out of reach. The Northeast has higher rates of participation in trapper education courses (79%) than all other regions of the country. In Maine, 75% of trappers surveyed had taken some sort of trapper education – a percent that will continue to increase given that trapper education has been a Maine trapping license prerequisite since 1988.

3.7 Disease

Typically, when wildlife populations rise above the capacity that the environment can support, natural mortality sources such as starvation and disease set in. Wildlife diseases can have far-reaching impacts— certainly to local wildlife populations, but sometimes to human, pet, and livestock health as well.

Canine distemper, parvovirus, leptospirosis, mange, and rabies are some of the most common diseases that affect some species of furbearers as well as other mammals, including humans and pets (Davidson and Nettles 1997).

Most of our native furbearers also carry ticks, which can have implications for human health. Beavers flood wetlands, often creating stagnant water perfect for breeding mosquitoes and midges, which then transmit diseases like EEE and malaria to humans, pets, and other wildlife. Beavers, muskrats, and other wildlife are also associated with waterborne diseases such as giardia, which can be a concern for recreation and drinking water sources.

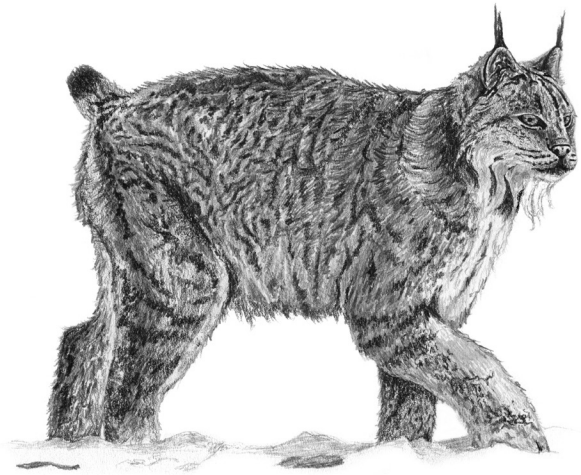
Rabies has received much attention in recent years, particularly in coastal communities. In 2019, the Maine CDC confirmed 89 cases of rabies, primarily in raccoons and skunks, with some areas of mid-coast Maine hit particularly hard.

In the City of Bath (population: 8,000) in 2019, there were 72 suspicious animal calls, 26 sick animals were dispatched by officers or citizens, and 16 animals tested positive for rabies. Of the 18 fox attacks on people or pets, 11 resulted in a person being bitten or scratched. The unusual number of aggressive gray fox attacks on people and domestic pets that persisted over 14 months raised human health and safety concerns, and prompted a localized, population reduction of raccoon, skunk, and fox in the infected area. In addition, outreach was conducted with citizens to promote better practices to prevent future wildlife problems, such as eliminating food (garbage, compost, pet food, bird feeders) and shelter (sheds, attics) opportunities associated with people.

3.8 Predation

Maine's carnivorous furbearers, such as coyotes, are known to spark human conflict by preying on livestock or pets. The public has also shown concern around coyotes (and black bears) preying on deer. In 2011, a legislative task force directed the Department to create a coyote depredation program. The program's objective is to reduce coyote density in high-priority areas each year between early-autumn and early-winter, and then monitor coyote presence and manage predation events as needed throughout the winter. This program employs hunters and trappers to harvest coyotes adjacent to important Deer Wintering Areas in remote areas that are difficult to access.

People are less tolerant of coyotes than they are of any other furbearer species, commonly viewing them as dangerous or a nuisance. When asked to rate the environmental benefit of various species on a scale of 0 (no value) to 10 (very beneficial), Maine residents, landowners, hunters and trappers all gave coyotes the lowest value of any furbearer. Negative attitudes towards coyotes may be related to a personal experience of seeing deer chased onto the ice and eaten alive, having a beloved pet go missing, or hearing about the rise in bold coyote attacks on people or pets in other states. Some people may feel that coyotes don't belong because they didn't occur in New England historically and, similar to wolves, they compete with hunters for game species. Interestingly, some predators, like fisher, were also more commonly viewed as a nuisance or dangerous, whereas bobcats and foxes were positively viewed by Maine residents (Responsive Management 2020). It appears that people are more tolerant of wildlife species, even if they cause conflicts (e.g., fox in the hen house), as long as they do not feel threatened by them.



3.9 Conservation of Sensitive Species

Predation concerns don't stop at pets, livestock, or popular game species. Many of Maine's rarest species can be significantly impacted by predation of individuals or nests. This is particularly true for the beaches in Maine that are occupied by nesting Piping Plovers or Least Terns. Trapping and removing the surplus of predators, like raccoon and skunk, is vital to the success of maintaining and restoring plovers and terns in Maine. Rare seabird species like the Atlantic Puffin, Arctic Tern, and Razorbill nest along the coast, with a significant proportion of their population residing on islands such as Petit Manan, Matinicus Rock, Metinic, and Eastern Egg Rock Islands. Researchers have documented increases in mink and otter on islands located close to shore, along with corresponding negative impacts on seabird nesting success as well as chick and adult survival. Targeted trapping efforts of predators on some islands has helped protect and restore nesting seabird populations.

Maintaining trapping is an important Department priority, as is protecting Canada lynx at the southern end of their geographic range. Maine's lynx population is doing well and is found throughout northern, western and eastern regions. In fact, Maine is home to the largest lynx population in the lower 48 states. In 2000, the US Fish and Wildlife Service (USFWS) listed lynx as a Threatened Species in Maine and 13 other northern states. Currently, resident breeding populations occur in Maine, Minnesota, Montana, Colorado and Washington. Prior to listing, lynx were protected in Maine with the closure of hunting and trapping of lynx in 1967. Although the U. S. Endangered Species Act (ESA) prohibits the "take" of threatened or endangered species that results in direct harm to the species or habitat destruction, the ESA authorizes the USFWS to issue permits for the "incidental take" of listed wildlife species (See Section 10a(1)(B) of the ESA) that may occur from otherwise lawful activities. In 2014, the Maine Department of Inland Fisheries and Wildlife submitted an incidental take plan to the USFWS for a Section 10 permit to provide statewide protection to trappers in the event that Canada lynx are incidentally trapped in lawfully made sets during Maine's legal trapping season, animal damage control (ADC), or predator management (PM) activities. This permit covers individuals that are licensed or otherwise authorized to trap including regulated trappers, ADC agents, and predator management trappers. In 2018, the USFWS announced their recommendation to remove lynx from Federal protection because the threat (inadequate protection of lynx habitat on federal lands) had been addressed. As a result, the USFWS worked with affected states, including Maine, on the development of a post-delisting monitoring plan, which is a requirement of the US Endangered Species Act if a species is delisted. In 2021, a court settlement determined that USFWS would not move towards delisting lynx from the ESA. Instead, the USFWS will review and update the species status assessment and develop a Lynx Recovery Plan by 2023. Regardless of the USFWS final decision, the Department remains committed to providing trapping opportunities while also reducing the incidental capture of lynx.

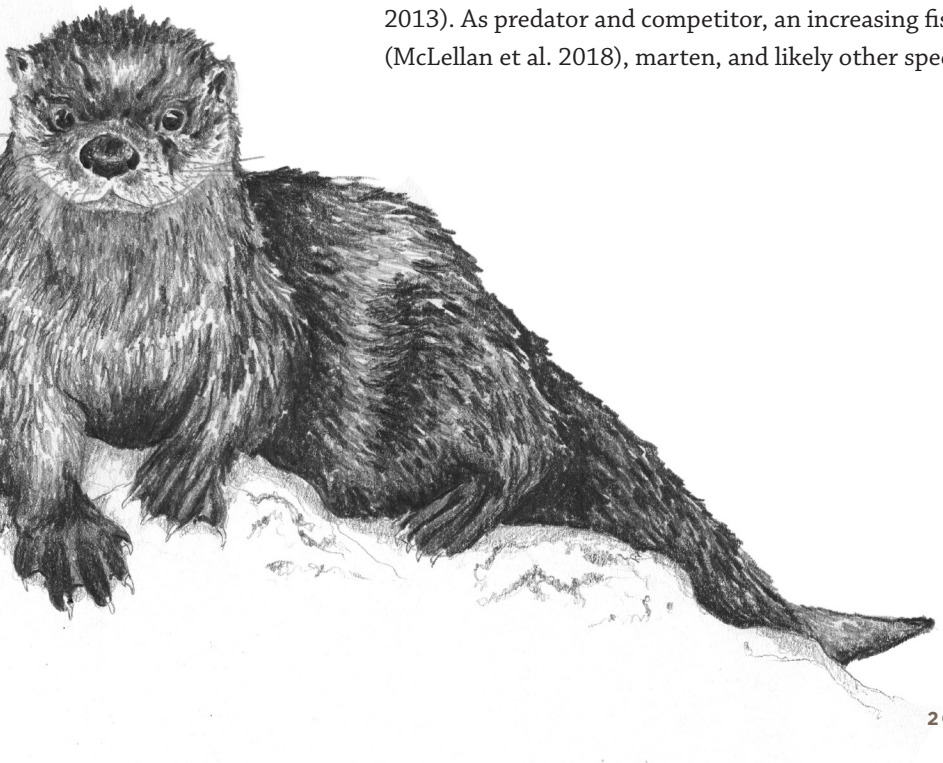
3.10 Species Interactions

Species interactions, while complex and challenging to study, are important wildlife management considerations.

Furbearing animals, like all species, are interconnected in a complex web of life wherein the population level of one species may impact many other species through habitat alterations, predation, disease or competition.

For instance, beavers create and enhance habitat for many plants and animals in or near wetland or riparian ecosystems. River otters are often associated with beavers because they frequently use active and old beaver houses and bank dens for resting and denning (LeBlanc et al. 2007, Stevens et al. 2011). Mink and muskrat are also often found living in similar habitats. Mink prey on muskrat, and mink/muskrat populations have undergone eight- to nine-year cycles in the past with muskrat cycling one to two years ahead of mink in Canada (Viljugrein et al. 2001).

Meso-carnivores compete for similar resources, and some species actively defend their territories and kill other animals outside their family group or other species. Research has shown that coyotes, which are dominant carnivores, can limit red fox populations (Harrison et al. 1989), but foxes can coexist by spending more time living closer to people (Moll et al. 2018). The gray fox expansion in Maine likely impacts red fox, and it's possible that competition is mediated by behavioral or habitat differences, such as the gray fox's superior climbing abilities and use of brushy shrub habitat. Similarly, marten and fisher overlap across areas of northwestern Maine and other parts of their range in the boreal forest. The distribution of marten and fisher likely influences each other's habitat selection, potentially as a result of competition (Fisher et al. 2013). As predator and competitor, an increasing fisher population has consequences for lynx (McLellan et al. 2018), marten, and likely other species.



3.11 Human-Wildlife Conflicts

Another key aspect of effective wildlife management is tracking conflicts with people. The number, severity, and geographic distribution of human-wildlife conflicts are important elements of 'social carrying capacity,' or the willingness of people to coexist with wildlife. For some species, the Department believes social carrying capacity should be a consideration in the management system, potentially triggering regulatory changes to increase hunter/trapper harvests if conflicts become too severe. Until recently, we have tracked inbound calls regarding human-wildlife conflicts in the Warden Service Records Management System (RMS) database.

Although the trend in conflict numbers can be tracked at a regional level, details of each incident must be recorded in a narrative form, which makes it difficult to efficiently summarize and categorize type and severity of conflicts. Recently, the State improved this system by transitioning from RMS to Spillman software. This has allowed us to create a more thorough human-wildlife conflict tracking database and ability to track changes in severity over time. This data will better inform management decisions and outreach efforts.

The Department assists in resolving human-wildlife conflicts by recommending effective practices that conserve wildlife whenever possible. These practices follow a step-down approach.

STEP 1. EDUCATION AND EXTENSION

Landowners are encouraged to take reasonable precautions to prevent human-wildlife conflicts, and when necessary, appropriate information or technical guidance is provided, enabling them to both alleviate the problem in the moment and avoid it in the future. Such information or guidance may include: one-on-one technical advice, handouts, pamphlets, and/or information on the Department's website to alleviate nuisance wildlife problems and to promote the positive aspects of wildlife.

STEP 2. PREVENTION

In most cases, attractants can be removed and/or preventative measures taken to prevent the conflict from reoccurring. Where effective and economically reasonable, measures are taken to neutralize the attraction or to exclude problem wildlife from areas or attractions to which they cause damage or pose a health or safety issue.

STEP 3. USE OF HUNTING AND TRAPPING REGULATIONS

Many wildlife species are managed through regulation of harvests. The goal is to maintain individuals and populations within a healthy range that provides appropriate public use while minimizing conflicts. The extent of human-wildlife conflicts is tracked via Departmental databases and is discussed, evaluated, and considered when adjusting harvest regulations and management system goals. When appropriate/practical, removal of the offending animal(s) is encouraged during the legal hunting or trapping season for that species.

STEP 4. LIVE-CAPTURE/RELOCATION

This is an appropriate method when animals continue to cause a problem and when the above procedures are not applicable, practical, or cost effective, and when removing the offending animal is justified (i.e., if it is causing significant property damage or posing a real safety threat). While non-lethal measures must be considered first, it is important to consider the biological and social consequences of non-lethal vs. lethal removal, as well as the feasibility of translocation of animals, except as noted with specific species (State Law 12 M.R.S. §12401 and §12402).

STEP 5. LETHAL CONTROL

Lethal control is justified when the above procedures are not applicable, practical, or cost effective. In many cases, a regional wildlife biologist or district game warden must give verbal or written communication for any person to kill wildlife.

The Department typically receives well over 10,000 calls each year regarding wildlife conflicts. More than two-thirds of Maine residents had wildlife conflicts in the past two years, and a third of them did nothing to resolve the issue. Among those who took action, most used repellents/deterrents (13%) or killed the animal (13%), while 6% hired someone to resolve the problem (Responsive Management 2020). Approximately 60% of trappers have been contacted by a landowner to conduct nuisance wildlife work (Responsive Management 2015). Trappers provide a free service, when trapping during the regulated trapping season, to help resolve many of these conflicts. However, when issues arise outside of the trapping season, the Department permits Animal Damage Control (ADC) agents, who are independent contractors, to help resolve wildlife conflicts at the cost to the landowner or private citizen. To become an ADC agent, a person must first take a trapper education course and obtain a trapping license, and many of our most skilled and expert ADC agents are experienced fur-trappers.

10,000+
CALLS PER YEAR
TO MDIFW REGARDING WILDLIFE CONFLICTS

Members of the public, businesses, municipalities, and agencies don't just call MDIFW and ADC agents for wildlife damage assistance; they often contact USDA Wildlife Services as well. USDA estimates the economic losses averted by addressing wildlife conflicts. Examples include the cost of an aircraft striking wildlife, damage to crops/pasture/property, timber losses, or the cost of rebuilding a flooded road or damaged bridge. From 2009 to 2018, USDA estimated that the potential losses caused by Maine furbearers (from calls their agency received) at over $665 million. Beavers were responsible for most of the USDA calls regarding wildlife conflicts in Maine (99%). This data is consistent with large industrial landowners responding that the beaver population is too high and that they regard beavers as a nuisance (Responsive Management 2020).

An abundant beaver population contributes to biodiversity, but has negative consequences when conflicts occur. The cost to repair or rebuild a road and associated infrastructure is costly and time consuming. Flooded roads block access for landowners and other users and have negative environmental consequences when road surfaces wash into waterways. Road repairs require rental of large equipment and loads of gravel to be hauled in. Site modification consisting of water control devices or "beaver deceivers" at road culverts are options to help prevent future flooding problems, but may not work in all locations. The cost to install these devices can vary from a couple hundred to several thousand dollars per site and require annual maintenance to be functional. Some of the large industrial landowners (>100,000 acres) estimate that they spend $50,000 each year to repair damages caused by beavers.

The Department's new Wildlife Complaint Reporting System will integrate data collected from Warden Service, Biological Staff, Agency Call centers, as well as ADC Agents. This information will be critical to determining types of conflict, when/where they occur, and actions taken. These data will be used to develop strategies that minimize negative human-wildlife conflicts, such as educational resources that promote better practices for coexistence. Ultimately, the Department strives to maintain positive value of all wildlife species.

3.12 Population Data

Fur trappers continue to provide the best available data on furbearer ecology and population biology that would be challenging to gather otherwise. While harvest has traditionally been the primary metric to assess furbearer populations, fur harvest trends are complex and can be affected by many factors including weather, abundance of natural foods (e.g., beechnuts, acorns, small mammals), fur value, gas prices, trapper effort, and species abundance. Trapper effort (measured by number of traps and nights set) and other metrics of trapper success can be used to track catch-per-unit effort trends, but they don't directly measure population abundance. Cameras are becoming a valuable tool to determine whether a species occurs in a given area, and they are well-suited to surveying for multiple species. In 2017, MDIFW and University of Maine began designing a camera study to monitor Maine's forest carnivores. Although the study is focused on marten and fisher, we collect data on all species recorded at the baited camera stations. Future research efforts will explore the value of the monitoring protocol for other species of forest carnivores, such as coyote, bobcat, weasel, fox, and prey items like snowshoe hare. Ultimately, by monitoring the occupancy rates of forest carnivores over large areas of the state, biologists will be able to track changes in carnivore populations over time. MDIFW will continue to research cost-effective methods to monitor furbearers that are independent of fur harvest/trapping data and utilize new methodologies that become available (e.g., eDNA).

3.13 Data Management

Managing Maine's furbearer species requires ongoing collection of biological data to monitor populations, as well as information from harvested animals and trappers (surveys and licensing data). Mandatory registration of harvested animals provides critical information on the town, method, and timing of harvest, as well as sex and age for some species. We use these data to calculate trapper success rates, and registration often provides an opportunity to collect additional biological data. MDIFW has long partnered with private businesses to register a significant amount of the state's harvested furbearers. Through an agreement with the Department, registration agents attach a seal to the animal and record pertinent information on a web-based furbearer registration system launched in 2019. Along with other technological advances, this allows agents to record information more efficiently and accurately, and to make it available to biologists more quickly.

Ultimately, by monitoring the occupancy rates of forest carnivores over large areas of the state, biologists will be able to track changes in carnivore populations over time.

Marten Photo by B. Evans/A. Mortelliti

3.14 Outreach & Communication

A key finding of the public survey effort was the resounding lack of general knowledge and/or intolerance of Maine's furbearer species. Many goals of this plan include more public support and understanding of the Department's key furbearer management strategies, more general awareness of Maine's 16 furbearer species, and greater participation in outdoor recreational activities involving these species.

3.15 Overarching Management Goals & Strategies

The furbearer steering committee and subcommittees identified several management goals and actions that apply universally to all 16 furbearer species. In most cases, these efforts are already underway or are part of the Department's core work program. They are:

Goal #1. Maintain healthy & abundant furbearer populations

- Monitor disease through annual trapper survey comments, staff observations, public reports, and rabies reports, and conduct further study when warranted. ***(Ongoing)***
- Determine status, distribution, population characteristics, and population trends using harvest, trapper survey, and conflict databases. ***(Ongoing)***
- Explore methods to estimate and monitor species populations independent of fur harvest data (e.g., eDNA, Audubon Wildlife Road Watch, habitat assessments, camera surveys, citizen science initiatives). ***(Ongoing)***

Goal #2. Maintain a sustainable furbearer harvest

- Monitor harvest with web-based registration system and annual trapper surveys for species not required to be tagged (e.g. annually estimate species harvest density by WMD). ***(Ongoing)***
- Monitor age and sex and explore alternative ways to collect these data for other species. ***(Ongoing)***
- Monitor trapper effort (e.g., trapping licenses, active trappers, trappers that caught each species, species catch per unit effort). ***(Ongoing)***

Goal #3. Maintain trapper interest & trapping opportunities

- Promote Best Management Practices for trapping. ***(Ongoing)***
- Continue to implement the Landowner Relations Program, which acknowledges the important contributions of landowners to the maintenance of wildlife habitats and helps ensure trapping access. ***(Ongoing)***
- Engage trappers with furbearer updates throughout the year (e.g., quarterly MTA newsletter, annual newsletter, annual meetings with trappers and directors, presentations at local chapters). ***(Ongoing)***
- Periodically survey trappers and hunters to determine satisfaction levels. ***(Ongoing)***
- Communicate areas of the state for trapping that have more conflicts. ***(Ongoing)***
- Implement a program to recruit, retain, and reactivate trappers (R3). ***(New)***
- Use current R3 survey data to inform and target specific user groups that are most likely to take up trapping as a new outdoor activity. ***(New)***
- Improve practical experience and conservation education aspects of trapper safety education courses (e.g., hands-on mentor opportunities). ***(New)***
- Review the trapping licensing and permitting system to identify ways to simplify it and increase participation while maintaining vital data on participation and effort. ***(New)***
- Remove barriers to trapping by offering more online options for licensing, education, and further training. ***(New)***
- Partner with other organizations to provide mentor and training opportunities (e.g., Next Step Workshops). ***(New)***
- Promote the diverse uses of furbearers (e.g., fur, meat, glands, teeth, skull, etc.). ***(New)***

Goal #4. Increase public understanding of furbearers & furbearer management

- Develop outreach messages highlighting the North American Model of Wildlife Conservation and the societal benefits achieved from utilizing hunting and trapping as management tools. ***(Ongoing)***
- Communicate the trapping rules and regulations, education and licensing requirements, and enforcement, as well as furbearer research and monitoring initiatives (e.g., general furbearer newsletter, Research and Management Reports). ***(Ongoing)***
- Raise the profile and ecological value of furbearers in Maine. ***(New)***
- Promote the value of furbearers to the ecosystem, as predator and/or prey. ***(New)***
- Promote distribution of furbearers and habitats where they can be viewed. ***(New)***
- Provide the public and landowners with opportunities to enjoy furbearers and identify their presence throughout the year (e.g., snow tracking, scat, houses, etc.). ***(New)***
- Promote Best Management Practices for Trapping and Next Step Workshops. ***(New)***
- Promote Living with Wildlife resources for non-lethal conflict resolution. ***(New)***

Goal #5. Minimize human-wildlife conflicts

- Continue to develop new outlets for the public to seek assistance when conflicts occur, primarily through MDIFW and USDA-WS. ***(Ongoing)***
- Improve Living with Wildlife resources to address common issues and promote co-existence. ***(Ongoing)***
- Continue to implement the Department's Human and Wildlife Conflict Policy and make improvements as needed. ***(Ongoing)***
- Continue to promote non-lethal options and trapping where appropriate, including in areas of the state that experience more wildlife conflicts.***(Ongoing)***
- Develop partnerships and training tools on how to resolve human-wildlife conflicts. ***(Ongoing)***
- Ensure public awareness of and access to trappers and ADC agents. ***(Ongoing)***
- Develop targeted information on conflict prevention during seasons when human-wildlife conflicts rise. ***(New)***
- Develop a database and mapping tool to track wildlife complaints. ***(New)***
- Periodically evaluate human-wildlife conflict complaint levels and responses. ***(New)***

Goal #6. Conservation of other species

- Continue working with USFWS and USDA-WS to address depredation of Endangered, Threatened, and Rare nesting shorebirds and pelagic bird species. ***(Ongoing)***
- Keep managing predation of other species, if warranted. ***(Ongoing)***
- Continue to implement the Incidental Take Plan for Maine's Trapping Program and work with trappers to reduce capture of lynx during the general trapping season. ***(Ongoing)***

4.0

BEAVER

4.0

BEAVER

Beavers are large, semi-aquatic rodents that play an important ecological and historic economic role in North America.

BEAVER HABITAT

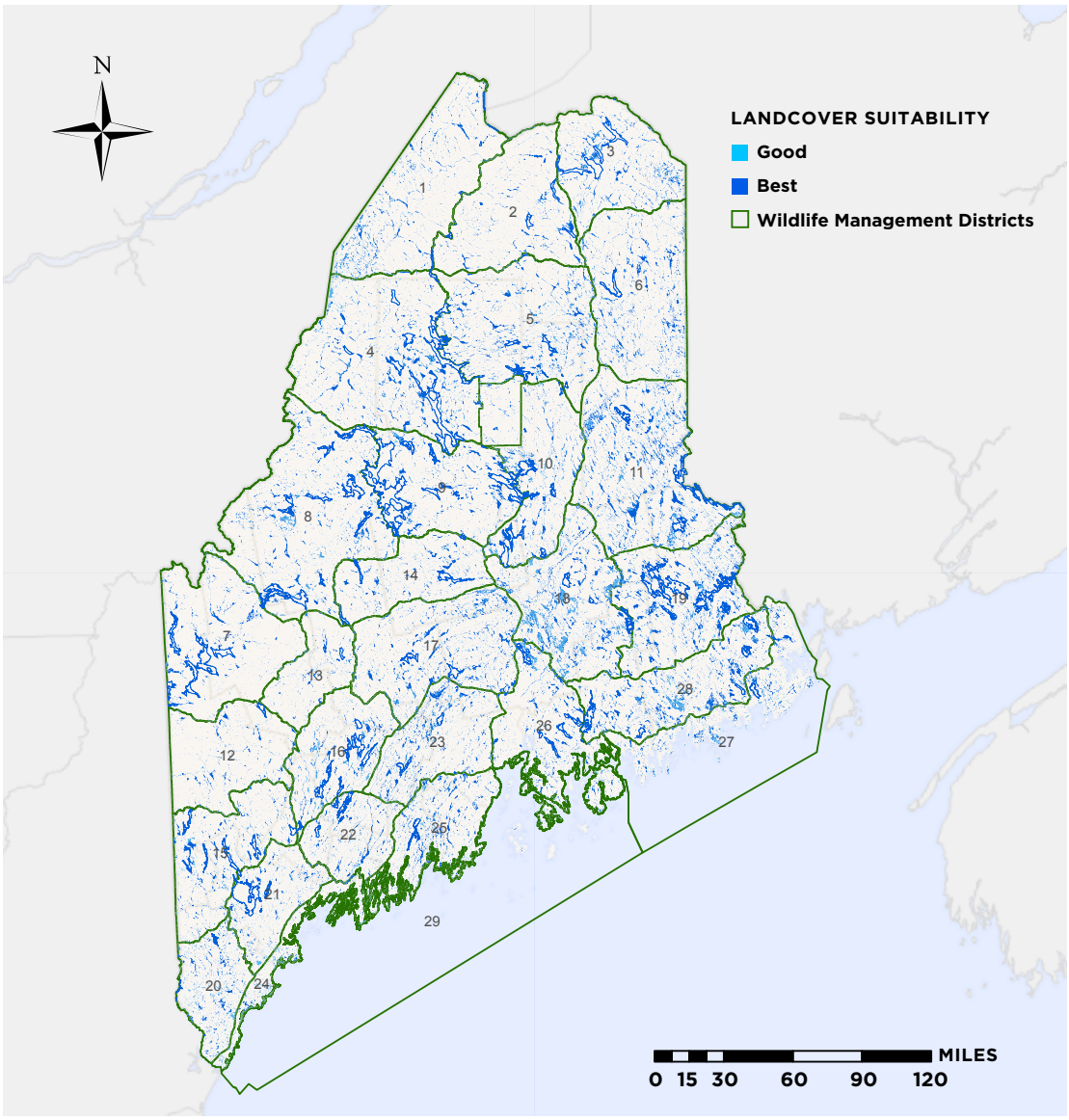


FIGURE 4.1 HABITAT SUITABILITY BASED ON BROAD HABITAT COVER TYPES AND ASSOCIATIONS FOR BEAVERS IN MAINE.

4.1 Natural History & Population Status

Beavers *(Castor canadensis)* are considered keystone species because they create and maintain habitat for many other species. They are the largest rodent in North America, reaching up to 60 pounds in size. Equipped with large incisor teeth, powerful jaws, a prominent tail, and webbed feet built for work and swimming, the beaver is nature's greatest engineer (Feldhamer et al. 2003). The beaver's compact physique and incessant drive to impound moving water serves their lifestyle well. From cutting down trees with their massive orange incisors, to building dams and houses, no job is too small for a beaver. Beavers manipulate their surroundings for their own benefit. By stabilizing water levels, they create and maintain habitats important to a variety of fish, amphibians, reptiles, birds, and mammals, as well as people who enjoy living alongside diverse, thriving wildlife.

Beavers use many different wetland types, typically surrounded by forests. Their favorite type of wetland is an impoundment with a relatively stable water level and depth that allows sunlight to reach the bottom (or littoral zone), allowing aquatic vegetation, like water lilies, to grow. Beavers are vegetarians and eat a variety of soft vegetation and woody plants. Their favorite food is the bark of young deciduous trees like aspen. Having evolved with wolves as a primary predator, beavers choose habitats that have food sources adjacent to or very close to water. The proximity to water not only keeps them safe – it also helps them efficiently transport food and building materials.

Beavers use water and cold temperatures to their full advantage. They have thick, waterproof fur consisting of two layers: a short, fine undercoat and a thicker, longer outercoat. Within their iconic stick and mud lodge is a dry den, accessible only from under the water or ice. They store food where it will be accessible just under the ice and near a lodge entrance. During the winter, they have no exposure to severe climate or significant predation. Otter may kill beaver under certain circumstances, but they are a minor threat. Where beaver occupy lakes and rivers, bank dens take the place of lodges, so dams are usually unnecessary or impractical.

POPULATION RECOVERY

Maine is home to one of the most abundant beaver populations in the northeastern United States, **(Figure 4.1, 4.2)** but it was not always this way. Historically, beavers were plentiful on the landscape and one of the most valuable commodities. They were used for food, bedding, clothing, and even as currency (NEFRTC 2015). In the early 1700s, goods and services were priced relative to a prime processed beaver pelt, called a "made beaver". For example, a wool blanket may cost 7 made beavers or equivalent (Carlos and Lewis 2008). Beavers were highly sought after for making fashionable and functional garments, such as the warm, durable felt hats that were extremely popular in Europe during the 16th and 17th centuries (Carlos and Lewis 2008). The beaver's castor glands have been used in perfumes, food additives (e.g., vanilla flavoring), and as medicine to cure earaches, headaches, and memory loss. And beaver meat, including roasted beaver tail, has been consumed for centuries. People continue to use beaver today for clothing, food, and other products such as beaver tail wallets and jewelry.

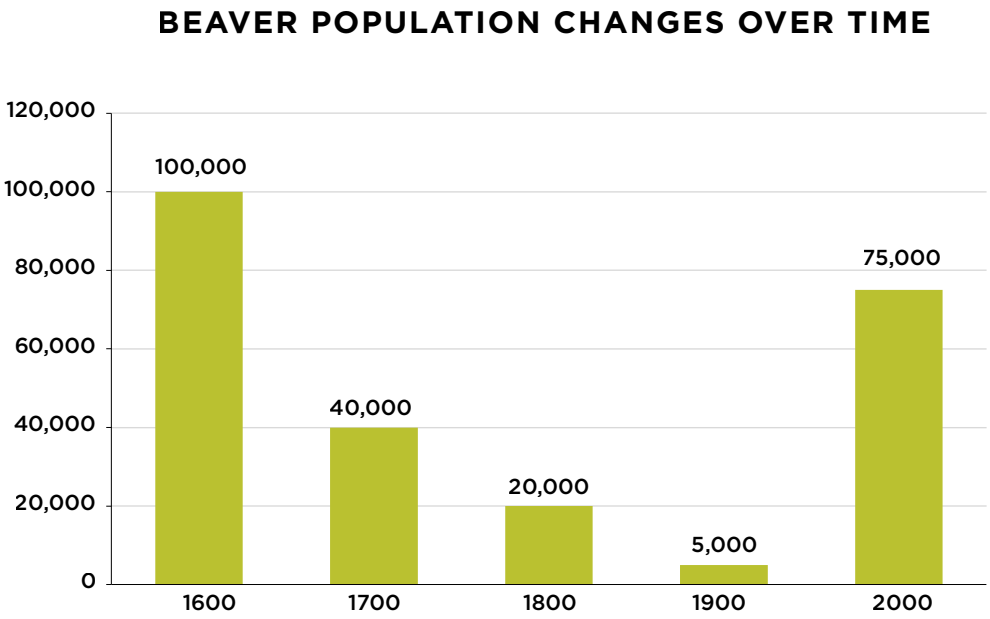


FIGURE 4.2 MAINE'S ESTIMATED BEAVER POPULATION REBOUNDED RAPIDLY ONCE REGULATIONS WERE ESTABLISHED IN THE LATE 1800S AND EARLY 1900S, AND HAS CONTINUED TO GROW.

During pre-colonial times, Maine's beaver population was estimated to be as high as 100,000 (Hodgdon and Hunt 1953); but by 1900, unrestricted use of beavers led to their near extirpation **(Figure 4.2)**. The harvest of beaver was prohibited by law in 1899, and the population began to recover. By 1915, beaver nuisance complaints were reported, and beaver trapping was allowed again in select townships to reduce flooding of agricultural lands and roadways. Since then, the beaver population has grown in response to few natural predators, abundant regenerating forests, and ample wetland habitat.

Since beavers are challenging to survey, MDIFW has traditionally monitored population trends using a blend of habitat and harvest data. During the last beaver assessment (1985), the population was estimated at between 45,000 and 70,000. This was based on a formula that incorporated age of harvested beaver and age groups in the population (Hilton 1986). In the mid-1980s, the amount of beaver habitat in Maine was estimated at 37,000 miles of inland shoreline. Beaver fur was valuable, and approximately 10,000 beaver were harvested each year. Since that time, demand for fur has fallen, with more recent annual harvests averaging closer to 5,000 beavers **(Figure 4.3)**. Beavers are abundant statewide, but fewer beaver tend to be harvested in western and northwestern Maine as a result of lower habitat quality and/or accessibility due to the remote nature of the region **(Figure 4.4).**

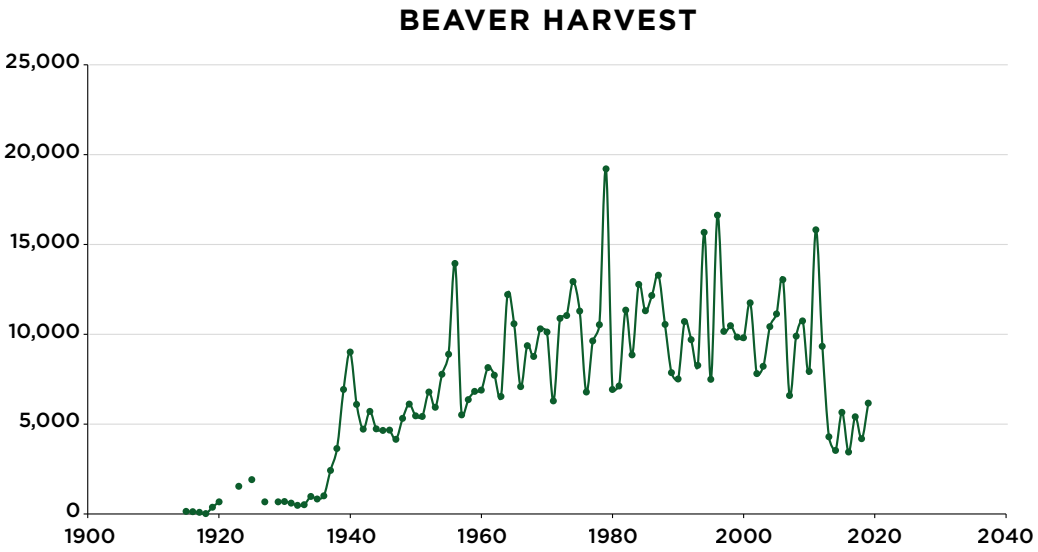


FIGURE 4.3 ANNUAL BEAVER HARVEST IN MAINE (1915-2019)

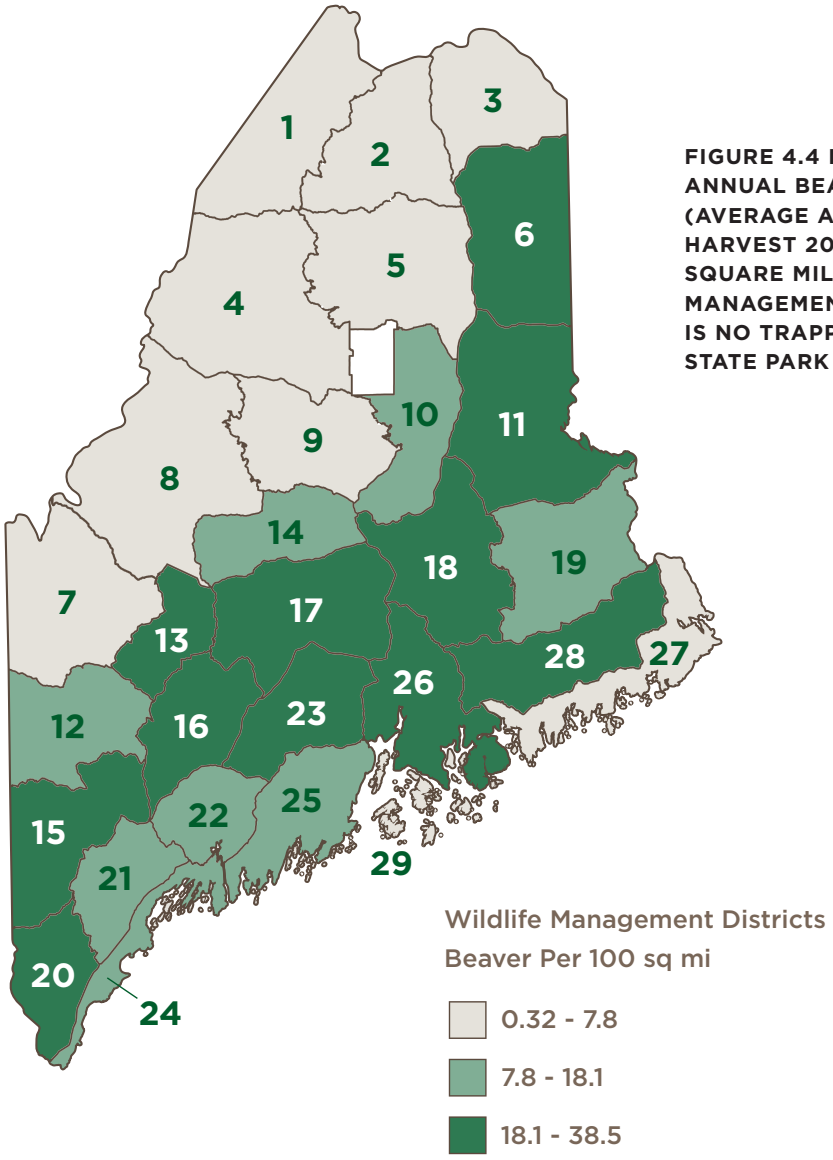


FIGURE 4.4 MAP OF MAINE'S ANNUAL BEAVER HARVEST (AVERAGE ANNUAL BEAVER HARVEST 2015-2019) PER 100 SQUARE MILES BY WILDLIFE MANAGEMENT DISTRICT. THERE IS NO TRAPPING IN BAXTER STATE PARK (WHITE POLYGON).

4.2 Beaver Management History

Maine's first game law, which passed in 1764, provided some protection for beavers by prohibiting the take of beaver after May 1, except by Native Americans **(Table 4.1).** During the 1800s, beavers could be taken October through May. By 1899, the season was closed, but the Commissioner had the authority to open areas where damage was occurring. In the early 1900s, the beaver population grew and the Commissioner recommended opening townships in several counties for trapping. Beaver trapping licenses were not required until 1927, and the Lacey Act of 1929 provided further regulation of trapping by prohibiting untagged furs to cross state lines. Maine's first beaver study was conducted in 1946 and evaluated habitat, population size, carrying capacity, disease, and pelt primeness. Beaver trapping seasons have changed over time depending on the area, generally expanding as the population has grown. With more recent interest in open-water trapping, and with the need to keep human-beaver conflicts down, the season was lengthened to roughly six months, from the fall to early spring. However, recent efforts to further expand the season have been met with some public opposition.

TABLE 4.1 SUMMARY OF RESEARCH AND MANAGEMENT ACTIONS FOR BEAVER (1764-2019)

YEAR	RESEARCH AND MANAGEMENT ACTIONS
1764	First game law was passed, prohibiting the taking of furs (except by Native Americans) in certain areas of the state.
1866	Maine Legislature passed a law to prohibit take of beavers and other furbearers from June 1-October 15. Beaver trapping season was 7.5 months (October 15-May 31).
1878	Beaver trapping season was shortened to 6.5 months (October 16-April 30).
1899	Beaver trapping season was closed, but the Commissioner had the ability to open the season in some areas if beavers were causing damage.
1913	Maine Legislature passed a law that required landowners to file a written complaint before the Commissioner could open an area to beaver trapping.
1915	Some areas were open to beaver trapping again and beaver pelts were required to be sealed or stamped by a game warden.
1927	Mandatory beaver trapping licenses were introduced. On average, 638 beaver trapping licenses were sold per year from 1927-1933, compared with 2,778 regular furbearer trapping licenses. Beaver skins had to be officially stamped (fee of $2 per pelt).
1929	Federal Lacey Act prohibited interstate shipment of untagged furs.
1934	New restrictions made it illegal for a person to damage or destroy a beaver dam or house, and rules prohibited setting a trap within 25 ft of a beaver house. At the time, a person was lawfully allowed to kill any wild animal – except beaver – caught in the act of destroying that person's property.
1946	Commissioner George J. Stobie initiated a Maine beaver study to evaluate their habitat, measure parasitism, and determine population, productivity, carrying capacity, and timing of pelt primeness.
1947	The Maine Legislature established an annual beaver trapping season from January 1-February 7 in areas where beavers were doing damage.
1955	The entire state was open to beaver trapping during January and February, but the Commissioner could close specific areas if necessary. The fee to tag a beaver skin was $1, and setting a trap within 10 ft of a beaver dam was prohibited.
1963	The Commissioner was given authority to set the length of the beaver trapping season or close areas without legislative approval. People were prohibited from setting or tending a beaver trap within 4 ft of another person's beaver trap. Killer-type traps with a jaw spread greater than 8 inches were allowed during the beaver trapping season as long as they were set, placed, and tended so the trap is completely under the water.

YEAR	RESEARCH AND MANAGEMENT ACTIONS
1970	The definition of beaver dam and beaver house was revised to pertain to a dam or house being maintained by beavers.
1972	The Commissioner's authority was extended so that they could lengthen the beaver trapping season.
1976	Beaver trapping season was extended to three months (December through February).
1982	Beaver skins had to be tagged by a warden or agent of the Commissioner for a fee of $0.25 each. It was unlawful for a nonresident to trap beaver in Maine.
1990	Beaver trapping season was extended to four months (December through March), but varied by Wildlife Management Unit. The beaver season in the north was the longest duration. It was unlawful to place a trap within 10 ft of a beaver house and 5 ft of a beaver dam in WMU 1 and 2, and within 25 ft of a beaver house and 10 ft of a beaver dam in WMUs 3-8.
1996	It was unlawful to trap within 10 ft of a beaver or muskrat house or 5 ft of a beaver dam.
1998	The Department transitioned to Wildlife Management Districts (WMD). Beaver trapping season was still December-March, but varied by WMD, and some towns or parts of towns were closed to beaver trapping at the landowner's request. New beaver season dates were mailed to all licensed trappers by mid-October of each year.
2002	Beaver trapping season takes place from November through March, but opens and closes at different times depending on WMD.
2003	Beaver trapping season takes place from November through April, but opens and closes at different times depending on WMD.
2011	Beaver trapping season was extended to mid-October through April in northwestern Maine (WMD 1, 2, 4, 5). Suitcase-type live traps, such as the Hancock live trap, were prohibited, with some exceptions for animal damage control. The law was revised to allow nonresidents to trap beaver if the nonresident's state or province of residency allowed Maine residents to trap beaver in that state or province.
2015	Beaver trapping season was extended by two weeks in the southern two-thirds of the state (WMD 15, 16, 20-26, 29), from a start date of December 1 to November 15. Beaver seasons were also adjusted for start date of mid-October (WMD 1-4) and November 1 (WMD 5-14, 17-19, 27, 28).
2016	Beaver trapping season was extended by one week (WMD 15, 16, 20-26 , 29) to start when the general trapping season opened (approximately November 1).
2019	In statute, the Commissioner was given the authority to lengthen beaver trapping season up to 21 days due to weather or other factors. Beaver trapping season was expanded by two weeks to end April 15 (WMD 7, 12-29).

See Appendix 3 for WMU/WMD map comparison.

4.3 Regulatory Framework

Like all Maine wildlife, beavers are a publicly owned resource held in trust by the State for the benefit of all Maine residents. The Department currently offers a regulated beaver trapping season set by Wildlife Management Districts (WMD). The state is separated into 29 WMDs which are designated based on climate, terrain, and habitat. Major physical landscape features (major roads, rivers, transmission lines, etc.), not political designations, define the bounds of each WMD. All WMDs are open to trapping unless specifically closed. Towns within WMDs that are open to trapping can be closed as the population requires, as can specific areas (defined by physical landscape features) within a town open to trapping. These are called Private Closures and are done for landowner relations or fish and wildlife habitat management purposes. Private Closures are published in the Summary of Maine Trapping Laws.

Beaver trapping season dates have historically changed each year, always opening and closing within the timeframe of November through April. Dates are set through the rulemaking process under the Maine Administrative Procedures Act, which provides an opportunity for public comment. There are no bag limits for beavers, but there are restrictions on equipment and trap placement, and all beaver pelts must be tagged by an agent of the Commissioner within 10 days following the close of the trapping season. The individual fur tag number, trapper's license, species, date (month), and town of capture are recorded.

4.4 Public Consultation – 2020 Key Findings

In 2019, Maine Department of Inland Fisheries and Wildlife hired Responsive Management to conduct research on public opinions of furbearers and furbearer management (Responsive Management 2020). Public attitudes toward beavers were positive, though knowledge of them could be greatly improved. Of all the furbearer species, Maine residents had the most knowledge of skunk, raccoon, and coyote. Beaver fell in the middle with 33% of residents responding that they knew a great deal or moderate amount about the species. Most people (67%) knew a little or nothing at all about them, while 4% responded "don't know." A substantially higher percentage of residents in the southern part of the state (43%) responded that they knew a great deal or moderate amount about beaver, as compared with the north/east (27%) and central (23%) regions. When asked to rank how beneficial they are on a scale of 0 (not at all) to 10 (extremely), beavers had the highest score (7.6) of any furbearer species. The south region ranked beaver with the highest score (8.3), followed by the central (7.1) and north/east (6.7) regions.

MAINE RESIDENTS' OPINIONS REGARDING BEAVER POPULATION

35%	6%	37%	21%
POPULATION TOO HIGH OR ABOUT RIGHT	POPULATION TOO LOW	THOUGHT NONE WERE IN AREA	DIDN'T KNOW

Regarding furbearer population levels, 35% of residents felt the beaver population was too high or about right, 6% felt it was too low, 37% thought there were none in their area, and 21% didn't know. A higher percentage of residents in the north/east region (11%) felt the beaver population was too high, compared with the central (3%) and south (2%) regions.

After fox, people enjoyed seeing beaver the most of any furbearer species in their area. When asked "which statement best describes your feelings about beaver around your home or in your area?", 41% of residents responded there were none, 25% said they enjoyed seeing and having them around, 14% said they enjoyed seeing them and having them around but worried about problems, 13% had no feelings, 4% viewed them as a nuisance, 3% didn't know, and 0% viewed them as dangerous. Landowners had a slightly different perception compared to the general population. They showed high concern about beaver, coyote, raccoon, and skunk; but they liked having beaver around as long as damage was minimized.

More than a third of residents (37%) had conflicts with wild animals or birds in the past two years, with beaver among the top 5 furbearer species (after raccoon, skunk, fox, and coyote) involved. More beaver problems were reported in the north/east (11%) as compared to the central (7%) and south (3%) regions. Landowners reported more beaver problems than residents, with 19% in the central region and 13% in the north/east and south regions reporting beaver conflicts in the past two years.

Most Maine residents (75%) approved of regulated trapping in general, while 17% disapproved and the rest were neutral. Support for regulated beaver trapping is a little lower than trapping in general, but still high with 63% of the general population saying they approved of trapping the species.

4.5 Management Issues & Threats

The Department receives complaints about beavers every year from homeowners, towns, farmers, businesses, recreationalists, and large landowners all over the state. Maine has over 23,000 miles of public roads (USDOT 2018) with tens of thousands of culverts. In addition to the cost to repair damages of flooding, road washouts introduce sediments into streams, which has negative consequences for fish and other aquatic wildlife. For large landowners and towns, it can cost thousands of dollars to repair roads flooded and culverts destroyed by beavers. For some waterfront homeowners, flooding of yards and basements and felling of ornamental trees are also problems. In Maine, the USDA Wildlife Services receives calls from the public about problems they are having with wildlife and they estimate cost associated with damages. Beavers were the furbearer species that resulted in the highest total losses. From 2009 to 2018, the USDA estimated that beaver damages amounted to $6.6 million. Damages were associated with the following, listed in the order of decreasing losses: roads and bridges, crops/pasture/property, other, utilities, and timber (USDA personal communication).

4.6 Population – Biological & Social Carrying Capacity

Beavers are sexually mature early in life. They breed at year two and produce moderate-sized litters (typically two to nine kits). Space and food are limited at every beaver flowage, so offspring are not allowed to stay home forever. Their primary foods (trees and large shrubs) require years or decades to be replenished. Therefore, every year, young-adult beaver (second year before next litters are born) are forced to leave or disperse on their own to find unoccupied habitat, or suitable habitat where a single potential mate resides.

BIOLOGICAL CARRYING CAPACITY

The functional use of a home colony depends on the size of a flowage, abundance of food, and number of inhabitants. Flowage occupancy generally goes through cycles of one to 20 years, depending on many factors, but most often related to sustained presence of foods including key tree or shrub species and emergent aquatic plants. Replacement of trees and shrubs, which beaver rely heavily on for food and building material, takes years; but the additional presence of ample aquatic plants can sometimes extend the viability of an established flowage. Biological carrying capacity, or the number of beavers supported by Maine's landscape at the flowage level, is correlated to these factors (Lawrence 1952, Fryxell 2001).

Beavers can travel many miles to locate unoccupied habitat, with their dispersal dependent on the availability and connectivity of aquatic habitats. Maine has an abundance of rivers, streams, brooks, lakes, ponds, and large wetlands. Being nearly 90% forested with an active forest industry that has created high tree densities of preferred food items, the food component of beaver habitat is well distributed and of high quality.

Like most wildlife, public opinion varies greatly on how many beavers are too many, or how many beavers are still not enough.

Beaver harvest (including mortalities from conflicts) was traditionally considered the primary limiting factor to beaver. In the past, it was assumed that if harvest did not exceed a certain threshold in a particular WMD, the beaver population could be maintained near biological carrying capacity. However, we believe the beaver population has grown steadily in the last several decades due to an abundance of high quality habitat and a decline in harvest pressure and most suitable habitat is now occupied by beavers.

SOCIAL CARRYING CAPACITY

Like most wildlife, public opinion varies greatly on how many beavers are too many, or how many beavers are still not enough. This opinion is coined Social Carrying Capacity, and is impacted by people's relationship with the species, whether that relationship involves viewing them, just knowing they are here, being adversely impacted, or being a consumptive user. For many with those interests, more is better. If you compare deer to beaver, the abundance of deer can directly impact people in ways such as vehicle collisions or vector-borne disease transmission, such as Lyme disease. Beavers rarely impact people in these ways, so this can affect the opinions of those without a direct relationship with this species. Giardia or 'beaver fever' is present in almost all Maine waters and is spread by many species, including beaver. However, the primary source of giardia is human fecal contamination (Hunter and Thompson 2005).

Another reason why some people feel there are too many of a species is the (real or perceived) impact the species has on other wildlife (e.g., coyote and deer). It is difficult to find examples of this with beaver. In fact, it is well documented that the beaver's creation and alteration of wetlands benefits many of Maine's wildlife, including some rare, threatened, and endangered species.

Alternatively, people who experience problems with a species often have a very different perspective. Nearly all beaver problems are associated with property damage or the cost of such damage. For some people, it may only be a one-time problem. For large landowners or jurisdictions responsible for transportation, the costs can be continual and significant. In some parts of the state, beaver numbers have exceeded social carrying capacity.

Today, beavers are managed as a valuable furbearer with open and closed seasons as well as rules and regulations that specify when, where, by whom, and with what type of equipment beavers can be trapped.

BEAVER POPULATIONS ARE NO LONGER ESTIMATED BY FORMAL METHODS

Beavers were nearly extirpated in the late 1800s, but their populations grew rapidly when trapping regulations were established in the late 1800s/early 1900s. In 1934, beavers became, by law, one of the few species that landowners could not kill in the act of damaging property. Today, beavers are managed as a valuable furbearer with open and closed seasons as well as rules and regulations that specify when, where, by whom, and with what type of equipment beavers can be trapped. Because of these regulations, an abundance of young forests and wetland habitat, and the absence of their primary natural predator (wolves), beaver populations are abundant across the state.

Historically, we estimated beaver population trends using quantitative assessments of available habitat and trapper effort. In the 1980s, there was a lot of interest in the fur trade. Beavers were managed at the town/township level, and population estimates were calculated based on habitat variables and limiting factors. An allowable harvest was estimated based on sustainable yield. In other words, the number of animals that could be removed was based on the number of animals born into the population. Biologists carefully reviewed annual harvest data and made recommendations for rule and regulation changes to ensure that beavers were not being over-utilized. The Department has always considered options to close specific flowages to trapping based on biological or social concerns such as local trapping pressure or landowner desires.

The last planning period for beaver (1985) established a management goal of maintaining stable beaver populations at current levels (estimated at 44,000-67,000 beaver). The harvest objective was to increase average annual harvest to 15,000 beaver statewide. This would maintain beavers near carrying capacity and minimize human/beaver conflicts.

An abundance of quality habitat, combined with a long-term decline in trapping participation, made an annual assessment of beaver numbers a low priority. During the last decade, human/beaver conflicts have remained consistent in some areas and increased in others, suggesting that Maine's beaver population is currently robust.

HUMAN/WILDLIFE CONFLICTS & SOLUTIONS

The work of maintaining a healthy beaver population is both biological and social. As trapping effort has fallen in recent decades, the number of beaver complaints has increased. To keep the public satisfied with the beaver population, and to keep people's attitudes positive, we need to generate public awareness of beavers' presence and ecosystem benefits while also showing people how to prevent and manage conflicts.

Beaver frequently come into conflict with people, with the most common problem being beavers' need to impound flowing water – particularly when that involves blocking road structures such as culverts and small bridges. The second-most problematic situation is when impounded water affects agriculture, developed property, land management, or recreational access. Less common, but not insignificant, is the issue of beavers killing or felling trees of aesthetic value (usually on waterfront properties).

The Department promotes co-existence with beavers through a step-down approach to resolving human-wildlife conflicts: 1) Education and Extension, 2) Prevention, 3) Use of Hunting and Trapping Regulations, 4) Live-Capture and Relocation, and 5) Lethal Removal.

The cost associated with problem beavers varies on a case-by-case basis. It is common for beavers to be removed at no cost by licensed trappers during the regulated beaver trapping season, which generally runs from mid-October to April. Department staff routinely assist complainants by connecting them with the local trappers. However, when done outside the trapping season, the cost to resolve beaver conflicts can be a substantial burden on landowners.

The expense associated with lethal removal, outside the trapping season, or live-capture and relocation by certified agents varies by location within Maine, distance from services, numbers of animals involved, nature of problem site (one-time event or chronic), and the service provider's rates. Often, this cost falls within the $50-$100 per beaver range. Some large forest landowners with significant beaver problems report spending up to $50,000 per year to hire contractors to repair roads and culverts, and hire agents to remove beavers (H. Stabins personal communications).

RESOLVING BEAVER CONFLICTS WITH SITE MODIFICATION

Beaver dams are the greatest source of conflict (creating flooded land conditions, road washouts, impassible roads, etc.), but can sometimes be addressed with modifications at the site that allow beaver to still live in the area without harming the road infrastructure or creating water quality issues. A physical barrier to exclude wildlife is often the best way to solve a human-wildlife conflict. Every year, young beavers disperse to find unoccupied habitat or a mate, creating a window of opportunity for landowners with good quality habitat and a history of problems to use site modification techniques. Since the 1970s, Maine landowners have been modifying problem sites with exclosures and water leveling devices, typically spending anywhere from a few hundred to over a thousand dollars per site. The objectives of site modification are to resolve a current problem, minimize or eliminate future conflicts, and maintain quality wetland wildlife habitat. However, every site is unique and must be evaluated. Site modification may not work in every location. Annual maintenance and repairs may also be needed to ensure success over time. For a detailed overview and description of these techniques, visit the living with wildlife section on the Department's website.

4.7 Beaver Management Goals & Strategies for 2020-2030

Goal #1. Maintain healthy, abundant beaver populations

- Explore methods to estimate and monitor the beaver population independent of fur harvest data, such as GIS technologies to monitor flowages over time, aerial surveys to identify active beaver colonies, or citizen science initiatives tracking beaver flowages on the landscape. ***(New; High Priority)***
- Maintain aquatic habitat protections (e.g., NRPA, SLODA, Clean Water Act). ***(Ongoing; Moderate Priority)***

Goal #2. Maintain a sustainable beaver harvest

- Ensure that the beaver harvest falls within allowable levels for each WMD, to accommodate social acceptance of beaver population levels while maintaining appropriate flowage occupancy and ample beaver-influenced habitats on Maine's landscape. ***(Ongoing; High Priority)***

Goal #3. Maintain trapper interest & trapping opportunities for beavers

- Maintain or increase the number of licensed trappers targeting beaver. ***(Ongoing; High Priority)***
- Review beaver trap setback distance regulations; and where appropriate, make consistent across WMDs. ***(Ongoing; High Priority)***
- Work with MDIFW landowner relations and land acquisition programs and partners to identify ways to increase and prioritize opportunities for accessible aquatic trapping activities when considering new acquisitions. ***(Ongoing; Moderate Priority)***
- Enhance aquatic trapping access and identify areas of need. ***(Ongoing; Moderate Priority)***
- Develop tools to determine current participation and interest from new beaver trappers. ***(New; High Priority)***
- Promote beaver as a healthy source of high-quality organic protein. ***(New; Moderate Priority)***
- Promote other products to utilize beaver (e.g., bait, castor glands, beaver tail jewelry, wallets, and other products). ***(New; Low Priority)***
- Develop outreach tools that promote unique aspects of prime beaver trapping and the intrinsic benefits of winter experiences like under-ice trapping. ***(New; Low Priority)***

Goal #4. Increase public understanding of beavers & beaver management

- Maintain, or increase, 2019 levels of satisfaction and support for Maine's beaver management program by the general public, trappers, and landowners. ***(Ongoing; High Priority)***
- Increase public awareness of the value of beaver and the role trapping plays in managing the species and reducing human-wildlife conflicts. ***(Ongoing; High Priority)***
- Develop shareable graphics promoting the ecological services that beavers provide, including wetland habitat alteration. ***(New; High Priority)***
- Develop lesson plans for educators promoting awareness of beaver and their positive ecological services. ***(New; Moderate Priority)***

Goal #5. Minimize human-beaver conflicts

- Reduce the number of human-beaver conflicts through the Department's Animal Damage Control program. ***(Ongoing; High Priority)***
- Develop a database and mapping tool to track beaver complaints. ***(Ongoing; High Priority)***
- Continue to maintain a list of regional chronic problem sites and active beaver trappers to resolve landowner conflicts. ***(Ongoing; High Priority)***
- Keep collaborating with USDA-WS to resolve beaver conflicts and collect associated data. ***(Ongoing; High Priority)***
- Increase the promotion of beaver exclusion and/or water control devices to prevent and resolve flooding conflicts, while also conserving important wetland habitats for other wildlife. ***(Ongoing; High Priority)***
- Develop education and extension materials for homeowners and land managers on how to resolve human-beaver conflicts. ***(Ongoing; High Priority)***
- Periodically survey the 12 largest landowners and other partners to determine how beavers are impacting road systems. ***(Ongoing; Moderate Priority)***
- Develop a tool to inventory the cost and monitor the success of water control devices on the landscape. ***(Ongoing; Moderate Priority)***
- Continue working with MDIFW fisheries biologists to identify areas where beaver presence impacts fish populations and incorporate these impacts into the regulatory framework and education/outreach initiatives. ***(Ongoing; Moderate Priority)***
- Explore options to align statutes regarding landowners' beaver conflict resolution options to be consistent with other non-T&E species regulations. ***(Ongoing; Moderate Priority)***
- Provide annual training on prevention techniques to MDIFW staff, highway managers, forestland managers, ADC agents, and USDA-Wildlife Services. ***(Ongoing; Moderate Priority)***
- Develop and periodically host workshops demonstrating techniques for landowners to co-exist with beavers. ***(Ongoing; Moderate Priority)***
- Periodically evaluate human-beaver conflict complaint levels and types of responses. ***(Ongoing; Low Priority)***

Goal #6. Conservation of other species

- Develop and promote outreach materials that highlight aquatic habitats and regulatory protections. ***(Ongoing; Moderate Priority)***
- Create a shareable graphic and Social Media materials highlighting all the species that benefit from beaver-altered wetland and surrounding habitats. ***(New; Moderate Priority)***

Expected Outcomes for Beaver Management

Implementing the beaver management strategies outlined in this plan will require adequate staffing, funding, and public support. It may not be necessary or feasible to carry out all strategies to achieve this plan's goals and objectives.

We anticipate the following beaver-related outcomes over the next 10 years (by 2030 unless otherwise noted):

By 2025, outreach and communication efforts will have increased public knowledge of beaver.	Public support for beaver management will remain above 60%.	Public tolerance for beaver will be maintained.	Through management actions and outreach efforts, beaver trapping and viewing opportunities will be maintained.	Keep statewide beaver complaints, which will be tracked, below 2021 levels.

5.0

RIVER OTTER

5.0

RIVER OTTER

River otters are semi-aquatic and occur along rivers, streams, ponds, wetlands, and in marine environments.

OTTER HABITAT

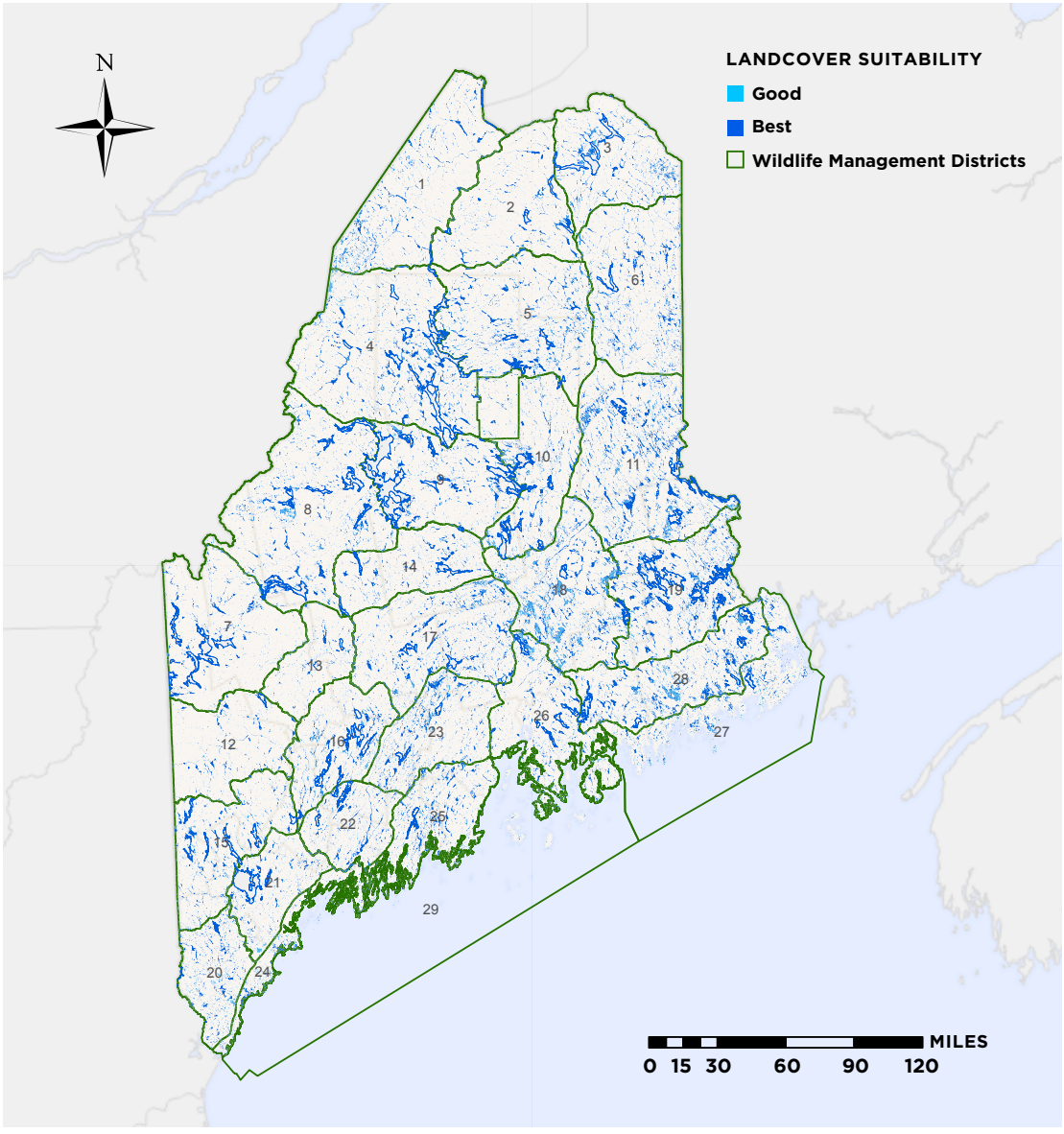


FIGURE 5.1 HABITAT SUITABILITY BASED ON BROAD HABITAT COVER TYPES AND ASSOCIATIONS FOR RIVER OTTERS IN MAINE.

5.1 Natural History & Population Status

Maine is home to one species of otter—the River Otter. Although similar in appearance, Sea Otters only occur on the coasts of the Pacific Ocean. River otters *(Lontra canadensis)* are semi-aquatic and occur along rivers, streams, ponds, wetlands, and even in marine environments **(Figure 5.1)**. At the time of European settlement, river otters could be found across most of sub-arctic North America, including all of Maine's major waterways (Melquist et al. 2003).

During the 1800s and early 1900s, environmental degradation from log drives and pollution from industrial and municipal waste left many areas of Maine uninhabitable by otters. By the 1930s, otters were still present in all 16 Maine counties, but their distribution and abundance was significantly reduced (Palmer 1937). Maine's river otters were not alone – populations elsewhere in the U.S. also experienced significant declines, including complete extirpation from 11 states (Raesly 2001).

Restrictions on pollution such as the Clean Water Act have allowed water quality to rebound and, along with regulations on trapping, have allowed otter populations to recover. In Maine, otters naturally recolonized the state, and now occupy all major watersheds. But in much of the country, local populations were so depleted that reintroductions were necessary. River otters were successfully reintroduced via trap and transfer methods into vacant areas of 22 states and 1 Canadian province, and they now occur in every continental state (Raesly 2001).

River otters are carnivorous, relying on prey they capture in the water or along the water's edge. Fish are their most common prey item; but where available (and especially in summer), crayfish also make up a large portion of their diet. They will also eat amphibians, waterfowl, muskrat, insects, mollusks, and occasionally other species (Stearns and Serfass 2011).

Otters choose their fish based on availability and swimming ability, most frequently consuming common and slower-swimming species like suckers, minnows, and catfish. However, they are still capable of catching trout, salmon, and other game species, and therefore can cause damage at fish hatcheries, private fish ponds, or aquaculture facilities where fish have little cover or opportunity to escape.

River otter and beaver populations are inescapably linked for multiple reasons. They use similar habitats, with otters' use of freshwater ecosystems higher in areas also occupied by beavers (Dubec et al. 1990, LeBlanc et al. 2007). When beavers impound streams, they increase the amount of habitat available to otters, creating diverse wetland conditions that benefit many species of otter prey.

Otters also use beaver dens and lodges for shelter and denning, sometimes even when the beavers are present (Melquist and Hornocker 1983). On rare occasions, otters will also consume beavers (Greer 1955). Due to their common co-occurrence, aquatic trappers frequently set traps targeting both species on the same trapline, and occasionally otters are incidentally taken in traps set for beaver. Therefore, harvest trends for the two species are highly correlated **(Figure 5.2)**.

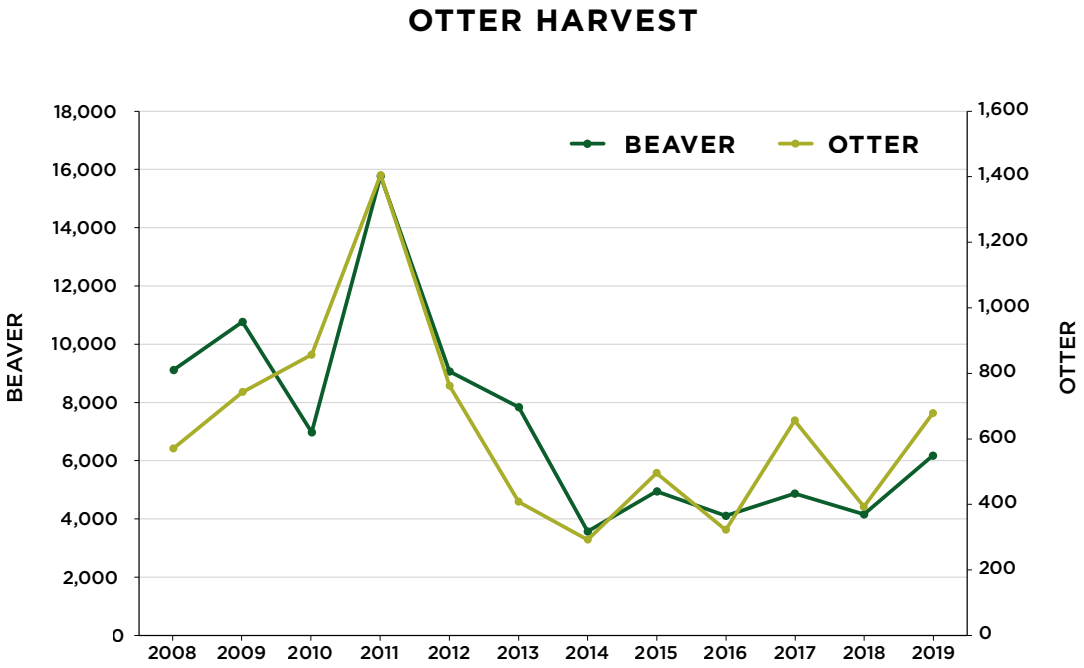


FIGURE 5.2 COMPARISON OF MAINE BEAVER AND RIVER OTTER HARVESTS (2008-2019).

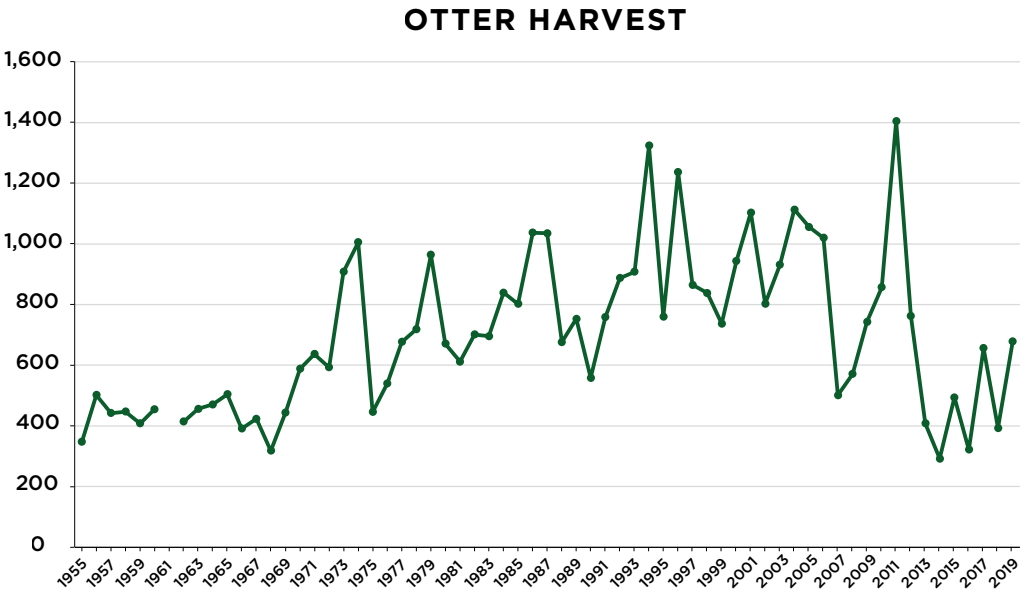


FIGURE 5.3 RIVER OTTER HARVESTED FROM 1955-2019 IN MAINE.

5.2. Management History

Maine has regulated the harvest of river otters since the late 1800s. In 1893, the open season for otters (which included hunting and trapping) ran from October 16 through April 30. Although hunting of otters was allowed until 1967, it was not a popular harvest method. After steel traps were introduced in the 1870s, most otters were taken via trapping. No bag limits have ever been set for river otters; instead, the otter harvest has primarily been regulated and managed on a statewide level by adjusting the length and timing of the season. The open otter season typically co-occurs with that of other furbearing species which change periodically but may include mink, fisher, or fox.

The season has always started between mid-October and early November and extended into the winter months **(Table 5.1)**. Since 1991, the general trapping season (including otter) has started on the Sunday preceding the opening day of the regular firearms season on deer and ended on December 31. In 2016, MDIFW began requiring trappers to submit a tooth with every tagged otter, from which we are able to obtain sex and age structure data.

A variety of factors can cause the annual otter harvest to vary, including weather, pelt price, and trapper effort. Historically, the otter harvest increased from an average of 151 otters per year in 1928-1935 (Palmer 1937) to a peak of 1,405 otter in 2011, and has since declined to an average of 496 otter from 2012 to 2019 **(Figure 5.2, 5.3)**. River otter trapping occurs throughout the state, with most otters currently trapped in eastern Maine **(Figure 5.4).**

TABLE 5.1 SUMMARY OF RIVER OTTER MANAGEMENT ACTIONS (1893-2019)

YEAR	MANAGEMENT ACTIONS
1893	Otter season was 6.5 months (mid-October though end of April).
1899	No closed season for otter.
1911	Otter season was restricted to five months (approximately November to March).
1913	Otter season was restricted to approximately four months (mid-October or November to February).
1929	Otter season was restricted to 2.5 months (mid-November to January).
1931	Northern counties were opened for an additional month of otter trapping (mid-October to January).
1935	Otter season was four months (October 15 to February 15), varying by county, with longer seasons in northern Maine.
1949	Otter season was one month (November).

YEAR	MANAGEMENT ACTIONS
1952	Otter season was three months (November, January, and February).
1967	Otter hunting was banned, and the trapping season was three months (November to January).
1971	Otter trapping season was four months (November to February).
1973	Otter trapping season was restricted to two months (November and January).
1976	Otter trapping season was restricted to one month (November).
1981	Trappers were required to have otter skins tagged, for a fee of 25 cents each, by a warden or agent of the commissioner, within 10 days after the close of the otter trapping season.
1982	Federal law requires an export permit for any transportation of otter skins outside the United States.
1985	Trappers can keep incidental otter caught during the beaver trapping season.
1988	Trapping season was expanded to six weeks (end of October to early/mid-December).
1991	Otter trapping season was two months (Sunday preceding opening day of firearms season on deer to December 31).
1992	Trappers can keep otter caught in muskrat traps.
1998	Otter must be tagged by MDIFW staff.
2016	Mandatory submission of otter jaw or canine tooth sample from all harvested otter.
2019	Trappers are required to tag otters within 10 days when taken during the spring beaver trapping season (January 1 to April 30) and required to submit annual fall and spring trapper effort reports.

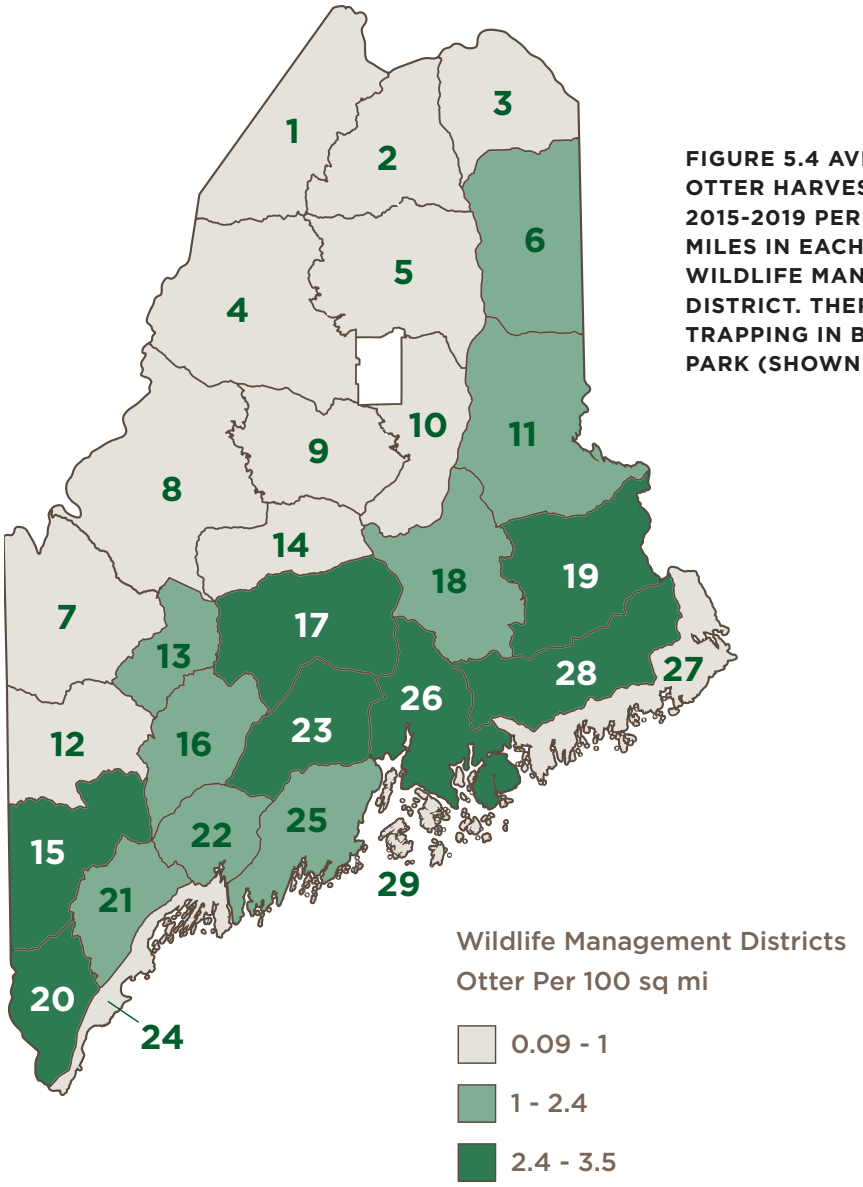


FIGURE 5.4 AVERAGE RIVER OTTER HARVESTED FROM 2015-2019 PER 100 SQUARE MILES IN EACH MAINE WILDLIFE MANAGEMENT DISTRICT. THERE IS NO TRAPPING IN BAXTER STATE PARK (SHOWN IN WHITE).

5.3 Regulatory Framework

The previous river otter plan (1988) gave MDIFW two management objectives. The first was to maintain the statewide population at the 1985 level, estimated at 19,000-24,000 otters. This estimate was based on a calculation of available otter habitat and the assumption that the population was at carrying capacity (the maximum number of individuals that an area can sustainably hold). Since then, sustained harvest levels, stable catch per unit effort rates, a stable ratio of beavers trapped per otter trapped, and other data indicate that we have met this objective.

The second objective was to maintain trapping opportunity (i.e., season length and timing) and the average harvest level of about 700 otters per year. This objective was met on both accounts, with the otter trapping season increasing from 38 to 59 days and the otter harvest averaging 800 per year since 1985.

The 1985 plan also required the Department to monitor otter population stability by evaluating otter harvest trends, both independently and as compared with the beaver harvest. It also established a maximum annual harvest level (1,800 otters) that would trigger management action such as reducing season length or restricting trapping techniques. No such action has been necessary, as harvests have remained below that number. Since 2013, the otter harvest has been below objective (averaging 428 otters from 2013 to 2018), with the decline primarily driven by reduced trapper effort including a 42% decline in the average number of otter trappers from 2008-2013 to 2014-2019.

Several of the world's 13 otter species, including hairy-nosed, sea otter, and giant otters, are rare and at risk of extinction.

Several of the world's 13 otter species, including hairy-nosed, sea otter, and giant otters, are rare and at risk of extinction. To prevent the international sale of endangered otters and other species, the Convention on International Trade of Endangered Species (CITES) put additional protections in place. CITES became effective in 1975 after being agreed upon by 80 countries, and now has 183 nations participating. CITES has two lists of species: Appendix 1 for species currently threatened with extinction, and Appendix 2 for species that may become threatened without international trade controls as well as species that look similar to the those listed in Appendix 1.

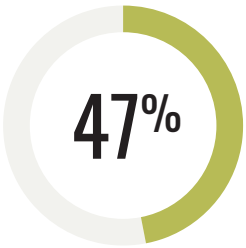
North American river otters are considered an Appendix 2 species because of their similarity to other endangered otter species. Because river otters are an Appendix 2 species, Maine and other states that permit otter trapping are required to submit annual reports to the U.S. Fish and Wildlife Service documenting the annual number of otters trapped and providing evidence that the otter harvest is sustainable. To document the annual harvest, MDIFW staff tag all harvested otters. To monitor the sustainability of the harvest, we use harvest levels, catch per unit effort by trappers, the ratio of otters trapped per beavers trapped, and age and sex data.

With increasing beaver populations, MDIFW has lengthened the beaver trapping season extending it beyond the otter season at times from 1950 to 1976, and every year since then. On occasion, otters are incidentally caught in beaver traps during this time. Since 1985, beaver trappers have been allowed to keep them; and over the last five years, those incidental catches have represented 26% of the total otter harvest. Similarly, the muskrat season has occasionally occurred outside the river otter season, and although trappers have been allowed to keep incidentally caught otters since 1992, the annual number of otters caught while muskrat trapping is small (less than five).

5.4 Public Consultation – 2020 Key Findings

River otters are viewed favorably by Maine's public, with a high beneficial index of 7.3 out of 10 (ranking third out of 10 furbearer species in the poll) in the general public survey (Responsive Management 2020). Further, only 1% of respondents consider them nuisances (tied for the lowest of all 10 species), and nobody reported them as dangerous. However, self-reported knowledge of otters was relatively low compared to other species, ranking 7th out of 10, with only 25% of respondents reporting they know a great deal or moderate amount about them.

OF MAINE RESIDENTS THINK OTTER POPULATION IS TOO LOW



OF MAINE RESIDENTS SAY NO OTTERS OCCUR IN THEIR AREA

OF THE GENERAL PUBLIC IS SUPPORTIVE OF OTTER TRAPPING

More residents think the otter population is too low (15%) than too high (0%), and this perception holds true in each of the three regions (south, central, north/east). However, a large portion of the general population reported that there are no otters in their area, with 47% responding that no otters occur in their area when asked about the population level, and 57% when asked about their feelings about otters around their home. Although otters occur statewide, they are a secretive species occurring only along waterbodies. Therefore, they don't occur near most homes, and are rarely seen. Thus, they are susceptible to being under reported where they do occur. Hunters (14%) and trappers (4%) were much less likely to report that no otters occurred in their area. Like the general public, hunters and trappers also responded more frequently that otter populations were too low (11% for hunters, 12% for trappers) than too high (3% for hunters, 9% for trappers), but the majority feel that the population is about right (41% of hunters, 60% of trappers).

The general public is supportive (62%) of otter trapping, though opposition (26%) was stronger than for most furbearer species, with only fox (34%) and bobcat (32%) having higher levels of opposition. As suspected, hunters (71%) and trappers (88%) are more supportive than the general public and rarely oppose (7% of hunters, 4% of trappers) otter trapping. Interestingly, among trapping opponents, otters were the species with the highest opposition (87%) to trapping. Among trappers, otters were one of the lowest targeted species, with 13% of trappers taking one in the 2018-19 trapping season, ranking 10th of 14 trapped species groups.

5.5 Management Issues & Threats

The primary management issue for river otters in Maine is that all of our current population monitoring indices are reliant on trapping. Trapping effort and success is influenced by several factors such as the weather, ice conditions, pelt price (of otters and beavers), gas price, and undoubtedly other factors. This can make interpreting changes in trapping indices difficult to evaluate. Also, the demographics of the trapping community is changing, and the number of trappers is in decline further complicating data analysis. These changes may lead to more uncertainty about trapping indices in the future. The number of nuisance complaints can be used as an additional population metric for some species. However, otters are very rarely reported as a problem, with only sporadic reports of problems at fish hatcheries, private fish ponds, and seabird nesting islands. For example, during the public survey effort, none of the respondents in the general population, hunter, trapping opponent, or landowner groups, and just 1% of trappers reported otters caused problems in the last 2 years.

The otter population is currently robust, and the level of harvest is having minimal impact on the statewide population. However, if for some reason the otter harvest needs to be reduced in the future, the incidental capture of otter in beaver traps could become a management issue. There are potential regulations that could be put in place to minimize incidental captures (e.g., altering trigger placement on beaver traps), but the effectiveness of such regulations is currently unknown.

River otters are the top predator in Maine's freshwater ecosystems, and as such they are potentially susceptible to declines in fish and other prey populations, and from the effects of the bioaccumulation of toxins. Poor water quality and increases in pollutants were contributors to otter population declines across North America in the 1800's and early 1900's. We would expect similar population declines if water quality were to decrease again. Therefore, it is imperative that Maine continue to have high water quality to provide healthy ecosystems so our otters and other wildlife can flourish.

5.6 Otter Management Goals & Strategies for 2020-2030

Goal #1. Maintain healthy, abundant otter populations

- Maintain aquatic habitat protections (e.g., NRPA, SLODA, Clean Water Act). ***(Ongoing; Moderate Priority)***
- Explore methods to estimate and monitor the species population independent of fur harvest data (e.g., eDNA, Audubon Wildlife Road Watch, habitat assessment, camera surveys, citizen science initiative). ***(New; High Priority)***

Goal #2. Maintain sustainable otter harvests

- Continue to monitor otter harvest and trapper success and collect age and sex data ***(Ongoing; High Priority)***.
- Ensure that otter harvest falls with an acceptable level proportional to annual beaver harvest ***(Ongoing; High Priority)***
- Ensure that otter harvest remains within an acceptable non-detrimental level according to the CITES program ***(Ongoing; High Priority)***.

Goal #3. Maintain Trapper Interest & Trapping Opportunities for otters

- Work with MDIFW landowner relations and land acquisition programs and partners to identify ways to increase and prioritize opportunities for accessible aquatic trapping activities when considering new acquisitions. ***(Ongoing; Moderate Priority)***

Goal #4. Increase public understanding of otters & otter management

- Maintain or increase 2019 levels of satisfaction and support for Maine's otter management program by the general public, trappers, and landowners. ***(Ongoing; High Priority)***
- Increase public awareness of the value of otter in the ecosystem and the role trapping plays in species management. ***(Ongoing; High Priority)***
- Develop lesson plans for educators promoting awareness of otter and their role as a predator. ***(New; Moderate Priority)***
- Develop an otter viewing guide that helps the public recognize and learn more about otter (e.g., winter tracks and slides, latrines, etc.). ***(New; Moderate Priority)***

Goal #5. Minimize human-otter conflicts

- Reduce the number of human-otter conflicts through the Department's Animal Damage Control program. ***(Ongoing; High Priority)***

Goal #6: Conservation of other species

- Continue working with USFWS and USDA-WS to address depredation of endangered, threatened and rare species of nesting shorebirds and pelagic birds. ***(Ongoing; High Priority)***
- Develop and promote outreach materials that highlight aquatic habitats and regulatory protections. ***(Ongoing; Moderate Priority)***

Expected Outcomes for Otter Management

Implementing the otter management strategies outlined in this plan will require adequate staffing, funding, and public support. It may not be necessary or feasible to carry out all strategies to achieve the plan's goals and objectives.

We anticipate the following otter-related outcomes over the next 10 years (by 2030 unless otherwise noted):

By 2025, outreach and communication efforts will have increased public knowledge of otter.

Public support for otter management will remain above 60%.

Through management actions and outreach efforts, otter trapping and viewing opportunities will be maintained.

Statewide otter complaints will be tracked and minimized.

6.0

MINK

6.0

MINK

The American Mink is a semi-aquatic carnivore found throughout much of North America, inhabiting coastal and inland wetlands and waterways.

MINK HABITAT

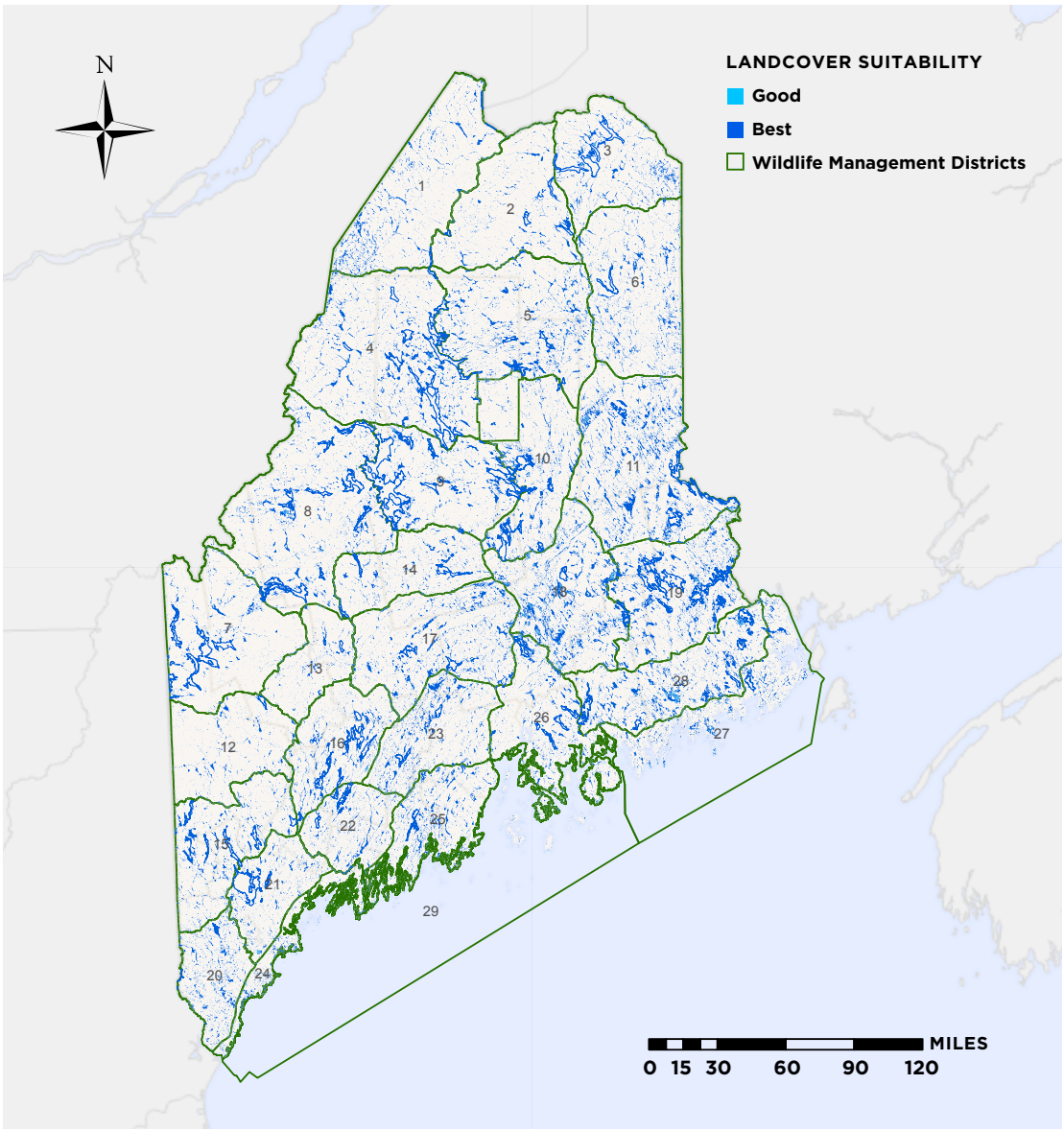


FIGURE 6.1. HABITAT SUITABILITY BASED ON BROAD HABITAT COVER TYPES AND ASSOCIATIONS FOR MINK IN MAINE.

6.1. History & Population Status

The American Mink *(Neogale vison)* is a semi-aquatic carnivore found throughout much of North America, inhabiting coastal and inland wetlands and waterways. Mink have rich, brown-to-black, soft and lustrous fur on a long, slender body. Mink have highly sought-after fur, and for centuries, they were bred throughout the world to support domestic fur markets to make a variety of clothing (Eagle and Whitman 1999). They are common throughout Maine, from coastal islands to remote forest streams **(Figure 6.1).**

Maine is the epicenter of an archaeological controversy surrounding a possibly extinct species of mink. The sea mink *(Mustela macrodon)*, known only from skeletal fragments found in Native American shell middens in the Gulf of Maine, was first described as a separate species (Manville 1966). Over the years, archaeologists have searched to find better evidence on whether these larger specimens were a distinct species, a subspecies of American Mink, or just larger examples of the latter due to the plentiful resources available in the coastal habitat. However, recent comparisons of recovered skeletal remains suggest that sea mink were indeed a separate species (Mead et al. 2000, Sealfon 2007).

Like most wildlife, Maine's historic mink populations are not well accounted for, though they are subject to lots of speculation. Some anecdotal references exist from before the era of modern wildlife management (Manley and Krohn 2005), including sporadic

Like most wildlife, Maine's historic mink populations are not well accounted for, though they are subject to lots of speculation.

efforts to quantify trapper harvests in the early 20th century. By the 1950s, regular surveys estimated the harvest for comparison with trapping licenses sold and average fur prices (Hunt 1986).

In 1981, tagging of individual mink furs became required, providing a more robust way to quantify the harvest and analyze population trends **(Figure 6.2).** Over the last few decades, MDIFW has conducted periodic voluntary trapper surveys, seeking to learn how much effort they expended in pursuit of individual furbearer species. In 2019, annual trapper effort surveys became mandatory. MDIFW monitors population trends using comparisons of licensed trappers, trapping efforts, fur prices, and mink harvest. Based on these metrics, annual harvests appear to have had little impact on mink populations, which have stayed relatively stable with minor fluctuations in their populations from natural factors. However, given reduced interest in recent years to harvest mink, it makes it challenging to rely solely on harvest data as a population index **(Figure 6.3).**

As a smaller carnivore, mink are occasional prey for a variety of larger predators such as owls, otter, and coyote (Eagle and Whitman 1999; Feldhammer et al 2003). Given their opportunistic diet that ranges from invertebrates to amphibians, fish, and even small mammals, they can exist in a variety of wetland habitats and uplands associated with wetlands, but population levels are dependent upon plentiful prey. Like other members of the weasel family, mink are efficient predators and will kill prey of similar or greater size, including muskrat and snowshoe hare (Feldhamer et al. 2003).

While not well quantified, there is concern that development and environmental degradation may diminish the quantity and quality of Maine's mink habitat and impact mink populations. Regulations like the Clean Water Act and Maine's Natural Resource Protection Act have lessened concerns by limiting development and pollution related to wetlands; but these factors could still impact mink in the future. In 2005, the Biodiversity Research Institute conducted an environmental contaminant study to determine mercury levels in mink and otter in Maine and other northeastern states and Canadian provinces. Their findings indicate that while improved environmental regulations have likely decreased mercury accumulation in mink over time, a large percentage (approximately 36%) of individuals still have mercury levels that could negatively impact their health and reproduction (Yates et al. 2004).

Native Americans rarely used mink as a food source except in lean times, but often trapped mink to use their fur for a variety of small garment items like waist bands, medicine bags, and "long pockets" to hold small necessities (Prins and McBride 2007). During European colonization of North America, mink initially held a lower value in the fur trade than other species like beaver and muskrat, but were commonly targeted by trappers pursuing other animals (Eagle and Whitman 1999). Until the latter 19th century, relatively lower harvest numbers (due to the mink's cryptic nature, life history, and lack of focused pursuit), kept demand for mink garments low; but mink popularity in fashion and function slowly grew through the early 20th century. By the 1950s, mink garments, including coats and stoles, were hugely popular. Since that time, mink have remained notable in fashion, although obscure and underappreciated in general as a species.

Mink are unfortunately not widely known as an integral part of our ecosystem here in Maine. While appreciated by some outdoor enthusiasts and nature lovers, they are disdained by others as competitors for fish and small livestock, like chickens. Although uncommon, these negative mink interactions have earned the species, like many in the weasel family, a long-standing reputation of trickery and thievery. Mink are also often maligned by nature watchers who witness animals they might favor, such as loon chicks, fall victim to natural predation events. Recent efforts to recover some of Maine's endangered, threatened, and rare coastal bird populations have been impacted by mink predation. To reduce such events, we rely on targeted local population reduction, sometimes assisted by efforts to increase the regional mink harvest during the general trapping season.

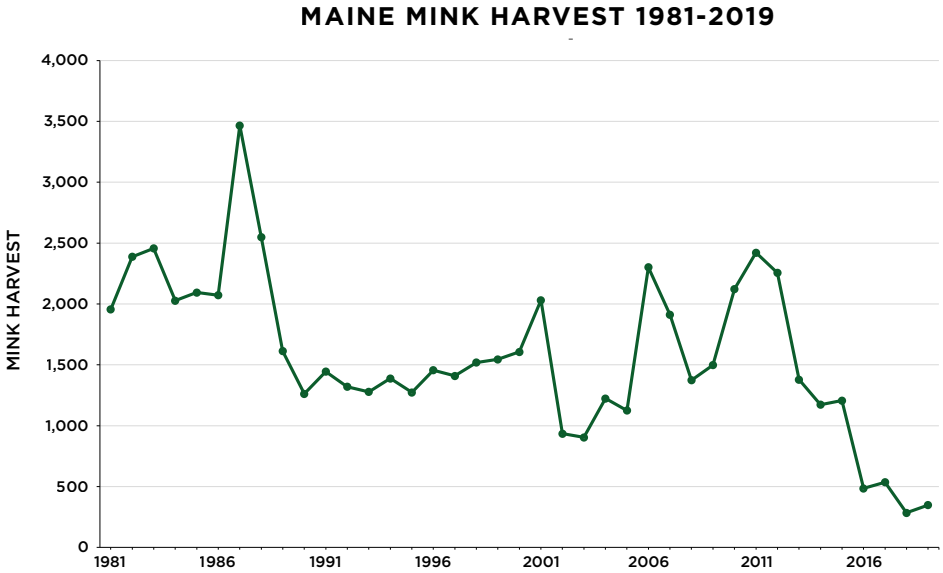
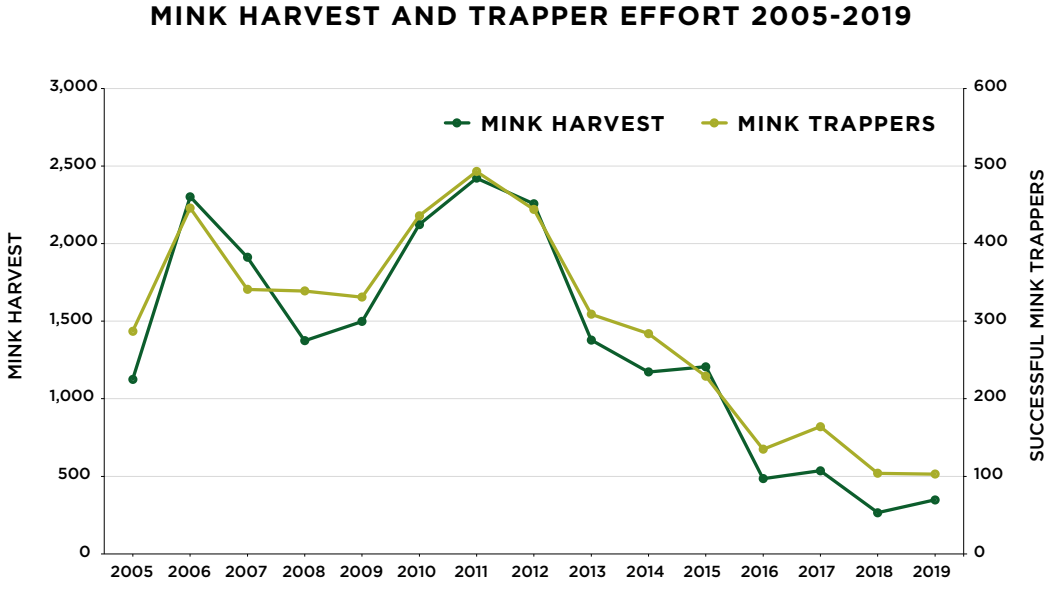


FIGURE 6.2 MINK HARVEST TRENDS FROM 1981 TO 2019 IN MAINE.



6.3 MINK HARVEST AND NUMBER OF SUCCESSFUL MINK TRAPPERS FROM 2005 TO 2019 IN MAINE.

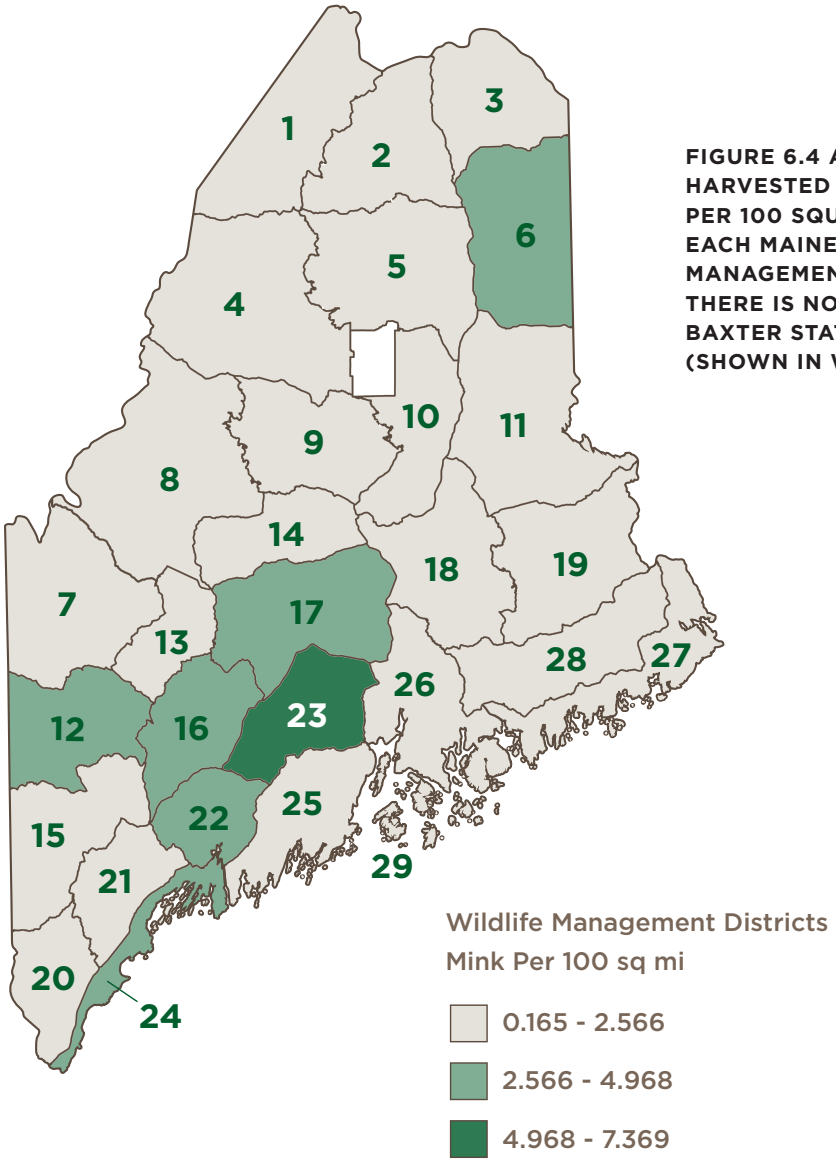


FIGURE 6.4 AVERAGE MINK HARVESTED FROM 2015-2019 PER 100 SQUARE MILES IN EACH MAINE WILDLIFE MANAGEMENT DISTRICT. THERE IS NO TRAPPING IN BAXTER STATE PARK (SHOWN IN WHITE).

6.2 Mink Management History

Historical regulations on the taking of game evolved in the early days of Maine's statehood. For a long time, the taking of furbearers was restricted to specific times of the year but remained open for much of the fall and winter. Through the early 20th century, the duration of those seasons generally shortened. From 1935 to 1940, an open season specifically for mink was established to occur from October 16 through February 15, with county-level season lengths varying within that open season. From 1940 to 1975, the open mink season was limited to the month of November. From 1976 to 1979, the open mink season was connected to the open season on other aquatic furbearers (except beaver). And since 1980, the open season for mink has been concurrent with the general trapping season for most furbearers, which currently runs from the Sunday before the deer firearms season until December 31.

Past management goals for mink have all been geared toward ensuring population stability while maintaining consistent harvest opportunities. As trapping has had little pressure on statewide populations, they have been allowed to fluctuate naturally by factors such as habitat quality and prey availability. We can keep mink populations healthy by continuing to monitor the harvest, population dynamics, and environmental factors, and adjusting regulations to address specific needs – often on a local Wildlife Management District (WMD) level rather than statewide. Maine is divided into 29 WMDs, which allow us to make more flexible and local management decisions when necessary.

As with that of other furbearer species, the mink harvest is tied to many factors including weather, fuel prices, mink fur prices, other semi-aquatic species fur prices (e.g., muskrat, beaver), the number of licensed trappers, and trapping effort. The annual mink harvest has fluctuated over the last four decades, averaging 1,500 animals each year. A peak harvest of almost 3,500 animals occurred in 1987 and a low of 284 in 2018.

In recent years, the number of active mink trappers, their levels of trapping effort, and annual harvest numbers have all declined, although a strong contingent of enthusiastic trappers remains. These declines have happened in step with declining wild-caught fur prices. When farm-raised mink prices are high, wild caught mink and muskrat are sought as a cheaper alternative; but currently, there is no shortage of low-priced farm raised mink.

Data analysis continues to show that with ample streams, rivers, and coastal habitat, mink populations remain robust. Ancillary reports from MDIFW staff, trappers, and other outdoor enthusiasts corroborate, as do reports from the general public, including road mortality reports, conflict reports, and general observations.

6.3. Regulatory Framework

TABLE 6.1 SUMMARY OF MINK MANAGEMENT ACTIONS (1935-2019).

YEAR	MANAGEMENT ACTION
1935	Mink trapping season was open October 16 to February 15, depending on the county.
1940	Mink trapping season was limited to the month of November.
1970	Mink hunting was restricted to Cumberland, Lincoln, and Sagadahoc Counties with firearms or bow and arrow (still November only). Members of the Penobscot or Passamaquoddy Tribes could hunt mink with bow and arrow or firearms on their own lands or islands.
1972	Mink hunting closed statewide.
1976	Mink trapping season was October 20 to November 30 in northern Maine and the month of November elsewhere.
1978	Mink trapping season was October 20 to November 25 across most of Maine, depending on wildlife management unit.
1981	Mink pelts were required to be tagged for a fee of 25 cents per skin.
1985	Mink trapping season was October 28 to December 4 statewide.
1990	Mink trapping season was October 28 to December 12 statewide.
1991	Mink trapping season was November 3 to December 31 statewide.
1996	Mink caught incidentally in muskrat traps were allowed to be kept.
2007	To avoid incidental capture of lynx, Wildlife Management Districts 1 to 11 enacted restrictions on the size and use of traps commonly used for mink. The districts allowed for all killer-type traps with inside jaw spreads of <5 inches to be set partially covered by water at all times, under overhanging stream banks, or in blind sets that use no bait, lure, or visible attractors.
2008	Mink incidentally caught during the beaver trapping season were allowed to be kept.
2012	In Wildlife Management Districts 14, 18, and 19, all killer-type traps with an inside jaw spread of <5 inches may be set partially covered by water at all times, under overhanging stream banks, or in blind sets that use no bait, lure, or visible attractors.
2015	Statewide, all killer-type traps with an inside jaw spread of ≤5 inches may be set partially covered by water at all times, under overhanging stream banks, or in blind sets that use no bait, lure, or visible attractors.
2019	Trappers are required to submit fall and spring trapper effort reports.

6.4 Public Consultation – 2020 Key Findings

In 2019, Maine Department of Inland Fisheries and Wildlife hired Responsive Management to conduct research on public opinions of furbearers and furbearer management (Responsive Management 2020). While people were not asked direct questions about mink during the survey, members of the public did recognize mink as a furbearer. For this reason, we can assume that mink are included in public opinion on general furbearer topics. Despite being known for raiding chicken coops and causing damage at fish hatcheries, mink were not identified by the public as a conflict-causing species.

6.5 Management Issues & Threats

People who are aware of mink prevalence and habits generally enjoy the species. And because mink are fairly secretive, social tolerance remains high. Still, occasional mink-human conflicts do occur. Mink will kill chickens and other poultry when given the opportunity (although, predator-proof fencing can help); and similarly, they can be an issue at fish hatcheries, particularly those with small outdoor raceways.

By preventing and managing conflicts, we can promote coexistence and positive attitudes toward mink while also protecting rare wildlife species.

Despite their robust populations, the mink's secretive nature makes this species quite difficult to observe in the wild. However, occasional chances do exist, and you can also detect their presence through sign. They're also a great target species for beginner trappers, given their abundance and the relative affordability and ease of use that mink traps and equipment offer.

Predator and prey interactions are a normal and healthy part of nature; however, sometimes predation occurs when other natural or human factors have compromised a species' population or distribution. Mink are common predators of Maine seabirds and waterfowl, including endangered, threatened, and rare birds like Atlantic puffin and roseate tern, as well as other prominent species like common eider. Managing mink with regulated trapping and specific targeted removal often reduces predation effects and increases prey populations.

PUBLIC AWARENESS & APPRECIATION

Public knowledge of mink and how they are managed are not the only factors that influence satisfaction with the species; but awareness and engagement is important for their conservation (and that of any species). The 2020 public surveys suggest a strong need to increase public knowledge of all Maine furbearers and how trapping works as a management tool. Although mink, like many members of the weasel family, are not well known, they are generally appreciated except when they prey upon livestock or on preferred iconic species (e.g., loon chicks).

6.6 Mink Management Goals & Strategies 2020-2030

Goal #1. Maintain healthy, abundant mink populations

- Explore methods to estimate and monitor the mink population independent of fur harvest data (e.g., eDNA, Audubon Wildlife Road Watch, habitat assessment, winter bridge occupancy surveys). ***(New; High Priority)***
- Explore methods to collect sex and age data for harvested mink. ***(New; Moderate Priority)***

Goal #2. Maintain a sustainable mink harvest

- Consider aligning mink and muskrat trapping seasons. ***(New; Moderate Priority)***

Goal #3. Maintain trapper interest & trapping opportunities for mink

- Work with MDIFW landowner relations and land acquisition programs and partners to identify ways to increase and prioritize opportunities for accessible aquatic trapping activities when considering new acquisitions. ***(Ongoing; Moderate Priority)***
- Develop tools to determine current participation and interest from new mink trappers. ***(New; Moderate Priority)***
- Promote mink trapping and increase the number of licensed trappers targeting mink. ***(New; Moderate Priority)***

Goal #4. Increase public understanding of mink & mink management

- Promote mink and the positive ecological services they provide to Maine's ecosystem. ***(Ongoing; High Priority)***
- Periodically survey the public to measure knowledge of and support for Maine's Mink management program. ***(New; Moderate Priority)***
- Develop educational outreach materials that highlight mink and their ecological role. ***(New; Moderate Priority)***
- Promote Wildlife Management Areas and other public lands that provide good habitat for enjoying mink. ***(New; Low Priority)***

Goal #5. Minimize human-mink conflicts

- Reduce human-mink conflicts using regulated trapping and MDIFW's Animal Damage Control program. ***(Ongoing; High Priority)***
- Work with MDIFW and private hatcheries to promote ways to mitigate mink damage. ***(Ongoing; Moderate Priority)***

Goal #6. Conservation of other species

- Promote mink trapping areas to conserve shorebirds and resolve other wildlife conflicts. ***(Ongoing; High Priority)***
- Continue working with USFWS and USDA-WS to address depredation of Endangered, Threatened, and Rare Species of nesting shorebirds and pelagic birds. ***(Ongoing; High Priority)***
- Explore methods of determining in what way, if any, mink predation impacts muskrat populations. ***(New; Low Priority)***

Expected Outcomes of Mink Management

Implementing the mink management strategies outlined in this plan will require adequate staffing, funding, and public support. It may not be necessary or feasible to carry out all strategies to achieve this plan's goals and objectives.

We anticipate the following mink-related outcomes over the next 10 years:

By 2030, MDIFW will have a better understanding of mink population status and demographics of harvested mink.

By 2025, our outreach and communication efforts will establish public knowledge and viewing opportunities of mink.

Our management actions will maintain or increase mink trapping opportunities.

7.0

MUSKRAT

7.0

MUSKRAT

Muskrats are semi-aquatic rodents with rich, glossy, brown waterproof fur, short legs, and a rudder-like tail.

MUSKRAT HABITAT

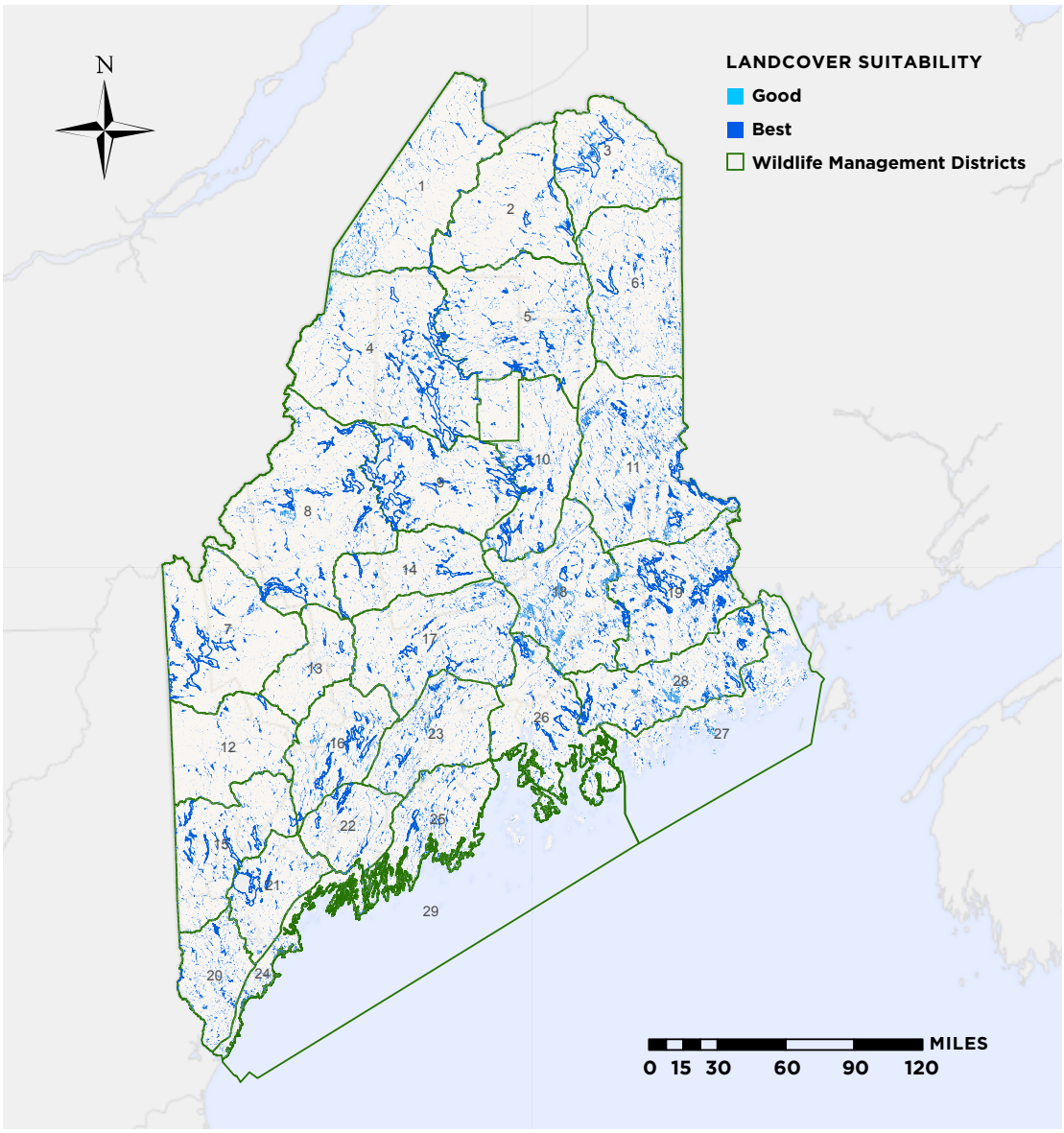


FIGURE 7.1 HABITAT SUITABILITY BASED ON BROAD HABITAT COVER TYPES AND ASSOCIATIONS FOR MUSKRAT IN MAINE.

7.1 History & Population Status

Muskrats *(Ondatra zibethicus)* are semi-aquatic football-sized rodents with rich, glossy, brown waterproof fur, short legs, and a rudder-like tail (Feldhamer et al 2003). Throughout Maine, most of the United States, and Canada, muskrats inhabit marshes, bogs, lake shores, ponds, rivers, streams, and ditches, but are usually absent from large bodies of water, or rapid-flowing streams and rivers. They feed on a wide variety of vegetation, favoring cattails (especially during the winter) and bulrush. Occasionally, they will consume frogs, crayfish, insects, mussels, clams, snails, fish, and other animal matter (Boutin and Birkenholz 1987).

Muskrats can be found living in stream bank cavities or conspicuous communal dens that they build out of mud and vegetation, and which can house 10 or more individuals.

Curiously, muskrats have even been found in active beaver lodges. Feed beds (platforms they use to get out of the water and eat) are also obvious signs of muskrats in the area. Breeding season varies from March through September, and muskrats can have up to three litters per year with four to eight kits per litter. They don't usually move any further than 50 feet from their lodge, but they are capable of moving as far as 20 miles.

Muskrat predators include mink, weasels, red fox, raccoon, hawks, eagles, owls and snapping turtles (Feldhamer et al. 2003). Other mortality factors include droughts, floods, hurricanes, and disease, all of which can have significant effects on muskrat populations. Maine's 1,000+ dams can also be detrimental to muskrats if they cause water levels to drop or rise too much.

The impact that muskrats have on wetlands is mixed. By opening dense vegetation, they make wetlands more appealing to certain species of birds; and some birds also use muskrat houses (including old ones) for nest sites. However, a high abundance of muskrats can remove incredible amounts of plant material, opening even dense marshes and causing declines in bird species and the number of individual birds, and ultimately a decline in muskrats. When these eat-outs occur, marshes can be ruined for several years, though they can also be quickly rejuvenated with proper management. Regulated trapping helps to keep muskrat numbers at a level that benefits wetland habitats and prevents large-scale damage.

Muskrats are culturally important to Native American tribes and are one of the most popular aquatic species in the U.S. to trap (Prins and McBride 2007). Muskrat pelts have traditionally been dyed and stripped to resemble mink *(Mustela vision)*, sable *(Martes zibellina)*, or marten *(Martes americana)*; or left in their natural state (Obbard 1987). In addition to their fur, muskrats are often harvested to eat – a use that is particularly valuable to Native peoples. The Micmac people would often refer to the Passamaquoddy/Maliseet people as the Muskrat people (J. Sewell personal communications). The muskrat is known to the Passamaquoddy Tribe as "kiwhos," which means "he who uproots the medicine." A traditional medicine known as "kiwhoswasq" (also referred to as flag root or muskrat root) is used as a tea and a soup to keep people healthy and prevent sickness. The muskrat is an important animal in the life of the Tribe, since it provides a source of high protein food and is usually located near the community (Prins and McBride 2007). Muskrat trapping was historically one of the first survival skills learned by the young people, and was a critical skill later in life when other foods were in shortage (J. Sewell personal communication).

PAST POPULATIONS

Muskrat populations are challenging to measure. Historically, muskrat population numbers in Maine have been determined using personal observations by Department employees, harvest rates, and published information. In 1936, each game warden in the state was sent a questionnaire asking them to report on the status of big game and furbearing species in their district. This effort was repeated in 1939 using the same questions as the 1936 survey: Were the species always present in the district? Were they formerly present but now absent? Were they formerly absent but now present? Are these species now abundant, common, or rare? The results of this questionnaire indicated that muskrats were common or abundant throughout the state.

CURRENT POPULATIONS

More recent muskrat population estimates and trends have come from a combination of mark recapture, breeding territory counts, house counts, fur auction sales, habitat data, and newly mandated trapper harvest reports.

In 1975, the first muskrat assessment was completed. At that time, muskrats were considered common to abundant (3 to 14 animals for every 100 acres of habitat) in WMUs 1, 4, 5, 6, 7, and 8. Population levels in WMUs 2 and 3 (western and northwestern Maine) were generally considered to be low (one animal for every 100 acres of habitat) **(Table 7.1)**.

TABLE 7.1 ESTIMATED MUSKRAT ABUNDANCE IN 1975.

WILDLIFE MANAGEMENT UNIT	MUSKRATS/100 ac. HABITAT	NUMBER OF MUSKRATS*
1	3	6,500
2	1	9,100
3	1	3,200
4	8	69,100
5	4	29,900
6	8	25,700
7	14	37,900
8	13	48,600
TOTAL		230,000

*** Mid-point of estimated range of Fall muskrat population.**

The 1985 assessment (Hunt 1986) reported a statewide population estimate of 371,200 muskrats (average density of 1.5 muskrats/acre of habitat). This estimate was based on density calculations from nine marsh types (Wetlands Inventory), three lake types, and rivers and streams. Wildlife Management Unit 8 had the highest estimated carrying capacity (109,900) followed by WMUs 4 (91,000), 7 (59,200), 6 (53,000), and 5 (32,100). Carrying capacity for WMUs 1, 2, and 3 was estimated to be less than 10,000 for each unit **(Table 7.2)**. The southern and coastal portions of the state had an abundance of high-quality habitat.

See Appendix 3 for WMU/WMD map comparison.

TABLE 7.2 ESTIMATED MUSKRAT ABUNDANCE IN 1985.

WILDLIFE MANAGEMENT UNIT	FALL DENSITY MUSKRATS/100 ac.	CARRYING CAPACITY
1	145	9,700
2	75	7,600
3	93	8,700
4	123	91,000
5	73	32,100
6	159	53,000
7	190	59,200
8	203	109,900
TOTAL		371,200

The annual number of muskrats harvested in Maine has fluctuated from a low of approximately 14,000 in 1962 to a high of 76,000 in 1974. More recent data on muskrat harvest since the mid-1980s are not available, but the annual Maine muskrat harvest is likely below 10,000. Although furbearer trapping effort has declined overall, muskrat are still desirable, with 22% of trappers pursuing muskrat during the 2018/19 season.

Since 2009, the Department has been recording the age and sex of muskrats at Maine fur auctions to better understand recruitment **(Table 7.3)**. Maine recruitment rates (six to 10 juveniles per adult female) appear to be similar to New York (S. Smith, NYDEC, personal communications).

In recent years, under-prime light or dark areas on the pelt known as kidney spots are seemingly becoming more common. During the tanning process, guard hairs can fall out where kidney spots occur. These spots were not described historically and appear to be more prevalent in recent decades. Their cause is not well understood but a working hypothesis is that the spots may be related to warming waters.

TABLE 7.3 SUMMARY OF MUSKRAT AGE AND SEX FROM A SUBSET OF TRAPPERS THAT HARVESTED MUSKRATS IN MAINE FROM 2009 TO 2019.

Number of trappers and muskrat pelts, percent of muskrat with kidney spots, percent juvenile, male to female ratio, juvenile to adult ratio, juvenile to adult female ratio, and average trap nights per muskrat harvested are reported.

YEAR	TRAPPERS	PELTS	% SPOTS	% JUV	M:F	J:A	J:AF	AVG TN/CAPTURE
2009	20	1,321	21.73	59.35	-	2.88	-	19
2010	20	1,384	0.72	77.02	2.20	3.38	10.45	20
2011	17	1,295	1.00	75.68	1.27	3.11	6.67	34
2012	11	748	1.47	64.04	1.88	1.78	5.51	16
2013	-	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-	-
2015	20	668	1.35	66.77	1.67	2.08	6.37	52
2016	16	634	-	74.13	1.37	2.96	8.10	13
2017	-	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-
2019	16	489	16.16	73.21	1.16	2.86	6.28	18

7.2 Muskrat Management History

Muskrat have traditionally been one of Maine's most sought-after furbearers due to their relative abundance, ease of harvest, and historic value. However, only a few records are available concerning trapping prior to 1955 **(Table 7.4).** In the 1935 and 1937 regulations pamphlets, there was an open season during the fall (Nov.) and spring (as early as March 20; as late as May 15) with dates that varied depending on the county. Special provisions (i.e. specific closures) were provided for Morrill Mill Pond, Massacre Pond, and Sebasticook River. In the 1940, 1942, and 1944 regulations pamphlets, open season ranged (depending on county) from March 20 to May 15; and in 1940, the month of November. In 1953, muskrat trapping was open statewide for the month of November, except in Washington and York counties where the season ran from March 20 to April 20. The commissioner could declare an open season on muskrats that were considered to be polluting water supplies or damaging property.

TABLE 7.4 SUMMARY OF MANAGEMENT ACTIONS FOR MUSKRAT FROM 1893-2019.

YEAR	MANAGEMENT ACTIONS
1893	A closed season was established for muskrat. No muskrat harvest was allowed from May 20 to March 1, except for at Lily Pond between Rockland and Camden, where there was no closed season.
1899	Closed season for muskrat was aligned with mink, marten, fisher, and otter, with no harvest of these species allowed from May 1 to Oct. 15.
1907	Closed season for muskrat, mink, and fisher was amended to run from May 1 to Dec. 1. Also, there were some town-specific yearlong closures.
1909	Closed season for muskrat was returned to May 1 to Oct. 15.
1911	Closed season for muskrat was amended again to run from April 1 to Oct. 20. At this time, there were widespread town-specific closures.
1913	Several significant law changes were made regarding furbearing species, including requirements for trappers to have a trapping license, label their traps, and tend traps every 24 hours. Closed muskrat season was changed to run from May 1 to Oct. 31., and a new restriction specified that traps could not be placed with 25 feet of a muskrat house. Poisoning was outlawed, but animals that were found to be destroying property were allowed to be killed (except beaver).
1917	Closed season for muskrats was adjusted once more to run from May 1 to Oct. 15.
1923	Closed season for muskrats was adjusted to run from May 15 to Oct. 31. A new provision made it unlawful to molest muskrat houses, special muskrat trapping regulations were enacted allowing for portions of a town or certain water bodies to be closed to the taking of muskrats.
1925	Closed season for muskrats was amended to run from May 1 to Nov. 13. A new provision required written permission in order to set traps on someone else's land in organized towns.
1934	Following a written complaint from a landowner, the Commissioner could now declare an open season on muskrats polluting water supplies or damaging property. Muskrat trapping season was open from April 1-30 and Nov. 1-30 in northern counties and March 20 to April 20 in southern counties. And it became illegal for a person to destroy or set a trap within 25 ft. of a muskrat house.

YEAR	MANAGEMENT ACTIONS
1967	Muskrats could not be taken by wire nets, box traps, or any traps other than ordinary steel traps, and only killer-type traps could be used for trapping muskrat during the spring season. The open season on muskrats occurred end of Oct. through mid-May, depending on the area north or south of the CPRR tracks.
1969	Muskrat trapping season was now open Nov. 1 to May 15 (north zone) and Nov. 1-April 30 (south zone).
1974	Muskrat trapping season was now open Oct. 20 to Nov. 30 and April 25 to May 15 in northern Maine (WMUs 1 and 2) as well as the months of Nov. and April in southern Maine (WMUs 3-8).
1980	Muskrat trapping seasons were reduced to the end of Oct. through the end of Nov., depending on the WMU.
1984	Trapping seasons and areas open to beaver trapping were also opened for muskrat trapping.
1985	Muskrat trapping season statewide was adjusted to run from the end of Oct. to early Dec.
1990	Muskrat trapping season statewide was adjusted to run from the end of Oct. to mid-Dec.
1991	Muskrat trapping season statewide was expanded to run from the end of Oct./early Nov. to the end of Dec.
1993	It was made illegal to damage, destroy, or set a trap within 10 ft. of a muskrat den, defined as any cavity capped by muskrats with vegetative material.
1996	Early muskrat trapping season was initiated in northern Maine (WMUs 1 and 2), opening one Sunday before the general trapping season began.
1998	Early muskrat trapping season was expanded to additional areas of northern Maine (WMDs 3 through 6 and 9 through 11). After the end of the general trapping season, muskrats were now allowed to be trapped in areas where the beaver season was open.
2009	MDIFW biologists began collecting age and sex data to monitor muskrat recruitment rates.
2018	The muskrat float definition was revised to include a float covered on the sides and top with solid material or hardware cloth, screen, or similar material.
2019	Muskrat trapping season end dates were changed to coincide with beaver season end dates. The definition of a muskrat float was revised to say that it must be set, placed, and tended so that it is completely surrounded by water. Trappers are also now required to submit annual fall and spring trapper effort reports.

See Appendix 3 for WMU/WMD map comparison.

7.3 Regulatory Framework

Like all Maine wildlife, muskrats are a publicly owned resource held in trust by the State for the benefit of all Maine residents. The Department currently offers a liberal but regulated muskrat trapping season set by Wildlife Management Districts (WMD). The state is separated into 29 WMDs which are designated based on climate, terrain, and habitat. Major physical landscape features (major roads, rivers, transmission lines, etc.), not political features, define the bounds of each WMD.

Muskrat trapping season opening and closing dates have historically changed each year, but generally fall within the months of November and December. Trapping seasons are set through the rulemaking process under the Maine Administrative Procedures Act, which provides an opportunity for public comment. While there are restrictions on equipment and trap placement, there are no bag limits for muskrats.

Maine's muskrat trapping statutes and regulations have changed many times throughout the years. From 1955 to 1979, the spring trapping season was changed 10 times before it was terminated in 1979 following concerns around the number of animals taken during the spring harvest, the numerous damaged pelts collected during the spring season, and potential waterfowl losses. Season lengths have fluctuated and varied between Oct. 20 to May 15, or some portion of this time. Trapping under the ice is a traditional muskrat management method and is allowed in Maine during seasons and in areas open to beaver trapping. It is illegal to destroy, damage, or set a trap within 10 feet of a muskrat house or den.

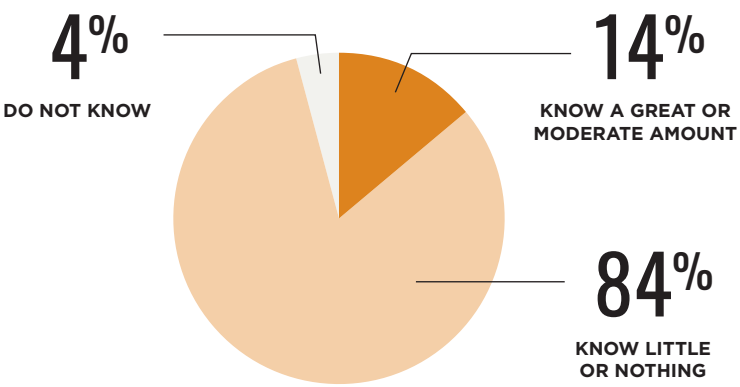
CURRENT MANAGEMENT

Regulations used to influence muskrat harvests include season length, concurrent openings, equipment limits, and trap tending. In addition to regular trapping rules and season dates, an early muskrat season was initiated in 1996 in WMU 1, 2, and was expanded in 1998 to include WMDs 3, 4, 5, 6, 9, 10, and 11. Also in 1998, a late muskrat season was established allowing muskrat trapping in areas open to beaver trapping.

See Appendix 3 for WMU/WMD map comparison.

7.4 Public Consultation – 2020 Key Findings

PUBLIC KNOWLEDGE OF MUSKRATS



A small percentage of the general population in Maine (14%) say that they know a great deal or a moderate amount about muskrats, with the highest self-professed knowledge coming from North/East Region residents. An overwhelming number of Maine residents (82%) say they know a little or nothing at all about muskrats, and 4% of Maine residents responded, "do not know."

PUBLIC OPINION OF MUSKRAT POPULATIONS

More Maine residents believe that the muskrat population in their area is about right (21%) than say it is too high (2%) or too low (5%). Residents are very tolerant of muskrats, with 16% providing the most tolerant response and only 3% saying that muskrats are a nuisance or are dangerous. Residents also rated how beneficial it is to have muskrats in Maine, on a scale of 0 to 10, with 0 being not at all beneficial and 10 being extremely beneficial. The mean overall rating was 7.1, which was a similar rating given to fox, otter, and bobcat.

PUBLIC SUPPORT OF MUSKRAT TRAPPING

There is about three times the support for (62%) as there is in opposition to (20%) regulated trapping as a method of muskrat population management. One percent of residents reported that they neither support nor oppose regulated trapping for muskrat population management and 17% reported that they did not know.

7.5 Management Issues & Threats

Muskrats have been identified as a priority 3 Species of Greatest Conservation Need (SGCN) in Maine's Wildlife Action Plan due to their cultural significance to Native tribes and relatively recent population changes in the Northeast.

Although muskrats are still common, there is a consensus among wildlife professionals and trappers that muskrat populations in the eastern United States and Canada have declined in recent decades (Ahlers and Heske 2017). Perceived muskrat declines have not been linked solely to one issue, but to a compounding number of environmental and social factors (Ahlers and Heske 2017, Ward and Gorelick 2018, and Ganoe et al. 2020). Environmental factors can alter available habitat and food, reproductive success, and mortality, all of which dictate regional muskrat population numbers. Social factors related to declining trapper effort and trapping license sales can alter the way wildlife professionals track and inventory population data over time. Loss of wetlands, increased predation, changing climate conditions, and disease may also have contributed to the declines and warrant further study.

Water Level Fluctuations

Muskrats require a permanent source of still or low-velocity water with ample emergent vegetation for forage and hiding cover. Muskrat generally do not store large quantities of food for the winter, and must forage under the ice or on underground plants to survive the cold winter months. In northern areas like Maine, this means water levels must be deep enough to prevent complete freezing. Additionally, due to the structure and relative proximity of muskrat houses or pushups to water level, wetlands and bodies of water that have fluctuating, or high seasonal levels tend to have relatively low muskrat densities. Extreme water level changes resulting from dams, precipitation, or drought events are also thought to negatively affect muskrat populations.

Invasive Plant Species

Muskrats consume a wide range of aquatic plants. They prefer maturing native shoots, rootstocks, and tubers with high nutrient concentrations, and cattails *(Typha sp.)* and bulrush *(Scirpus sp.)* are important food sources throughout most of the United States and Canada, with cattails being especially significant in the winter months. They also can adapt readily to many invasive and non-native species of vegetation. However, the introduction of certain invasive or non-native wetland plants such as Common Reed *(Phragmites spp.)* and invasive, non-native cattails *(Typha augustifolia)* in some Maine wetland systems may displace native wetland plant species, leading to less interspersion of vegetation and open water, and potentially lower muskrat populations (Greenhorn et al 2016).

Decreasing Use and Demand

Muskrat are well-known for their valuable fur, but they are also important for the ecological role they play in our wetlands. Muskrats provide food for a host of Maine's predators; and by consuming aquatic plants, they help to maintain wetland plant diversity (Boutin and Birkenholz 1987, Erb and Perry 2003).

Maine is home to a vast network of marshes, bogs, lake shores, ponds, rivers, and streams that provide some of the best muskrat trapping opportunities in the United States. And at one time, muskrats were the country's most popular aquatic species to trap. As with other furbearer species, decreases in the use of, demand for, and price of muskrat fur (locally and nationally) have removed traditional trapping incentives and caused trappers to target the species less. To recruit the next generation of trappers, we will need to develop alternative and nontraditional uses for trapped muskrats.

Because muskrats are abundant and easy to catch, their traps are simple and safe to use, and their skins are less time-consuming to process than other species, they are a great target species for new trappers, especially children. And properly prepared muskrat meat is nutritious and delicious.

While fur auction sales data and trapper effort surveys have provided valuable population trend data to biologists in the past, data from these sources has decreased. To identify changes in the muskrat population moving forward, MDIFW will need to develop additional monitoring techniques to supplement trapper harvest information.

Disease

Diseases such as tularemia and hemorrhagic disease can decimate local and, in some instances, regional muskrat populations for years. In the case of hemorrhagic disease, die-offs appear to begin in the same areas ("hot spots") as previous epidemics and spread in all directions. Isolation may limit the spread, as may hot weather; but if "hot spots" are repopulated during the summer, the disease may reappear again in the fall (Erb and Perry 2003, Ganoe et al. 2020).

Muskrat Conflicts

In Maine, there are very few complaints concerning muskrat; but muskrat burrowing into banks and dams of ponds, ditches, and impoundments can cause severe damage. Most muskrat complaints come from landowners of small farm ponds where muskrats are burrowing into banks and causing leakage. Landowners with such issues can contact a local trapper to remove the animals during the regulated trapping season or, if immediate attention is required, an Animal Damage Control Agent.

PUBLIC AWARENESS & APPRECIATION

Muskrats tend to go unnoticed by most Mainers, and they get the most interest and attention through targeted, regulated trapping (or less frequently through landowner conflicts). Yet, they have cultural significance as a source of sustenance for Native American communities and, since they are active year round all day and they build conspicuous houses and push-ups, they provide good viewing opportunities. We can ensure public satisfaction with muskrats by consumptive and non-consumptive users alike by facilitating trapping opportunities and targeted conflict response programs.

7.6 Management Goals & Strategies 2020-2030

Goal #1. Maintain healthy, abundant muskrat populations

- Maintain aquatic habitat protections (e.g., NRPA, SLODA, Clean Water Act). ***(Ongoing; Moderate Priority)***
- Research methods to estimate and monitor the muskrat population independent of fur harvest data (e.g., muskrat house counts). ***(New; High Priority)***
- Contribute to a regional research project to understand muskrat population status and trends. ***(New; Moderate Priority)***
- Research methods to examine the role that predation plays on muskrat populations. ***(New; Low Priority)***

Goal #2. Maintain sustainable harvest of muskrats

- Explore the collection of data for muskrat harvest and population dynamics through sex and age pelt ratios at fur auctions. ***(Ongoing; High Priority)***
- Improve monitoring of muskrat harvest data using tabulated fur auction data and fur buyer reports. ***(Ongoing; Moderate Priority)***

Goal #3. Maintain trapper interest & trapping opportunities of muskrats

- Work with MDIFW landowner relations and land acquisition programs and partners to identify ways to increase and prioritize opportunities for accessible aquatic trapping activities when considering new acquisitions. ***(Ongoing; Moderate Priority)***
- Review and simplify current trapping regulations, where appropriate, to maintain muskrat trapping participation and opportunities (e.g., muskrat trap setback distance). ***(Ongoing; Moderate Priority)***
- Develop and deliver next-step programs, using muskrat trapping tools and techniques as the introductory experience, to encourage new trapping participants, particularly young families ***(Ongoing; Low Priority)***
- Encourage greater interest and participation in muskrat trapping by new participants. ***(New; High Priority)***
- Develop education and outreach materials for trappers to determine age class and sex of harvested muskrats. ***(New; Moderate Priority)***
- Develop tools to determine current participation and interest from new muskrat trappers. ***(New; Moderate Priority)***

Goal #4. Increase public understanding of muskrats & muskrat management

- Develop and promote outreach materials highlighting aquatic habitats and regulatory protections. ***(Ongoing; Moderate Priority)***
- Develop education and outreach tools and programs to increase awareness and knowledge of muskrat and their ecological role. ***(New; Moderate Priority)***
- Promote Wildlife Management Areas and other public lands that provide good habitat for enjoying muskrat. ***(New; Low Priority)***
- Promote muskrat meat as a healthy source of high-quality organic protein. ***(New; Low Priority)***

Goal #5. Minimize human-muskrat conflicts

- Keep monitoring muskrat conflicts and develop outreach materials that will help landowners prevent muskrat damage to impoundments. ***(Ongoing; Moderate Priority)***

Goal #6. Conservation of other species

- Continue managing muskrat populations in ways that maintain high-quality wetland habitats for waterfowl and shorebirds. ***(New; Moderate Priority)***

Expected Outcomes for Muskrat Management

Implementing the muskrat management strategies outlined in this plan will require adequate staffing, funding, and public support. It may not be necessary or feasible to carry out all strategies to achieve this plan's goals and objectives.

We anticipate the following muskrat-related outcomes are anticipated over the next 10 years (by 2030, unless otherwise noted):

By 2025, outreach and communication efforts will have increased public knowledge of muskrat.

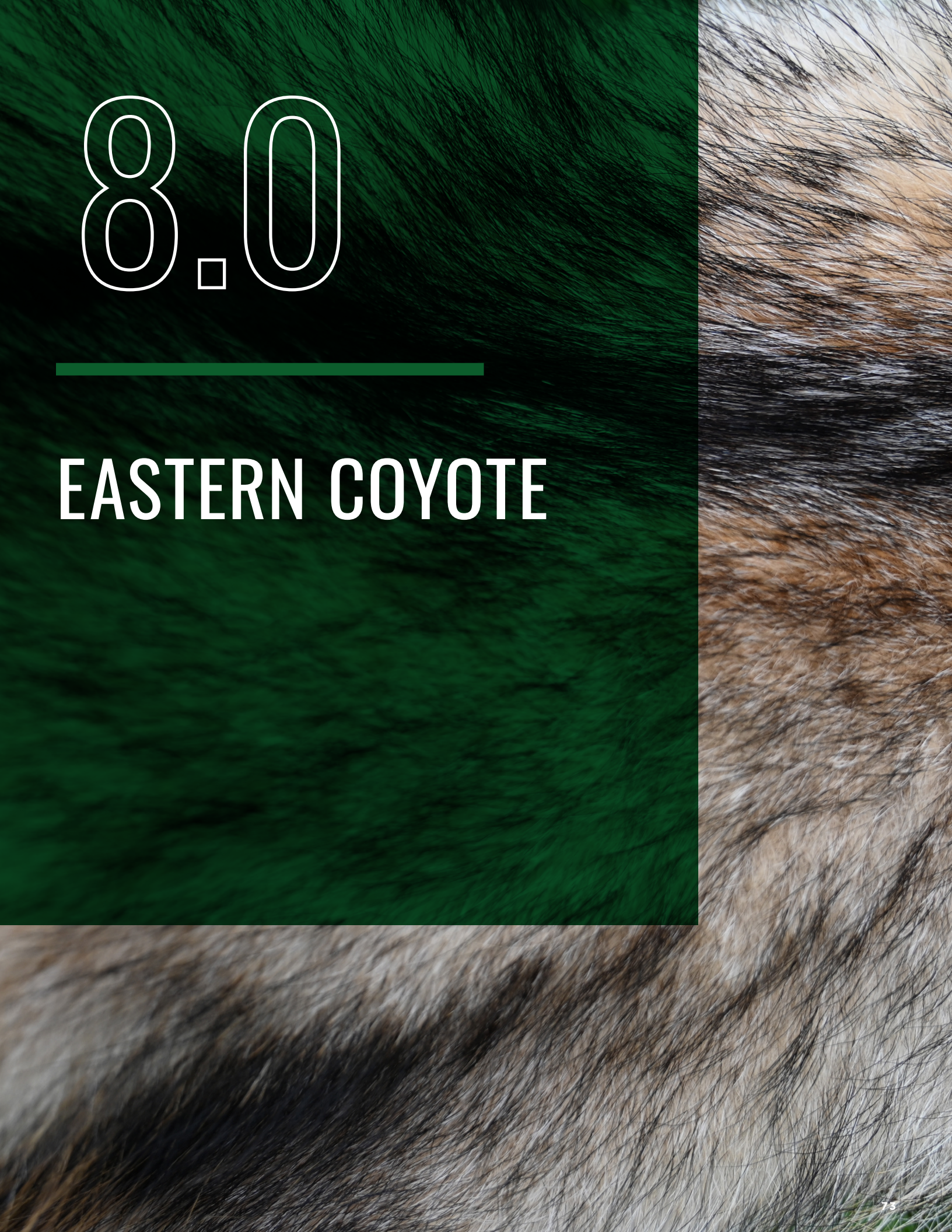
Through management actions and outreach, we will maintain muskrat trapping and viewing opportunities.

We will be able to correlate harvest reports (from trapper report data) with population indices.

Public support for muskrat management will remain above 60%.

8.0

EASTERN COYOTE



8.0

EASTERN COYOTE

The coyote (Canis latrans) is a medium-sized carnivore that is native to North America and occurs in all 48 contiguous states, Alaska, Mexico, and most of the Canadian provinces.

COYOTE HABITAT

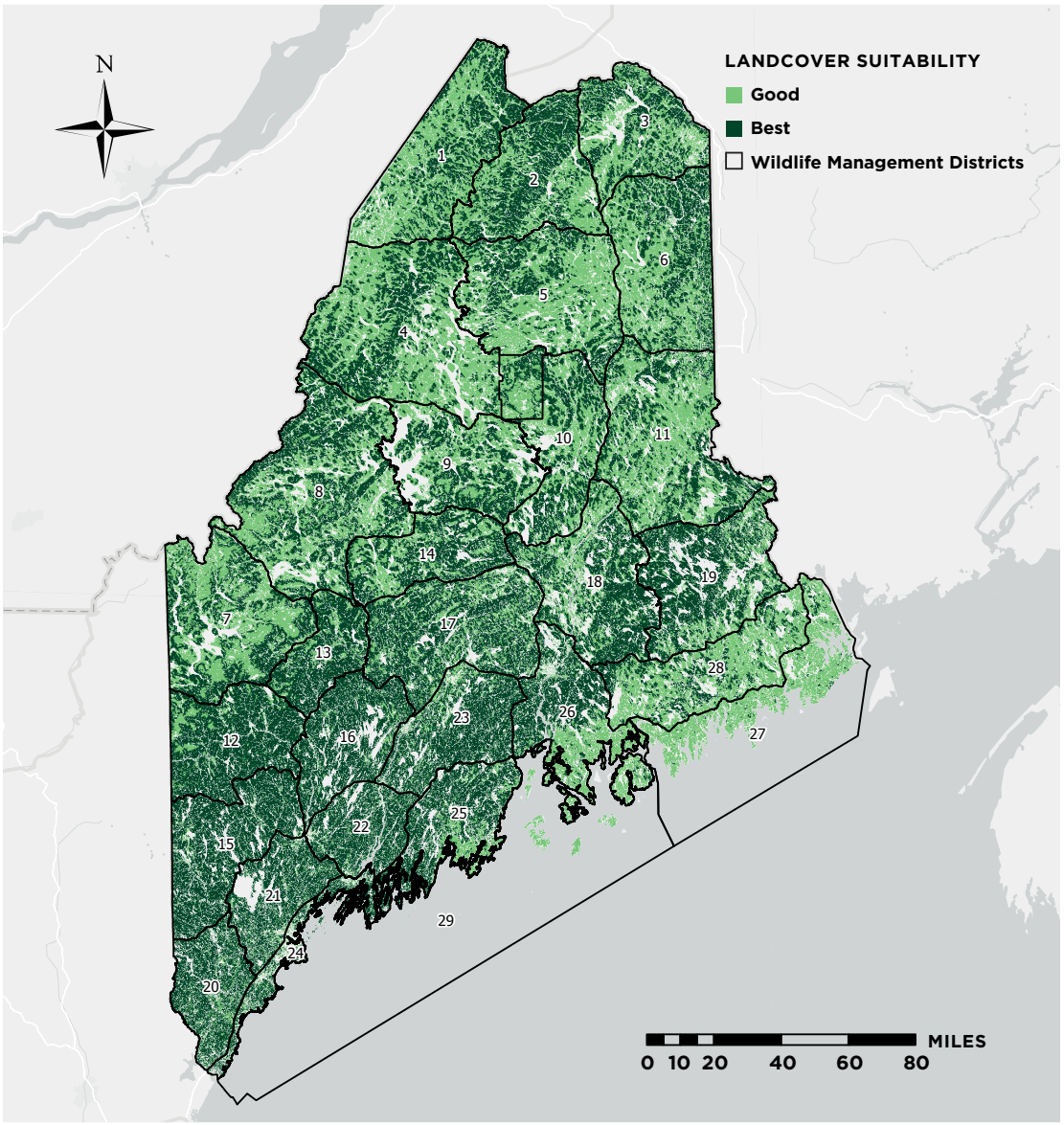
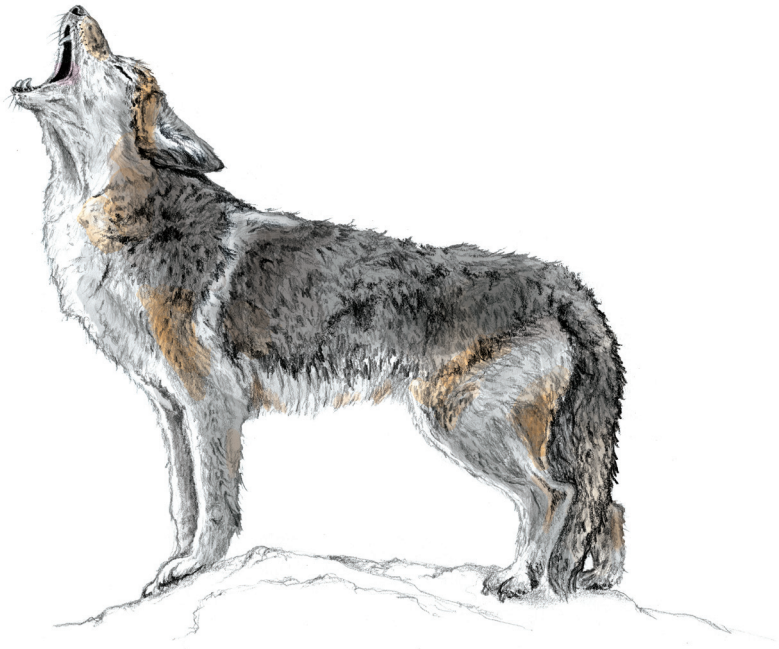


FIGURE 8.1 HABITAT SUITABILITY BASED ON BROAD HABITAT COVER TYPES AND ASSOCIATIONS FOR COYOTES IN MAINE.



8.1. Natural History & Population Status

DISTRIBUTION

Coyotes were first documented in Maine as early as 1936; and in the 1960s people noticed that the coyote population was increasing and becoming well-established in many areas (Richens and Hugie 1974). Although coyotes did not historically occur in Maine, they are considered a naturalized species, like Virginia opossums, that expanded their geographic range through natural dispersal. Coyotes are now common throughout Maine, occurring in a wide variety of habitats that include dense remote forests, farmlands, urban areas, and large coastal islands **(Figure 8.1).**

FOOD HABITS

Studies across eastern North America show coyotes to be opportunistic generalists, consuming everything from carrion to small rodents, fruits, and plants. In Maine, coyote food habits vary seasonally, ranging from omnivorous during summer and autumn to carnivorous in winter (Parker 1995). Common summer and autumn foods include white-tailed deer, snowshoe hare, domestic animals, small mammals, fruit, plants, insects, songbirds, and other wild animals, including red fox (Richens and Hugie 1974). Maine coyotes' diets were historically dominated by white-tailed deer and snowshoe hare during winter and spring; but more recently, beaver seems to have become a more important year-round food source in some areas (Hilton 1976; Warsen 2012). Similarly, wild turkey populations have increased and expanded their range northward over the past several decades, introducing another new key food resource for coyotes and other predators (Niedzielski and Bowman 2014).

Eastern coyotes are effective predators and scavengers of larger game animals. In areas of Maine where coyotes and moose coexist, moose are a common scavenging source, especially in late winter/early spring when moose calf (9- to 12-month-old) mortality peaks (MDIFW, unpublished data; Balluffi-Fry et al. 2020). While researchers in central Ontario have reported the predation of four adult (>1.5-year-old) moose by eastern coyotes or eastern coyote/eastern wolf hybrids (Benson and Patterson 2013), it appears that moose predation by coyotes is not significant in Maine. In 320 moose necropsies performed between 2014 and 2021, MDIFW wildlife biologists have not documented a single moose that was killed by coyotes.

Eastern coyotes prey effectively on deer of all age classes as well as newborns and juveniles of larger ungulates. There are also reports of coyotes attacking and killing adult ungulates larger than deer, such as elk (Paquet 1992), a practice that appears especially prevalent among eastern coyotes (Gompper 2002). Predators' feeding habits are of particular interest because their influence on prey populations can maintain overall ecosystem health (Fortin et al. 2005); and depending on prey choice, may also affect livestock populations (Hunter and Price 1992).

TAXONOMY

One of the most notable differences between the eastern coyote and their western counterpart is body size. Maine coyotes average 30 and 35 pounds (female and male, respectively), which is roughly 10 pounds heavier than western coyotes (Richens and Hugie 1974). Despite numerous anecdotal reports of coyotes in the 60- to 80-pound range, it is uncommon for coyotes to weigh in over 50 pounds (Hilton 1978). Eastern coyotes are a result of historical hybridization between wolves and western coyotes (and to a lesser degree, dogs). Research on the genetic make-up of Maine coyotes in the early 2000s showed that individual eastern coyotes can display varying degrees of coyote and wolf ancestry (Wilson et al. 2004). Of the 100 Maine coyotes sampled, 93% had ancestries dominated (>50%) by eastern coyote genomics, 22% showed eastern wolf ancestries (>5%), and only 4% had similar genomic similarity to western coyotes (>50% western coyote). Interestingly, one coyote with a high degree of eastern wolf ancestry (89%) was also one of the smallest in the study, weighing in at just 27 pounds.

INTERACTIONS WITH OTHER SPECIES

Predation of deer by coyotes is a controversial topic among Maine's public. A common perspective is that coyotes limit deer populations and hunting opportunities. This can have negative economic and social impacts, especially in rural northern Maine communities that rely on guiding "big-woods" buck hunters.

Predators have their greatest influence on prey populations when their impact is added to other forms of mortality such as starvation and disease **(Figure 8.2).** There is some evidence that in areas of the northeast with declining winter habitat, deer populations are declining and likely linked to coyote predation (Pekins and Tarr 2008).

When predators remove deer that would have died from other causes during the year, predation is compensatory and does not limit yearly population growth **(Figure 8.2).** However, at the northern edge of their range where snow depths are higher and winters are longer (e.g., northern Maine, Canada), coyotes may have a greater influence on deer populations (Messier et al. 1986), as they tend to focus more on deer than snowshoe hare in areas with higher winter severity (Patterson et al. 1998). Surveillance of deer mortality in Maine in the 1980s indicated that in snow depths greater than 18 inches where deer movements are restricted, coyotes can cause significant winter mortality, regardless of health or nutritional status of deer (Lavigne 1992). This scenario would be considered additive mortality **(Figure 8.2)** and can be exasperated when the ungulate population is low relative to the carrying capacity of the habitat, then predation is more likely to suppress these populations (Gasaway et al. 1983).

Numerous scientific studies during the early spread of coyote populations suggested that coyotes do not regulate deer populations.

Deer wintering habitat in western, northern, and eastern Maine has been compromised over the last 70 years, potentially reducing a deer's ability to conserve energy and survive the winter. This often forces deer into unsuitable cover and can be advantageous to coyotes at times when the snow conditions favor them over deer.

Numerous scientific studies during the early spread of coyote populations suggested that coyotes do not regulate deer populations. One example reported that the coyote's ability to control game populations in northern Michigan was negligible (Ozoga and Elsworth 1966). However, recent research in the Southeastern United States indicates that coyotes can have a significant impact on fawn recruitment, particularly when understory cover is limiting (Kilgo et al. 2009, Gulsby et al. 2017). Research and debate continue across the country about the potential implications that coyote predation may (or may not) have on broad-scale deer population changes over time (Bragina et al. 2019, Cherry et al. 2016).

A recent MDIFW study to determine cause-specific mortality for wintering deer suggests that more deer mortalities are directly attributed to coyotes in the northern Maine study sites (WMDs 1, 5 and 6) vs. the central Maine study site (WMD 17), most of which occurred when there was deep snowpack (MDIFW unpublished data). This suggests coyote predation is not a significant source of mortality in central and southern Maine; but in northern Maine where habitat is compromised and winters are more severe, it can sometimes be a significant source.

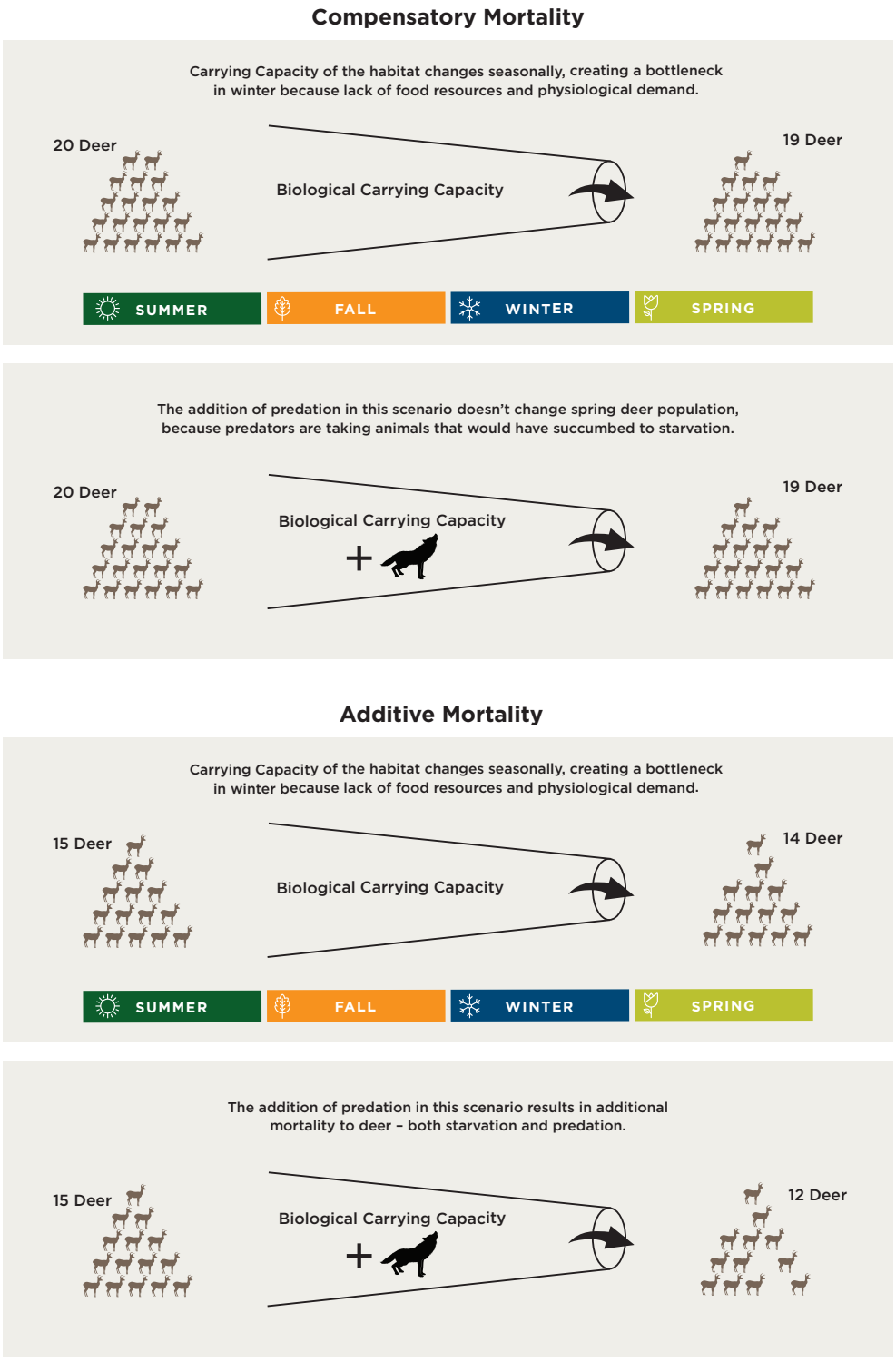


FIGURE 8.2 ILLUSTRATION OF THE EFFECT THAT SEASONAL CARRYING CAPACITY HAS ON DEER POPULATION SIZE.

Under the compensatory scenario, deer could be removed by predation without affecting the spring deer population size. In other words, the winter habitat can only support 19 deer; thus, one deer will die whether predators are present or not. Under the additive scenario, predation increases the overall mortality rate and reduces the spring deer population size by another two deer.

In addition to their effect on prey populations, coyotes may also compete with or displace other predators living in the same ecological community. Interactions between Maine coyotes, fox, and bobcat — all of which prey on snowshoe hare — have been thoroughly studied. Coyotes may outcompete bobcat and fox for snowshoe hare along forest edges when prey is limited; and as a result, the presence of coyote may limit the number of bobcats that can exist in an area (Litvaitis and Harrison 1989).

Similarly, fox may be displaced from hunting along forest edges and other prime hare habitat, but often can compensate by shifting their diet to other small mammals (Theberge and Wedeles 1989). A Vermont study (Ingle 1990) documented a variety of red fox avoidance behaviors (both spatial and temporal) in response to coyotes and concluded that red fox had undoubtedly lower populations at the time of the study than prior to the arrival of coyotes in that state.

Although coyotes will kill fox and bobcat, the three species can coexist by hunting in different habitats (Voigt and Earle 1983, Litvaitis and Harrison 1989). In general, fox tend to avoid coyote territories altogether (Voigt and Earle 1983), while bobcat may outcompete coyotes for hare in densely wooded areas (Litvaitis and Harrison 1989). Coyotes are generally efficient carrion competitors; however, there have been many anecdotal reports in Maine of bobcat and lynx outcompeting coyotes on large carcasses such as deer and moose. Additionally, a 12-year research study on Canada lynx in northern Maine revealed no negative impacts to lynx due to coyotes coexisting with them there (MDIFW unpublished data).

REPRODUCTION

In Maine, female coyotes become sexually active as early as the first week in February (Hilton 1978), forming a pair bond with one male that helps raise the litter. They produce one litter per year of roughly seven young (sizes range from 5 to 9 pups), born from mid-April to May (Hilton 1978, Parker 1995). Generally, 60 to 80% of adult females and 20 to 25% of juveniles (less than 1 year old) breed and bear young each year (Parker 1995). These numbers vary depending on environmental conditions, food availability, and population density.

DISPERSAL

Dispersal is the movement an animal makes from its birth place to where it reproduces, and is the primary mechanism by which animals find and inhabit new areas and avoid inbreeding (Caughley and Sinclair 1994). It is also a time of high mortality as animals move through unfamiliar territory. Maine's coyotes begin dispersing at about five months of age, in late September (Harrison 1992b). Dispersal peaks during October and November and again in February and March. In Harrison's study, 86% of the pups dispersed during their first year, with 53%, 33%, and 14% of the juvenile coyotes emigrating during autumn, late winter, and after the first winter, respectively. All pups in this study dispersed by the time they reached 1.5 years of age.

It is theorized that autumn dispersal may be prompted by increased aggression among siblings, and late winter dispersal by increased aggression from adults during pair bonding (Harrison 1992b). In the Maine studies, coyotes dispersed an average of 64 miles, with the longest dispersal being 214 miles. Survival rates during dispersal were highly variable, but averaged 47% (annual survival), as compared to 74% for juveniles that remained in their original territory.

SOCIAL BEHAVIOR

Coyotes are monogamous (only have one mate at a time) and may maintain pair bonds for several years (Parker 1995). The primary social unit is a family group, consisting of the mated pair and offspring under one year of age (Harrison 1992a). Occasionally, these social units include late-dispersing juveniles, nonrelated individuals, or extended family members cooperating in a pack (Harrison 1992a).

Family groups usually hold discrete territories. Outside the family group, there are transient individuals that normally range from 6 to 18 months of age (Harrison 1992a). These transients reside in other coyotes' territories until they can establish their own. In Maine, the number of adult transients is nearly equal to the number of adults holding territories (D. Harrison, personal communication).

Coyotes' social behavior ranges from solitary living (typical of small canids such as fox) to pack living (typical of large canids such as wolves) (Harrison 1992a). The degree of social interaction among coyotes varies highly and depends upon factors such as prey size, prey availability, and coyote densities in adjacent areas (Bowen 1981, Harrison 1992a, Harrison 1992b). Large prey, like deer, are more efficiently killed and the carcass more easily defended as the number of coyotes that are cooperatively hunting increases (Bowen 1981, Gese et al. 1988, Harrison 1992a). Consequently, cooperative hunting is common in places where small mammal densities are low and large prey make up a major portion of the coyote's diet. Group size largely depends upon the number of juveniles that remain with the mated pair.

MORTALITY

Mortality rates (the number of individuals dying per unit of time) vary with the coyote's age (Parker 1995) and are often calculated separately for juveniles and adults. Human causes (e.g., hunting, trapping, vehicular strikes) are generally the highest coyote mortality sources. Human-caused mortality among juvenile Maine coyotes was nearly twice as high for dispersing animals as for residents, with 40% of dispersing juveniles dying from human-related mortality and 12% from natural causes (Harrison 1992b). By contrast, only 22% of juveniles that remained residents died from human-related mortality and 3% from natural causes. Major (1983) reported that 83% of the coyotes trapped during the 1980 fall trapping season were less than one year old.

Disease occurrence rates and their contributions to eastern coyote mortality are not well documented (Parker 1995), but parasitism and other diseases are influential to coyotes as they become stressed from poor nutrition or weather (Gier et al. 1978). Some common coyote diseases include sarcoptic mange, distemper, canine parvovirus (Gese et al. 1991), canine hepatitis, and various parasites (e.g., tapeworms, mites, and lice) (Gier et al. 1978). Recently, trapper and hunter reports of ticks on coyotes and other furbearers (e.g., fox, fisher) have increased. When coyote densities are high, severe outbreaks of sarcoptic mange can infect up to 70% of the population, causing high mortality rates (Gier et al. 1978). While coyotes can and do contract the rabies virus, they are not as susceptible to it as fox, skunk, raccoons, or bats. In Maine, only four coyotes have tested positive for the rabies virus since 1933 (one in 1976, one in 1978, and two in 2000; unpublished data, Maine Health and Environmental Testing Lab). Of the aforementioned health complications, anecdotal reports from trappers, hunters, and the general public indicate that Maine coyotes are most vulnerable to and affected by sarcoptic mange.

8.2 Coyote Management History

Coyotes are managed by a combination of regulations in statute (Legislature) and in rule (MDIFW). In 1971, the coyote was officially classified as a furbearer in Maine, and the Department began managing the coyote population with a limited trapping season **(Table 8.1).** In 1972, year-round coyote hunting and trapping was allowed; but the excessive incidental capture of fisher and bobcat caused the Department to limit the trapping season length in 1976. In 1979, the Department initiated a coyote control policy to target coyotes in or near deer wintering areas, which eventually became the Department's coyote snaring program. In 1983, a special night hunting season for coyotes was introduced by statute to increase coyote harvest opportunities, and the length of this season was increased five times over the next 28 years. In 1985, the Department set coyote management objectives and implemented a system that included: increasing the annual harvest of trapped animals to 1,500-2,000 coyotes, raising the hunting harvest to 500 coyotes, and improving the Department's response to coyote nuisance complaints. An early fox and coyote season was instituted in 1989 to allow one week of trapping prior to the general trapping season, with another week added in 1997 to add trapping opportunity in non-frozen ground conditions. In 2003, the Legislature discontinued the coyote snaring program.

TABLE 8.1 SUMMARY OF COYOTE RESEARCH AND MANAGEMENT ACTIONS (1971-2021) IN MAINE.

YEAR	MANAGEMENT ACTION
1971	Coyotes were classified as furbearers and trapping was allowed from November 1 – February 15.
1972	Hunting and trapping of coyotes was legal year-round. This included hunting coyotes with dogs.
1976	The coyote trapping season was generally limited to late October through December and special permits were issued to licensed trappers to take coyotes any time of year if they were causing problems. The first coyote planning document was developed, addressing the expansion of coyotes into Maine and promoting increasing coyote harvest rates. Henry Hilton completed his Master's research on the physical characteristics, taxonomic status, and food habits of Maine's eastern coyotes.
1977	Mandatory registration of coyote pelts taken by trappers was initiated for a fee of 25 cents a pelt.
1979	The Department initiated a coyote control policy to reduce coyote predation on white-tailed deer and other wildlife. From December-April, Department staff and select licensed trappers could remove coyotes by trapping within or adjacent to deer wintering areas. Wardens were responsible for identifying areas where coyote control was needed. Only wardens could set neck snares as part of this program.
1980	The Coyote Management Plan was revised with a primary objective to encourage more skilled trapping of coyotes and studying the interactions of coyotes with other species.

YEAR	MANAGEMENT ACTION
1981	Dr. Dan Harrison (University of Maine) conducted research on the denning ecology, movements, and dispersal of coyotes in Eastern Maine for his Master's thesis. He conducted further research on coyote dispersal, mortality, and spatial interactions with red foxes in the same study area for his PhD dissertation. Several other Maine coyote studies took place during the 1980s (J. T. Major, D. B. Engelhardt, D. W. May, and S. L. Caturano).
1982	Foothold traps with teeth on the jaws were prohibited on dry land prior to the deer season in certain management units. The following year, they were banned on dry land statewide.
1983	A special night hunting season (January-February) for coyotes was introduced by statute to increase coyote hunting opportunities. In addition, the Department established a formal damage control program and created an Animal Damage Control (ADC) Coordinator position in the Wildlife Division.
1985	A public working group set management goals to increase coyote harvest and control activities. Coyote night hunting season was expanded by one month (January-March), and the Legislature enabled trappers to snare coyotes in January and February (Title 12 MRSA 7013 and 7035).
1988	The season length for night hunting was increased by one month (January-April).
1989	An early fox and coyote trapping season was established to allow an additional seven days of trapping prior to the regular season. The Legislature enacted a one-year coyote awards program to increase incentives for harvesting coyotes. The ADC coyote control program was revised to allow registered and certified ADC cooperators to set neck snares for coyotes near deer yards where predation was a problem. The Department developed snaring guidelines to limit incidental catches of non-target species (e.g., bald eagles, deer).
1995	The Legislature mandated that the Department conduct a study on coyotes' impact on deer and propose recommendations to encourage the harvest of coyotes. It was estimated that coyote predation caused 30% of Maine's annual deer mortality, with coyotes limiting the deer population in areas where 1) wintering habitat quality was reduced, 2) winters were more severe, and 3) alternate prey were less abundant (Lavigne 1995).
1997	The early fox and coyote trapping season was extended a week, allowing two weeks of trapping for these species prior to the regular trapping season. The Legislature passed a new bill (An Act to Protect Deer, H.P. 99-L.D. 123), which transferred $10,000 from the Department's funds to supplement the coyote control program in 1997 and 1998.

YEAR	MANAGEMENT ACTION
1998	The ADC coyote control program was revised to increase training, incentives, and opportunities for snaring of coyotes, and to increase the Department's monitoring and oversight of snaring activities.
1999	The Coyote Species Assessment was revised to identify management challenges including the need for further education to address polarized public opinions on coyotes.
2003	The Legislature removed the coyote snaring portion of the ADC coyote control program in statute.
2004	The Department completed a coyote genomics study to determine the ancestry of Maine's coyotes.
2007	Waste of Game law was added by the legislature (Title 12; section 11224), prohibiting a person from wasting a wild bird or wild animal while hunting; the law was later amended in 2009 to exempt coyotes. For the purposes of this law, waste means to intentionally leave a wounded or killed animal without making a reasonable attempt to retrieve it for consumption or use. Coyote night hunting season was also expanded by one month (January to May).
2009	Coyote night hunting season was expanded again by two weeks (Dec. 16 to June 1). *Maine's Game Plan for Deer* detailed a comprehensive plan to rebuild the deer herd in northern, eastern, and western Maine. The Department began assessing coyote predation on wintering deer in deer wintering areas (DWAs) with the goal of directing hunter effort to those areas. As they observed predation events, staff successfully directed volunteer effort to some such areas.
2011	Coyote night hunting season was expanded by three months (Dec. 16 to Aug. 31). The Legislature (Section 10 of LD 1569) directed the Department to organize an advisory group of professional guides and trappers to help develop and implement a deer predation management program. The program's objectives were to annually reduce coyote density in high-priority areas between early autumn and early winter, and then monitor coyote presence and manage predation events as needed through winter.
2014	In WMDs 1-6 and 8-11, foothold trap size restrictions were put in place to limit incidental capture of lynx (traps had to have a jaw spread of ≤53/8 inches).
2015	More foothold trapping practice and equipment rules were put in place to limit incidental capture of lynx, including statewide rules that all foothold traps set on dry land must have three swiveling points and the chain must be centrally mounted at the trap's base, and that foothold traps must not be set above ground or snow level. In WMDs 1-11, 14, 18, and 19, each trap must be securely anchored to the ground with a clear catch circle around it and no drags permitted.

YEAR	MANAGEMENT ACTION
2016	The Deer section of the Big Game Management Plan determined it was a high priority to evaluate the effectiveness of the coyote management program and identify improvements.
2018	A working committee was charged with reviewing the scope of the predator management program. The program continues to focus on areas that currently support populations of wintering deer during restrictive conditions and that are within the NEWME Deer Recovery Area. The trapping phase of the program commences three days after the start of the early coyote and fox trapping season and runs through the end of November or until conditions allow. The hunting phase of the program typically begins when there is adequate snow cover to monitor coyote-deer activity in December and ends when deer have dispersed in the spring or by May 15.
2019	Harvested coyotes were allowed to be gifted to other people who can register the coyotes. Trappers are required to submit annual trapper effort reports.

8.3 Regulatory Framework

Like all Maine wildlife, coyotes are a publicly owned resource held in trust by the State for the benefit of all Maine residents. Coyotes can be hunted and trapped using methods that include bait, dogs, and calling. Currently, there is no closed season for daytime hunting of coyotes. During daylight hunting hours, hunters can use the aid of dogs to hunt coyotes. There is an additional coyote night-hunting season that runs from mid-December to August 31st each year. To participate, a hunter must have a valid night-hunting permit and also possess a predator calling device. Trapping for coyotes is allowed during two separate seasons in Maine, the early fox and coyote season and general trapping season. The early fox and coyote season was established in 1989 and occurs statewide two weeks prior to the opening of the general trapping season. The general trapping season runs from the Sunday preceding the regular firearms season for deer until December 31st, annually. Starting in 2014, many trapping regulations were put in place to limit incidental captures of lynx. For coyote trapping specifically, this limited the size of a foothold trap and prohibited the use of drags to anchor the trap in WMDs 1-11, 14, 18, and 19. Additional statewide restrictions, including the prohibition of exposed bait or visible attractors, were placed on foothold traps used during the early fox and coyote season.

COYOTE HARVEST TRENDS

All coyote pelts taken by trapping must be tagged and registered within ten days after the close of coyote trapping season. There is no requirement to register coyotes taken by hunting, unless the fur will be sold or traded. In 2019, Department rule-making efforts allowed coyote hunters to gift unregistered coyotes to another person to use the fur or carcass. Coyotes are a popular but challenging furbearer to trap or hunt. The highest registered harvests occur in southern and central Maine (WMDs 15, 17, 20, 23; **Figure 8.3**), where 7 to 12 coyotes are taken per 100 square miles, respectively.

Forty-two percent of trappers and sixteen percent of hunters targeted coyotes during the 2018-19 season (Responsive Management 2020). However, roughly a third of Maine trappers are unsuccessful at catching at least one coyote during the trapping season. In fact, on average, only about 200 trappers successfully harvest a coyote each year. To compare with coyote hunters, approximately 8,500 coyote night hunting permits are issued each year, yet only about 100 coyote hunters register a coyote each year. The number of coyotes taken from hunting is unknown and difficult to estimate. Nonetheless, the registered coyote harvest increased from 1977 to 2001 with increased trapper/hunter participation **(Figure 8.4).** Since 1998, the annual registered harvest (trapping and hunting combined) has been between 1,000 and 2,700 coyotes **(Figure 8.5).** Registered harvests have remained relatively stable over the last decade (2010-2019), averaging 1,500 coyotes each year. The number of coyotes taken per trapper has also been stable, ranging from four to seven coyotes per trapper (2008-2019; **Figure 8.6).** Coyote trapping success has been similar, with 1.1 to 1.6 coyotes caught per 100 trap-nights (where a trap night is a single trap set for a single night) from the 2018 to 2020 trapping seasons, respectively. Despite this low success rate, coyote trapping effort remains highest of any furbearer species, with 300 coyote trappers reporting a total of 92,000 trap-nights in 2019. Southern and Central Maine areas (WMD 15, 17, 20 and 23) account for the highest density of coyotes caught from 2015 to 2019.

PREDATOR MANAGEMENT

Coyote predation on white-tailed deer remains a controversial subject in Maine, and there is an equal amount of debate on the effectiveness of coyote control. Nonetheless, there is evidence in the northeast that coyotes and black bears are important predators of fawns during the summer and fall, whereas coyotes are the primary cause of mortality for fawns ≥7 months (Ballard et al. 1999).

Success of these predator control programs depends upon many factors including the presence of coyotes, weather, and the effort and skill of program participants.

As such, several efforts have been underway to reduce coyote populations in areas with important deer wintering areas (DWAs) and where deer are below management objectives. Success of these predator control programs depends upon many factors including the presence of coyotes, weather, and the effort and skill of program participants.

In the winter of 2010-11, the Legislature directed the Department to convene a working group to develop and implement a program for managing predation on deer. This program has since been coined the Predator Management Program and has been funded by general funds and/or deer hunter tagging fees. Its objective is to proactively reduce coyote density in priority northern, eastern, and western Maine DWAs. Regional wildlife biologists identify and contract with qualified trappers and hunters that are known to be capable and available to conduct coyote removals in these prioritized areas. Many of these designated program areas are remote and may not receive significant levels of trapping and/or hunting effort during regular seasons. The focal period for predator management is autumn to early winter, followed by reactive efforts to monitor coyote presence and manage predation as needed throughout the winter. Since 2011, the program has occurred annually in as many as 73 priority DWAs (See **Table 8.1** for breakdown), with the annual number of coyotes taken ranging from 11 to 541. The average annual cost of direct payments to program participants is nearly $52,000.

TABLE 1. ANNUAL REMOVAL OF COYOTES UNDER THE PREDATOR MANAGEMENT PROGRAM, INCLUDING TOTAL COST OF DIRECT PAYMENTS TO PROGRAM PARTICIPANTS. THE PROGRAM STARTED WITH A PILOT FROM MARCH TO MAY 2011, AND AVERAGE VALUES DO NOT INCLUDE THIS INITIAL PILOT PERIOD.

PROGRAM YEAR	NUMBER OF DWAS	NUMBER OF PROGRAM PARTICIPANTS	COYOTE REMOVALS BY TRAPPING	COYOTE REMOVALS BY HUNTING	TOTAL COYOTES REMOVED	TOTAL COST
2010-11	9	5	0	11	11	$1,609.00
2011-12	37	12	0	121	121	$15,156.00
2012-13	52	71 + 21 VOLUNTEERS	102	439	541	$63,668.00
2013-14	73	67 + 20 VOLUNTEERS	107	278	385	$68,346.00
2014-15	52	70 + 21 VOLUNTEERS	78	225	303	$41,035.00
2015-16	52	62 + 17 VOLUNTEERS	118	119	237	$43,374.00
2016-17	52	62 + 17 VOLUNTEERS	116	170	286	$62,540.02
2017-18	52	68 + 9 VOLUNTEERS	121	97	218	$40,721.59
2018-19	55	56	170	218	388	$69,670.08
2019-20	55	60	131	179	310	$52,926.83
2020-21	55	41	86	190	276	$61,180.61
AVERAGES MINUS THE FIRST YEAR	53.5	56.9	93	203.6	297	$51,861.81

Another contentious issue related to predator management is coyote contests. In Maine, their purpose is typically to incentivize coyote hunting and trapping participation with the expectation that increased coyote harvest will improve deer survival. Participants must follow all hunting and trapping regulations. Local businesses typically sponsor the program and provide the bulk of the funding, including awards which may be given for characteristics such as biggest male and female coyote. Some contests require all coyotes be registered and pelts to be tagged to enter. Although the contests may increase the value of coyotes taken, they do not result in high numbers because coyotes are challenging to harvest. For example, one recent contest resulted in 35 people taking 209 coyotes with $20/coyote paid to each person; and the other contest resulted in 46 people taking 144 coyotes with $21/coyote paid to each person.

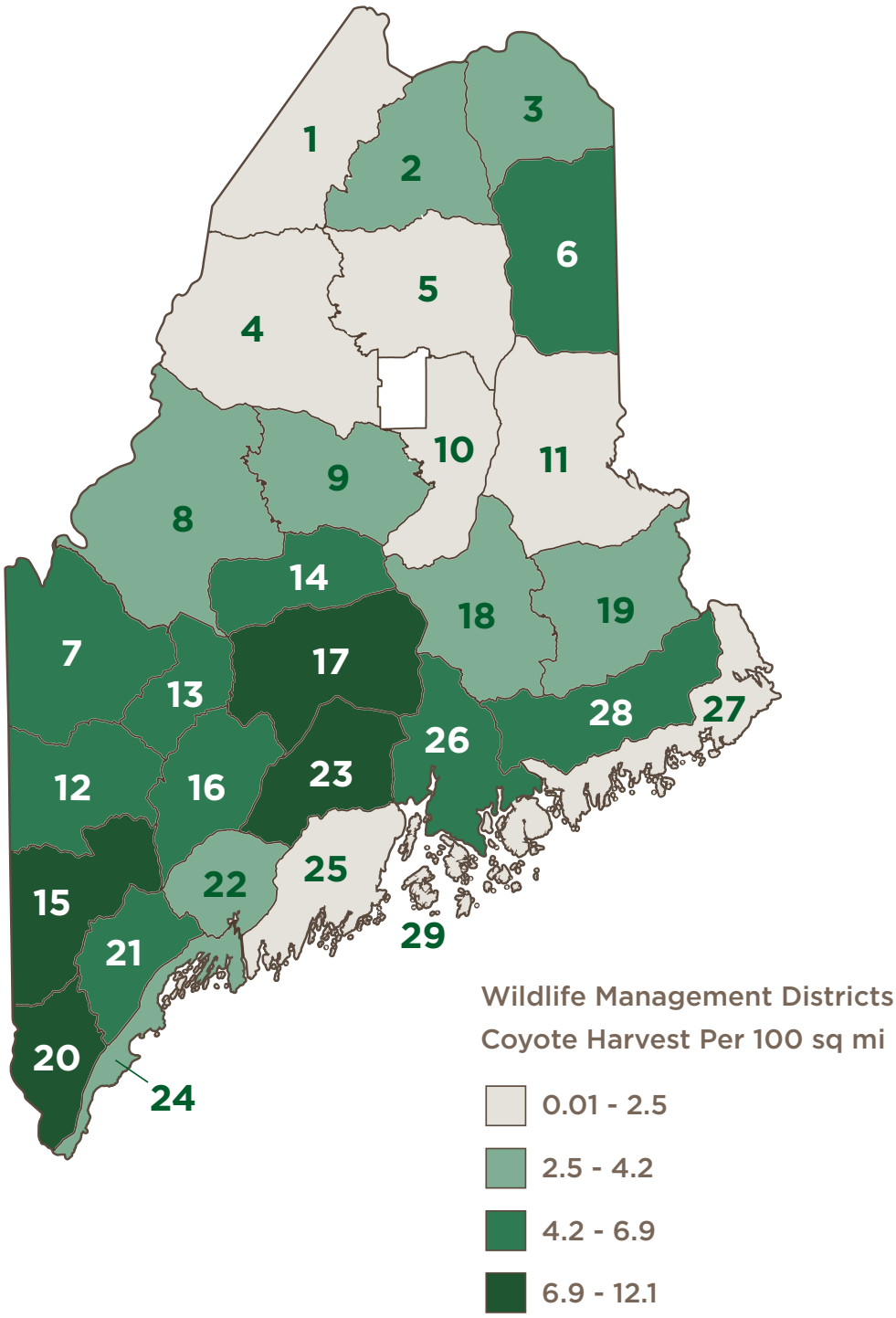


FIGURE 8.3 AVERAGE NUMBER OF REGISTERED COYOTE HARVESTS PER 100 SQUARE MILES IN EACH MAINE WILDLIFE MANAGEMENT DISTRICT DURING THE 2015-2019 TRAPPING AND HUNTING SEASONS. THERE IS NO TRAPPING IN BAXTER STATE PARK (SHOWN IN WHITE).

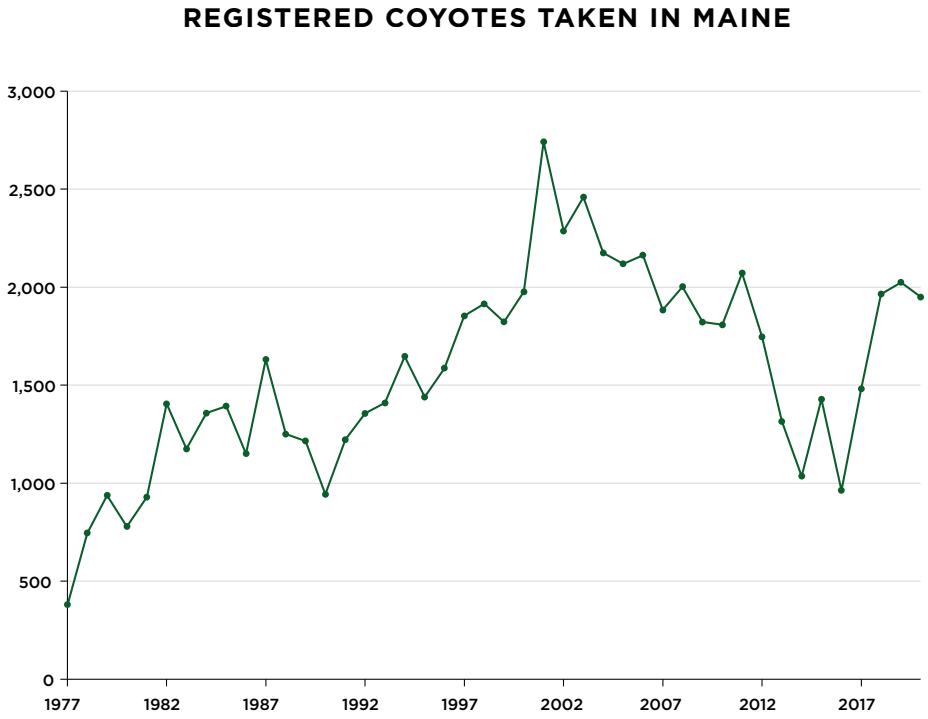


FIGURE 8.4 SUMMARY OF REPORTED MAINE COYOTES TAKEN DURING THE TRAPPING AND HUNTING SEASONS FROM 1977 TO 2020.

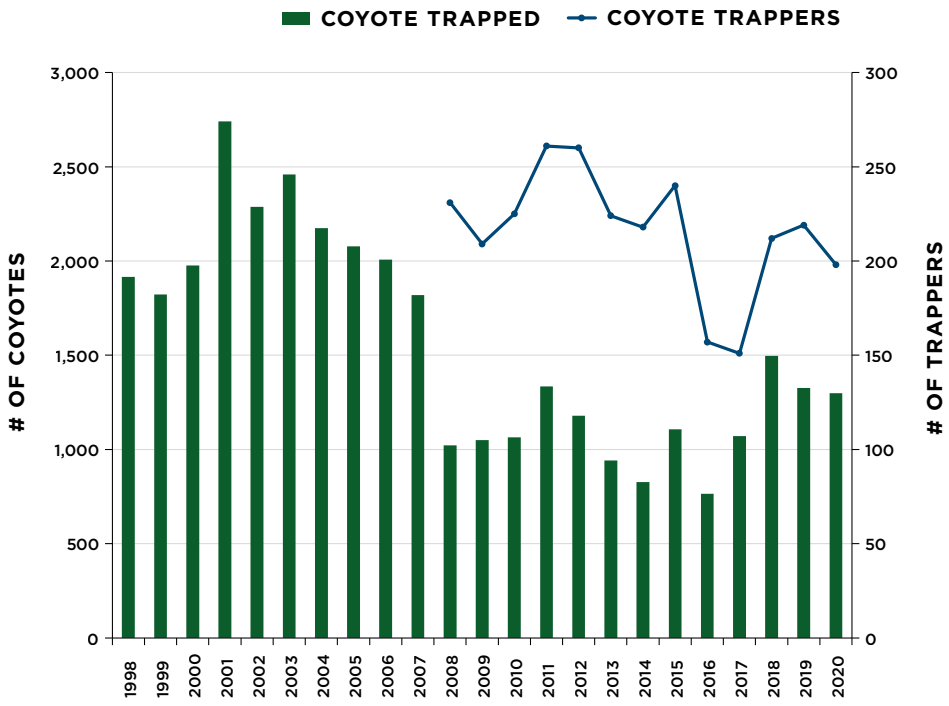


FIGURE 8.5 COYOTE TRAPPING HARVESTS (BARS, LEFT AXIS) AND NUMBER OF TRAPPERS REGISTERING COYOTES (LINE, RIGHT AXIS) FROM 1998-2020 IN MAINE.

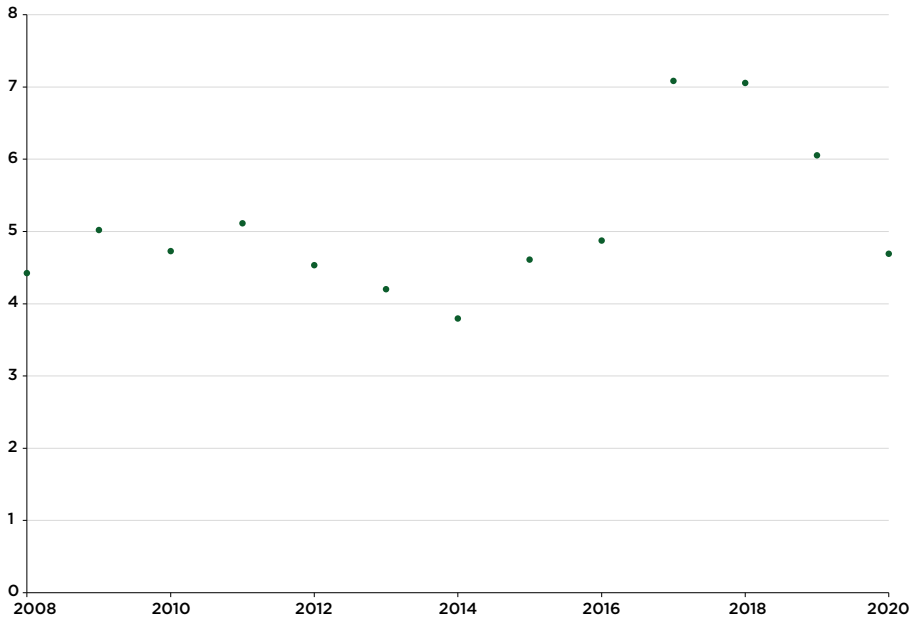


FIGURE 8.6 THE AVERAGE NUMBER OF COYOTES HARVESTED PER SUCCESSFUL COYOTE TRAPPER FROM 2008-2020 IN MAINE.

8.4 Public Consultation – 2020 Key Findings

PUBLIC KNOWLEDGE OF COYOTES

Nearly half (47%) of Maine's general population reported that they know a great deal or moderate amount about coyotes, putting self-professed coyote knowledge among the highest of the furbearer species, just behind skunks (52%) and raccoons (50%). Residents in the north/east region claimed to be the most knowledgeable of the three regions (north/east, central, and south).

Hunters and trappers self-reported the most coyote knowledge of the five groups, with 82% and 95%, respectively, indicating that they know a moderate or great deal. Meanwhile, 39% of trapping opponents and 43% of landowners reported having that level of coyote knowledge.

MAINE RESIDENTS REPORTING A GREAT DEAL OR MODERATE AMOUNT OF KNOWLEDGE ABOUT COYOTES

47%	82%	95%	39%	43%
GENERAL POPULATION	HUNTERS	TRAPPERS	TRAPPING OPPONENTS	LANDOWNERS

More Maine residents believe that the coyote population is too high (27%) than too low (2%), and 32% believe it is about right. Of hunters, 70% felt that the coyote population was too high, while none felt that it was too low. Similarly, 72% of trapping participants felt that the coyote population was too high, and just 1% said it was too low. A quarter (25%) of both hunters and trappers said it was about right. Of trapping opponents, 16% thought the coyote population was too high, 1% felt it was too low, and 27% said it was about right. About half (49%) of landowners thought it was too high, 4% thought it was too low, and 38% thought it was at a reasonable level. It is not surprising that all groups felt the coyote population was too high since the number of coyotes that are heard howling, yipping, and barking during group vocalizations is often overestimated.

When Maine residents were asked about the value of coyotes near their home or in their general area, residents from each of the survey regions equally reported coyotes as being a nuisance or danger to them (37% in north/east, 38% in central, and 38% in south). Compared with the general population, higher amounts of hunters and trappers felt that coyotes were either a nuisance or danger to them (66% and 64%, respectively). Similarly, nearly half of Maine landowners (49%) believe that coyotes are a nuisance or pose some level of danger, with more surveyed landowners in the North/East and Central Regions (54% and 56%, respectively) being concerned about coyotes than those living in the South region (37%). And nearly a quarter (22%) of respondents not in favor of trapping still regarded the coyote as a nuisance or danger, with 24% of this group reporting that they enjoy seeing coyotes but worry about the problems they cause. The most common concerns may be related to competition with hunters for the same species that coyotes pursue (e.g., deer) or the safety of children, pets, and/or livestock around people's homes and property.

When asked to rank 10 furbearing species on a scale of 0 (least beneficial) to 10 (most beneficial), Maine residents ranked coyotes the lowest of all furbearers (overall mean of 5.1). The landowners among them also ranked coyotes as the least beneficial furbearer, with a combined mean score of 4.2. And hunters and trappers gave them even lower mean scores (3.2 for hunters and 3.0 for trappers). This response from trappers was surprising given the popularity of trapping coyotes combined with the relatively high price of coyote pelts (compared to the other furbearing species). Trapping opponents ranked coyotes next-to-last (only ahead of fisher) with a combined mean score of 6.7. In general, much of the negative sentiment is derived from the vilified perception that coyotes have always carried in addition to a misunderstanding of the value of predators to prey populations. Furthermore, there is little public knowledge that coyotes forage on a variety of items, including grasses, fruits, and seeds during a large portion of the year.

PUBLIC SUPPORT OF COYOTE TRAPPING

When we asked Maine residents whether they approve of or oppose regulated trapping as a coyote population management method, 71% of the general population approved and 20% did not. In fact, that same 71% supported a coyote management program even if it meant an increase in deer and turkey numbers in their area. Trapping approval by hunters and trappers was very high (87% and 90%, respectively), but 5% of hunters and 6% of trappers still did not approve of this management tool. These responses could be related to the regulatory restrictions associated with land trapping. In contrast, only 31% of trapping opponents supported regulated trapping for management, with 48% opposing it. And a large percentage (68%) of Maine landowners said that they support it. (Responsive Management 2020).

CONFLICTS WITH COYOTES

Reported human-coyote conflicts do not occur as often as conflicts with other species, but coyotes seem to receive a considerable amount of negative public perception. Both MDIFW and the United States Department of Agriculture (Wildlife Services) respond to calls from the public regarding wildlife concerns, including but not limited to coyotes, and field 200 to 700 calls each year specifically related to coyote. These range from casual coyote sightings to landowners reporting incidents between coyotes and their pets. Most can be resolved over the phone, while some require site visits to verify the problem's severity. Some of the more severe coyote problems reported and verified over the last several decades in Maine involve livestock (sheep, chickens, turkeys, geese, llamas, cow calves, goats) and pet (companion and hobby animals) losses, and property (gardens and buildings) damage. Verified coyote conflicts range from three per year (e.g., 3 of 368 animal complaints in 2019 and 2020) to 19 per year (e.g., 19 of 435 animal complaints in 1994 and 1995).

Despite these lower verified conflict numbers, 14% of Maine landowners reported having a problem with coyotes. This was the highest percentage of all reported species, with landowners in some regions reporting higher conflict rates, including 30% of landowners in the south (Responsive Management 2016, 2020).

To date, confirmed cases of physical human-coyote contact have only involved a small number of turkey hunters, and the episodes have resulted in little reported injury.

There is an increasing concern that coyotes living in more urban and residential areas are becoming bolder as attacks to humans and pets nationwide have steadily increased (White and Gehrt 2009; Baker and Timm 2017); but since Maine remains a predominately rural state, people rarely report physical contact with coyotes. To date, confirmed cases of physical human-coyote contact have only involved a small number of turkey hunters, and the episodes have resulted in little reported injury. However, as other jurisdictions have experienced, there is potential for human-coyote contacts to increase, particularly in Maine towns with regulatory restrictions on hunting and trapping methods. Breck et al. 2019 suggest that in areas where coyotes are pressured or pursued by humans, they tend to be less aggressive and avoid humans.

8.5 Management Issues & Threats

Our knowledge of coyote status currently relies on traditional metrics including harvested coyote registrations, trapper-effort surveys, and public and staff reports, all of which are subject to gas prices, the fur market, and the economy. Although social carrying capacity indicates that the coyote population is high, the Department needs to explore emerging techniques for monitoring coyote populations independent of harvest metrics.

Public opinion about Maine coyote management continues to be polarized. Northern and southern Maine differ in terms of coyote impacts, behavior, interactions with humans, and human tolerance, but the potential effect of coyote predation on white-tailed deer remains a statewide focal point, driving strong negative beliefs and attitudes about coyotes.

During this planning process, we considered a full breadth of coyote management issues, some of which are controversial or have significant data gaps. Public attitudes or regulatory modifications not specifically addressed in this plan lacked consensus from the planning committee and broad public support to address at this time.

As with other furbearers in this document, there is a need to provide Maine citizens with more information about this important mammal and adaptable predator, including how to more effectively coexist. The Department also needs to make efforts to retain hunting and trapping as management tools, given their effectiveness at addressing human-coyote conflicts, maintaining healthy populations, and keeping coyotes wary of humans.

8.6 Coyote Management Goals & Strategies for 2020-2030

Goal #1. Maintain healthy, abundant coyote populations

- Continue to monitor common coyote diseases and parasites (e.g., mange, parvovirus, distemper, ticks, etc.) and emerging disease issues. ***(Ongoing; Low Priority)***
- Explore methods to estimate and monitor the coyote population independent of fur harvest data, such as citizen science survey contributions (e.g., cameras, howling, tracks, scat, etc.). ***(New; High Priority)***
- Research ways to increase understanding of coyote interaction with other meso-carnivores and their prey. ***(New; Low Priority)***
- Conduct an in-depth predator removal study to understand predator/prey dynamics in northern areas. ***(New; Low Priority)***
- Conduct a study to better understand coyote movements and winter deer predation in northern areas. ***(New; Low Priority)***
- Conduct a survival study to determine causes of fawn mortality, including predation by coyotes and other predators in northern areas. ***(New; Low Priority)***

Goal #2. Maintain a sustainable coyote harvest

- Continue to utilize catch per unit effort and general observations from trapper harvest reports as metrics of tracking coyote population trends. ***(Ongoing; High Priority)***
- Ensure that the coyote harvest remains within acceptable social and biological carrying capacity. ***(Ongoing; Low Priority)***
- Explore methods to estimate and monitor coyotes taken by hunting with the goal of enumerating coyote populations and changes over time. ***(New; High Priority)***

Goal #3. Maintain coyote trapping & hunting opportunities

- Maintain or increase the number of licensed trappers targeting coyote to reduce human-wildlife conflicts. ***(Ongoing; High Priority)***
- Continue to support the Northeast Association of Fish and Wildlife Agencies' non-lead campaign. ***(Ongoing; High Priority)***
- Continue to provide educational messaging about traps and trapping to hunters to minimize hunter-trapper conflicts. ***(Ongoing; High Priority)***
- Explore the use of new, humane, and effective coyote traps. ***(Ongoing; Low Priority)***
- Develop tools to determine current participation and interest from new canid trappers and hunters. ***(New; High Priority)***
- Work with partners to develop educational videos on how to utilize coyotes for their fur and other products. ***(New; High Priority)***
- Develop effective outreach tools to promote unique and challenging aspects of canid trapping and hunting. ***(New; High Priority)***

Goal #4. Increase public understanding of coyotes & coyote management

- Maintain or increase 2019 levels of public, trapper, and landowner satisfaction with and support for Maine's coyote management program. ***(Ongoing; High Priority)***
- Increase the public's awareness, perceived value, and acceptance of the coyote as an important predator. ***(Ongoing; High Priority)***
- Increase public awareness of the roles trapping and hunting play in coyote management and human-wildlife conflict reduction. ***(Ongoing; High Priority)***
- Develop lesson plans for educators promoting coyotes and their positive ecological services. ***(New; Moderate Priority)***
- Develop outreach materials for coyote trappers and the public that highlight and promote trapping Best Management Practices. ***(New; Moderate Priority)***
- To reduce conflicts, work with Landowner Relations and Public Lands to explore signage or other ways to publicize the dates hunting dogs may be running at large. ***(New; Low Priority).***

Goal #5. Minimize human-coyote conflicts

- Reduce the number of human-coyote conflicts by implementing the Department's Animal Damage Control program. ***(Ongoing; High Priority)***
- Develop a database and mapping tool to track coyote complaints. ***(Ongoing; High Priority)***
- Develop easy-to-use education and extension materials for homeowners and other land managers on resolving human-coyote conflicts. ***(Ongoing; High Priority)***
- Periodically evaluate levels of complaints and types of responses to human-coyote conflicts. ***(Ongoing; Low Priority)***
- Develop educational and extension materials on how to interact with wildlife and explore options for placing informational signage on key public land entrances. ***(New; Low Priority)***

Goal #6. Conservation of other species

- Continue trapper education and promote outreach materials on how to minimize incidental capture of lynx during the early canid trapping season. ***(Ongoing; High Priority)***
- Keep working with USDA WS to manage coyote predation on New England Cottontails and rare shorebirds. ***(Ongoing; Moderate Priority)***
- Compile all available data sources, develop metrics, and identify data gaps to improve the Predator Management Program. ***(New; High Priority)***

Expected Outcomes for Coyote Management

Implementing the coyote management strategies outlined in this plan will require adequate staffing, funding, and public support, and it may not be necessary or feasible to carry out all strategies to achieve this plan's goals and objectives.

We anticipate the following coyote-related outcomes over the next 10 years:

Outreach and communication efforts will increase public knowledge of coyotes by 2025.

Public support for coyote management will remain above 60% by 2030.

Public tolerance for coyotes will increase by 2030.

Management actions and outreach efforts will maintain coyote hunting, trapping, and viewing opportunities.

Statewide coyote complaints will be tracked and brought below 2021 levels.

9.0

RED & GRAY FOX

9.0

FOX

Both members of the canid (dog) family, the red and gray fox also share some cat-like traits (such as semi-retractable claws). But these two fox species differ in important ways, too, from appearance to behavior, habitat, and geographic distribution.

FOX HABITAT

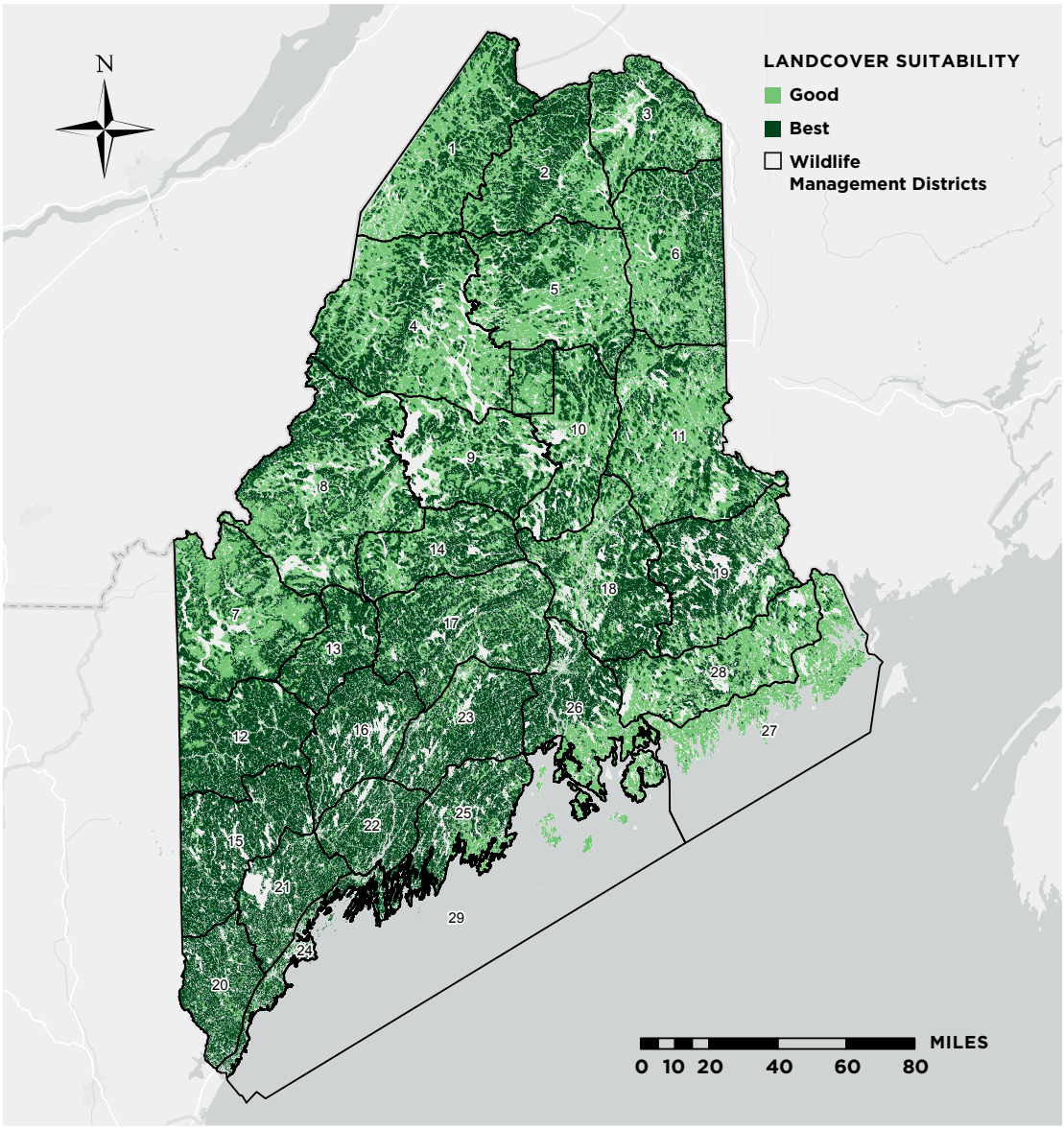


FIGURE 9.1 HABITAT SUITABILITY BASED ON BROAD HABITAT COVER TYPES AND ASSOCIATIONS FOR RED AND GRAY FOX.

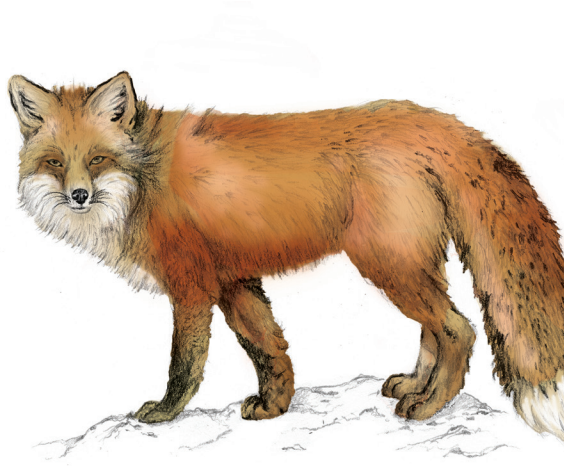
9.1 Natural History & Population Status

Maine has two species of fox: the red fox *(Vulpes vulpes)* and the gray fox *(Urocyon cinereoargenteus)*. Both species are similar in size, but there are some important differences in their appearance, behavior, habitat, and distribution. Red foxes are found statewide, while gray foxes are currently established in southern and central Maine. Fossil and genetic evidence indicates both species inhabited North America prior to the Pleistocene Period. The gray fox is a member of the older genetic lineage (genus *Urocyon*), which predates the red fox (genus *Vulpes*).

Both fox species are considered native to North America; but historically, red fox tended to range further north in the boreal forest. Red fox have occurred in Maine for a longer period, while the gray fox is a more recent arrival and is still expanding its range (Bozarth et al. 2011). The Province of New Brunswick, Canada documented its first gray fox in 2007 and reports of gray foxes continue to trickle in (McAlpine et al. 2016).

Expansion of both red and gray fox is likely a response to human influence on the landscape (especially farming and forestry), which can benefit both fox species. The distribution of red and gray fox overlaps in southern, mid-coast and central Maine, though they differ in the habitats they use and how adaptable they are to people.

There was a period in the mid-1700s to early 1900s during which humans stocked European red fox into many east coast states for hunting and/or fur farming (Kamler and Ballard 2002). Though the influence of these stocked animals on native fox populations is debated, evidence suggests nonnative red foxes may adapt better to living near people (Kamler and Ballard 2002).



RED FOX

The red fox is the most widely distributed canid in the world, and they are abundant in all 16 Maine counties. They are medium sized, weighing between eight and 15 pounds. Unlike other canids, they have little sexual dimorphism between males (known as dogs) and females (known as vixens). Their coat is most often orange with bands of dark brown or black hairs along the spine and to a lesser extent down the front shoulder blades. The chin, lower lips, throat, front of the chest, and tip of the tail are white, and the lower legs and feet are black. The white tail tip and black feet distinguish the red fox from the gray fox.

The red fox's coat is well suited for cold climates, with a very dense, insulative inner layer of fur roughly an inch to an inch and a half long plus a layer of silky outer guard hairs several inches in length that help shed moisture, keeping the inner fur dry. These outer guard hairs are more prevalent in winter and in red fox living in the northernmost part of their range. Additional evidence that red fox are more tolerant of northern climates than gray fox includes the recent observation that red fox, which are larger and closely related to arctic fox (*Vulpes lagopus*), are showing up in areas to the far north, and displacing arctic foxes (Elmhagen et al. 2017).

Red fox can exhibit many different colors including the silver/black color phase; the cross fox, with a dark stripe down the length of the back and shoulders; and the most unusual Samson fox, which has a coat of only soft wooly underfur (no guard hairs). The Samson coat is caused by a recessive genetic mutation and it's not clear whether the condition has always occurred or whether it originated from fox fur farms (Voipio 1990).

Red fox possess many traits shared by other canids, such as a lack of rotation in ulna and radius bones, elongated skull and zygomatic arch, elongated rostrum, a dental formulae of 42 teeth including shearing carnassial teeth, caching, denning, and scavenging behavior, and establishment of strong pair bonds by mates, yet they also possess some traits more often seen in felids (cats) (Henry 2013). These include vertical-slit pupils with a tapetum lucidum membrane, use of a sustained bite on prey rather than a shake bite, relatively long, dagger-like teeth, semi-retractable claws that enable some tree climbing, and sensory vibrissae hairs on the muzzle and forelegs. These shared traits may be a consequence of coevolution, since both fox and cats hunt the same size prey and thus evolved similar adaptations to kill them.

Red foxes have keen eyesight and hearing, and are very agile. Legendary 20th century vertebrate morphologist Milton Hildebrand (1954) concluded the red fox has proportionately longer legs and a lighter body than would be expected for a canid its size. This enables the fox to lunge up to fifteen feet on horizontal ground and 25 feet downhill. With their longer legs and lighter bodies, fox can launch themselves these distances from an optimum angle of near 45 degrees to pounce on small mammals hidden under the snow or vegetation. These impressive pounces increase their success in catching the equally well-evolved small mammals that compose a large part of their diet.

GRAY FOX

Gray fox weigh about ten pounds and are distinguished by their gray coloration, a hint of red on the neck, ears, and lower legs, light-colored chest and belly, and black-tipped tail with a black stripe running down it. The salt-and-pepper coloration results from individual guard hairs that are banded with white, gray, and black. Gray foxes are a little shorter but stockier than red fox. They occur in the northern parts of Venezuela and Columbia in South America, much of the United States, and southern parts of central and eastern Canada. The gray fox, like opossum and turkey vulture, has become more prevalent in Maine in recent decades. Historically, gray foxes were known to occur in parts of York and Cumberland County, and they are currently abundant in southern and mid-coast areas while continuing to expand into northern Maine. Maine's northernmost gray fox was recorded in Rockwood Strip (near Moosehead Lake) in 2020.

The gray fox is distantly related to the red fox, with the two species exhibiting some similarities and some differences. If the red fox possesses some felid features, the gray fox goes one step further. While the red fox can ascend the lower branches of trees, especially if they are angled rather than vertical, the gray fox, with its semi-retractable claws and greater level of front-leg rotation between the ulna and radius bones, can climb and descend trees proficiently enough to evade predation by coyotes, which cannot climb trees. This arboreal ability beyond that of the red fox may give the gray fox enough of an advantage to allow it to share habitats with the coyote. While the red fox prefers the open country with a mix of fields and forest, the gray fox is more associated with brushy, shrubby, rocky, or deciduous forest. They can live in areas with rugged topography, but their limited distribution at higher latitudes suggest they may be restricted by colder, snowy climates and/or may be outcompeted there by the more common red fox. Gray foxes are also well-adapted to living near people and may take advantage of food and denning sources in residential areas. In recent years, bird feeders have become issues since they attract a wide range of wildlife, which can lead to conflicts.

REPRODUCTION

Red fox breed annually beginning at one year old. They are usually monogamous, and in most cases the dog and vixen both provide for the offspring. Although red fox can live to be 10 to 12 years old, they rarely live beyond four to six years in the wild. The breeding season in Maine takes place from December through March, peaking in February. During this time, fox disperse a strong odor from their glands at scent stations. The vixen typically selects the den site, favoring slightly elevated, well-drained, sunny locations with sandy loam soil, usually within 100 yards of a reliable water source. Most fox have a primary den, but will often excavate others within the home range to be used if their primary site is disturbed. Fox often reuse dens for multiple years and sometimes even generations.

In April or May, following a gestation period of approximately 50 days, Maine's female fox give birth to an average litter of five kits. The kits are helpless, weigh less than a quarter of a pound, and are covered in a charcoal-colored coat. The female tends to the young, providing for them and keeping them warm; and this is the only considerable time an adult spends in the den. Once the kits' eyes open in 10 to 12 days, the vixen starts going out on short forays from the den, returning every four hours to nurse. At about five weeks of age, coinciding with the onset of weaning, the kits develop a sandy-colored coat and start venturing out of the den themselves. Red foxes are weaned at eight weeks, and by ten weeks they once again change coat color to the orange/red typical of adults. At this time, both adults are working overtime bringing food back to the den area. Among the waiting kits, the most assertive beggars get the most food.

Young males disperse before females and travel a greater distance from their parents' territory, up to 40 miles.

When the habitat is good and prey is abundant, offspring from the previous year (usually a female) will sometimes stay and contribute to kit rearing. Usually by mid-to-late June the adults cut back on bringing food to the den site, perhaps to encourage the kits to travel more. This is the time when MDIFW gets the most fox-related calls from the public (sometimes just observations; sometimes because they're causing problems). People often observe kits in the open on summer days. Kits may accompany adults on hunts and spend less time at dens, though the family group will still rendezvous at den sites, which is typical of canid species. Around September, Maine's male kits reach sexual maturity and start showing less tolerance of their littermates. Young males disperse before females and travel a greater distance from their parents' territory, up to 40 miles.

Female offspring usually leave in early winter and don't travel quite as far, if at all (when resources are abundant, they will sometimes stay to function as a helper). In higher density fox populations, males may breed with multiple females who then den near each other, though they still maintain home ranges. This departure from monogamy is another example of how fox can adapt to their environment to maximize their fitness.

Like red fox, gray fox breed in winter and have about four kits each spring. Gray foxes will den in brush piles, rock crevices, hollow logs, underground burrows, abandoned buildings, or tree cavities. Gray foxes are thought to be monogamous, with both parents helping care for their offspring, though research has documented that some adult males forage separately and do not make frequent trips to the den like the females (Fritzell 1987). By the time the kits are three months old, they start getting more independent, learn to hunt with the female, and vacate the den. By seven months, they can hunt on their own and are independent from their parents. Young gray foxes disperse in the fall, with males typically travelling further than females; but if the food resources are good, young foxes will not travel as far and may stay in their parents' territory.

HABITAT & FOOD

Fox home range size can vary based upon habitat quality and food availability, but Maine generally supports good fox habitat **(Figure 9.1).** In Maine, the average red fox home range has varied between six and twelve square miles, representing good and marginal habitat quality (Shelburne and Matula 1981, Major 1983). Red foxes are most often associated with edge habitat, as this tends to harbor a higher abundance and diversity of food. Canadian Naturalist Ernest Thompson Seton (1913) noted that red foxes are a species of "half open country." As Maine's percentage of agricultural land cover increased in the 1800s, carrying capacity increased for red fox and decreased for gray fox. In the late 1800s and early 1900s, as the agricultural lands were left to mature into forests, the preferred red fox habitat decreased. Unlike the gray fox, who seeks out forested habitat and likely benefited from this farm-to-forest conversion, the red fox still is more likely to settle in agricultural lands, the urban/forest interface, and increasingly, within human residential areas. In these areas, they find food (of both wild and anthropogenic origin), try to keep a low profile, and are more likely to avoid the coyote, a larger canid which will kill them.

Foxes are primarily nocturnal, though they hunt during dawn and dusk and are occasionally seen out during the day, particularly during the spring/summer when rearing pups. Their omnivorous diet consists of animal and plant foods that vary based on the season and availability. In the summer, red fox will eat soft mast like berries (often visible in their scat), as well as insects such as grasshoppers, crickets, and beetles. These small bundles of calories are easy to find, and less intense to hunt for than their typical larger prey, which consists of small mammals such as mice, chipmunks, and voles, as well as ground nesting birds. When hunting, red fox walk game trails and use their well-developed senses of smell and hearing to locate prey. Their special hunting style consists of slowly and quietly stalking, lifting their head when they detect prey, and getting in position to bound an average of two to six feet (but sometimes far greater distances), landing on their prey with their front paws and dispatching with a bite. Fox are very focused on these types of hunts. Red foxes have a lower rate of success catching wild birds (particularly small songbirds) compared with ground nesting birds like grouse, woodcock and turkey, which they hunt like a feline by running at them with a low-to-the ground burst of speed.

Red fox prey on snowshoe hare and cottontail rabbits by stalking until close, then pursuing them at full speed. Maine's New England Cottontail are state-endangered, and remaining populations are critically small and isolated at several sites along coastal York and Cumberland Counties. Research and management efforts are underway to increase the abundance and range of the rabbit, and part of these efforts involve minimizing mortality factors over which we have some control, including predation by fox.

Because research has been limited, there are no estimates of gray foxes' home range size in the Northeast. Nationally, their home range sizes vary geographically, ranging from less than one to seven square miles, and appear to be much larger in the east than in the west. This could be related to differences in habitat and food resources (Fritzell 1987). Gray foxes are true omnivores with diets that vary seasonally and regionally. They feed primarily on rabbits, mice, voles, rats, birds, bird eggs, insects, nuts, and fruits. In the summer, crickets and grasshoppers are also common foods. Plant matter (especially fruit in the late summer/early fall) appears to make up a larger portion of the gray fox's diet than it does for the red fox.

While competition between coyote and red fox has been documented (Harrison 1982, Lavin et al. 2003, Major 1987), interactions between red and gray fox are not well understood. Based on stable isotope analysis, red foxes had the largest diet overlap with coyotes and gray foxes during summer, fall, and early winter, suggesting high levels of competition (Masters 2020). Gray fox and coyote diets were the least similar, whereas the red and gray foxes were more similar and consumed more anthropogenic foods. Gray fox held the lowest trophic position in all seasons and had the most diverse diet, whereas coyotes had the least diverse diet during fall/early winter (Masters 2020). Competition between the three canids appears to be highest during fall/early winter as food availability declines. Future climate and habitat changes may cause the gray fox's range to shift further north, increasing competition between the two fox species.

MORTALITY

We know that hunting, trapping, roadkill, predation, and disease all cause fox mortality. Fox predators include large raptors like eagles and great horned owls, as well as bobcats and coyotes (though gray foxes are better adapted than their red fox counterparts at escaping coyotes by climbing trees). Foxes can also contract many diseases and parasites including rabies, sarcoptic mange, canine distemper, tularemia, listeriosis, leptospirosis, histoplasmosis, toxoplasmosis, canine hepatitis, and Tyzzer's disease (Fritzell 1987). Mange and Samson fox (lack of guard hairs) both make it challenging to stay warm and survive winter in northern climates. Red foxes (and coyotes) are especially susceptible to mange, while it is rarely reported in gray foxes; while Samson fox (lack of guard hairs) seems to be more common in red foxes (Little et al. 1998). Anecdotal observations of Samson gray foxes have increased recently in Maine and tend to be associated with areas where gray foxes are more abundant. Canine distemper is a prevalent disease (Davidson et al. 1992) that can lead to localized gray fox population reductions and has high mortality rates for other species (e.g., fisher). And finally, rabies in foxes is often the furious, aggressive form that can lead to population decreases in both red and gray foxes.

9.2 Management History

Maine has regulated the trapping and hunting of foxes since 1915 **(Table 9.1).** Simply referred to as "foxes" in rule or law, red and gray foxes share the same hunting and trapping regulations. There are no bag limits for foxes, but MDIFW regulates their harvest statewide by adjusting season timing and length, and relies on fur tagging records to monitor the outcome.

The open season for trapping, which is typically the most successful fox harvest method, occurs with that of other upland furbearer species. Season length has varied over time, typically beginning in November to align with when pelts are prime and can be utilized. In 1976, Maine began requiring fox pelts to be tagged before they could be bought, sold, or transported out of state; and in 1980, the Department required fur tagging agents to differentiate which species of fox were tagged. Prior to that, red and gray foxes were lumped together as "fox" since gray foxes were absent or uncommon. In 1989, Maine established an early (late October) canid trapping season, which was later expanded to add two more weeks of fox and coyote trapping before the general trapping season began. Since 1997, the fox trapping season has been two and half months long (mid-October through the end of December). In addition to tagging pelts, trappers must now submit annual harvest reports to document their effort and success.

Historically, the fox hunting season length has varied, with some time periods having no closed hunting (1955-1975). Since 1978, the season has been about four months long (October-February). Fox hunting methods include hunting with trained dogs (popular in the late 1800s/early 1900s but uncommon now), over bait, calling, or while hunting other species like deer or snowshoe hare. In 2021, MDIFW added hunting method type to the registration and tagging process to collect more detailed information on method of take.

Although hunting may contribute a smaller amount of the overall fox harvest, effort has fluctuated widely in the past. In the 1970s and 1980s, as fur prices climbed from nine dollars a pelt (1970) to sixty-three dollars per pelt (1978), Maine's number of successful upland fur hunters ranged from 335 to 1,582 (1976-1984; Caron 1986). Around then, heavy trapping pressure, disease, and increasing numbers of coyotes were thought to contribute to a decline in the red fox population. Fox harvests have fluctuated due to other factors too, including changes in hunting and trapping seasons over time and even variable trapper questionnaire reporting rates during some time periods (1955-1975). The tagging of all fox pelts beginning in 1976 and differentiating fox species in 1980 improved our ability to monitor harvest trends; but as a result, the new numbers may not be directly comparable to previous years **(Figure 9.2).**

Since 1997, the fox trapping season has been consistent, with the red fox harvest ranging from approximately 430 (2014) to 2,000 foxes (2001). In more recent years (2017-2019), fox harvesting interest appears low, with average red fox pelts worth $17 and gray fox worth $14. The average annual number of successful red fox trappers (140) is almost five times higher than the number of successful hunters (30). On average, trappers harvest 512 foxes compared with hunters' 52. The number of red foxes caught per land trapper (trapper who caught bobcat, coyote, or fox) has varied from 1.4 to 2.5 with no consistent trend (2008-2019). Red foxes are harvested in all 29 wildlife management districts (WMDs), with the highest harvest densities (2015-2019) occurring in southern and central Maine and sizable numbers coming from agricultural areas of northeastern Maine **(Figure 9.4).**

Since 1980, the gray fox harvest has varied from a low of 25 (1996) to a high of 437 (2012; **Figure 9.3**). Recently (2017-2019), the average gray fox harvest has been 222 (trapping) and five (hunting), taken by an average of 87 successful gray fox trappers and eight successful hunters per year. The number of gray foxes caught per successful land trapper is much lower than that of red foxes, ranging from 0.44 to 1.4, with no consistent trend (2008-2019). Gray foxes are harvested in 16 of the 29 WMDs, with the highest harvest densities (2015-2019) in southern Maine in York and Cumberland Counties **(Figure 9.5)**. The highest red (six red foxes/100 sq mi) and gray (four to five gray foxes per 100 sq mi) fox harvest densities come from WMDs 15, 20, and 21 (2015-2019). Typically, red fox is more common than gray fox; but WMD 24 has similar red and gray fox harvests (3.4 gray fox and 3.5 red fox per 100 sq mi).

TABLE. 9.1 SUMMARY OF FOX RESEARCH AND MANAGEMENT ACTIONS (1915-2019)

YEAR	MANAGEMENT ACTION
1915	A fox trapping and hunting season was established (Nov. 1-Feb. 28). The use of poisons to kill foxes or other animals, except vermin in buildings, was prohibited.
1930	People could train dogs to hunt foxes from Nov. 16 to Feb. 15. It was illegal to dig out, destroy, or set a trap in a fox den. Farmed or ranched foxes were protected from hunting and trapping.
1934	The trapping and hunting season on furbearing animals (including fox) was Oct. 16 to Jan. 31 in northern counties and Nov. 16 to Jan. 31 in southern counties. Hunting foxes with dogs was permitted from Nov. 16 to Feb. 15 in certain counties.
1944	Foxes could be trapped any time on a trapper's own land, within 100 yards of a poultry shelter or range. Destroying or trapping fox dens was prohibited from Feb. 15 to Oct. 15.
1955	The fox trapping season was Nov. 1 to Feb. 15 and there was no closed hunting season.
1976	Fox pelts must be tagged and registered before they can be bought, sold, or transported out of Maine. The fox trapping season was shortened to Oct. 20 to Dec. 1 and the fox hunting season was restricted to Oct. 20 through Feb. 1.
1978	The fox trapping season was regulated by Wildlife Management Unit, with all seasons falling between Oct. 20 and Nov. 25. The hunting season was increased to about four months (Oct. 20 to Feb. 14).
1980	Gray foxes were differentiated from red foxes when tagged (previously, they were lumped with red fox in harvest summaries).
1981	Dr. Harrison (University of Maine) conducted research on eastern Maine coyotes' denning ecology, movements, and dispersal for his Master's thesis and further research on coyote dispersal, mortality, and spatial interactions with red foxes in the same study area for his PhD. Sherburne and Matula studied the abundance and habitat use of northern Maine red fox and other species using track counts, traps, and radio telemetry.

YEAR	MANAGEMENT ACTION
1982	The fox trapping season started one week earlier and was approximately five weeks (Oct. 20 to Nov. 30) in the Northern Zone, and four weeks (Oct. 28 to Nov. 30) in the rest of the state. In certain WMDs, foothold traps with teeth on the jaws were prohibited on dry land prior to deer season. They were banned on dry land statewide the following year.
1983	Major completed a study as part of his PhD on the ecology and interspecific relationships of western Maine coyotes, bobcats, and red foxes.
1984	For his Master's thesis, Halpin studied eastern Maine red fox winter habitat use and ecology and Maine red fox history.
1985	The fox trapping season was approximately six weeks (Oct. 28 to Dec. 15) in the Northern District, and five weeks (Oct. 28 to Dec. 4) in the rest of the state.
1989	An early fox and coyote trapping season was established, adding seven days of trapping prior to the general trapping season.
1990	Statewide fox hunting season closing dates were expanded by two weeks (Oct. 22 to Feb. 28). Dibello, Arthur, and Krohn studied food habits of coyotes, red foxes, and bobcats using scats found in western and eastern Maine.
1991	General trapping season was approximately two months (late October/early November through Dec. 31).
1997	The early fox and coyote trapping season was lengthened by a week, allowing two weeks of trapping for these species prior to the regular trapping season.
2014	In WMDs 1-6 and 8-11, foothold trap size restrictions were put in place to protect lynx (traps had to be ≤5 3/8 inch jaw spread).
2015	More foothold trapping practice and equipment rules were put in place to limit incidental capture of lynx, including statewide rules that all foothold traps set on dry land must have three swiveling points and the chain must be centrally mounted at the trap's base, and that foothold traps must not be set above ground or snow level. In WMDs 1-11, 14, 18, and 19, each trap must be securely anchored to the ground with a clear catch circle around it and no drags permitted.
2019	Trappers are required to submit annual trapper effort reports.
2020	H. Masters studied competition and coexistence among canids using stable isotopes (hairs and muscle) and stomach contents as part of his Master's research (University of Southern Maine).
2021	MDIFW revised its web-based fur registration and tagging system to record hunting method type (e.g., bait, dogs, calling, etc.).

9.3 Regulatory Framework

The previous red fox management plan (1986) established one goal: to allow the red fox population to fluctuate naturally in all wildlife management units (WMUs) by (1) maintaining current hunting and trapping season length and timing and (2) monitoring the red fox population (Caron 1986).

Keeping in mind that good quality fox habitat can be found statewide, and harvest pressure does not significantly affect fox populations, possible consequences and concerns around high population growth were noted, including the risk of disease outbreaks (e.g., sarcoptic mange and rabies), which can ultimately cause population declines.

At that time, the fox hunting season was about three and a half months long (Oct. 28 to Feb. 15) and the fox trapping season was four to five weeks (Oct. 28 to Dec. 4 or 15, depending on North or South zone). Since 1986, the fox hunting season has been expanded by two weeks (now Oct. 18 to Feb. 28), as has the trapping season (now mid-October to Dec. 31).

The plan's harvest objective was met by maintaining hunting and trapping opportunities, and the abundance objective was partially met by increased red fox research in the 1980s. However, little has been done to study fox populations since then. There are many knowledge gaps and lack of research on gray fox in the Northeast, but we do know that their numbers are increasing. The best data source on the status and distribution of red and gray fox continues to come from harvest data and anecdotal observations, but other metrics would strengthen our ability to detect population changes.

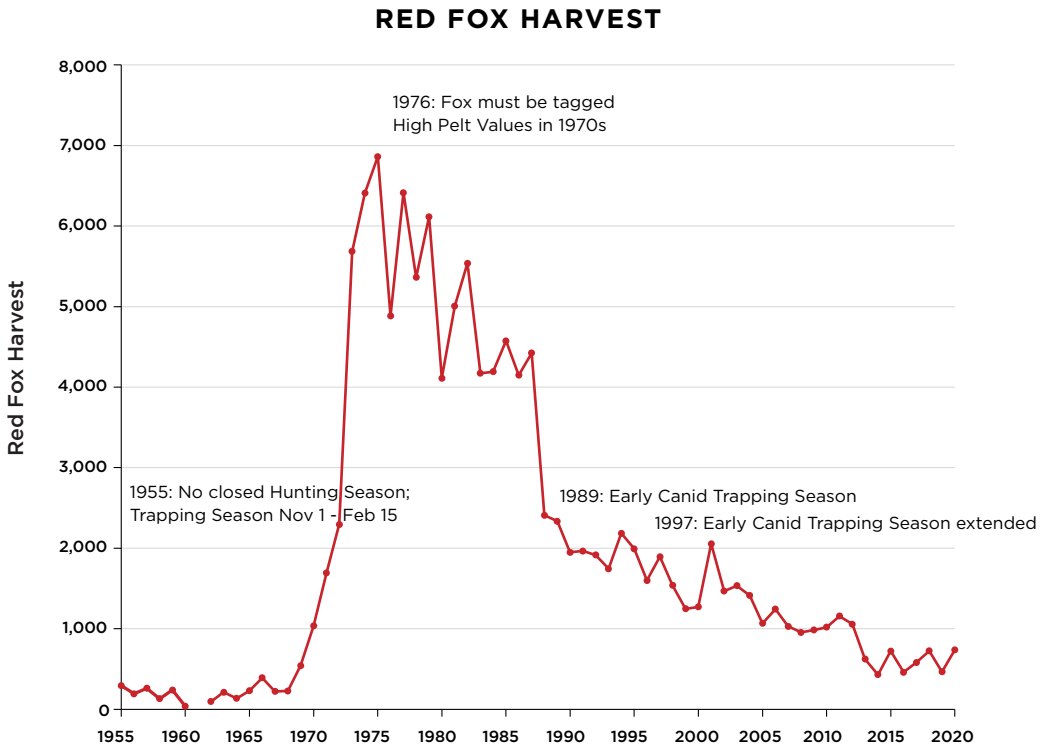


FIGURE 9.2 RED FOX HARVESTED IN MAINE BY TRAPPING AND HUNTING FROM 1955-2020.

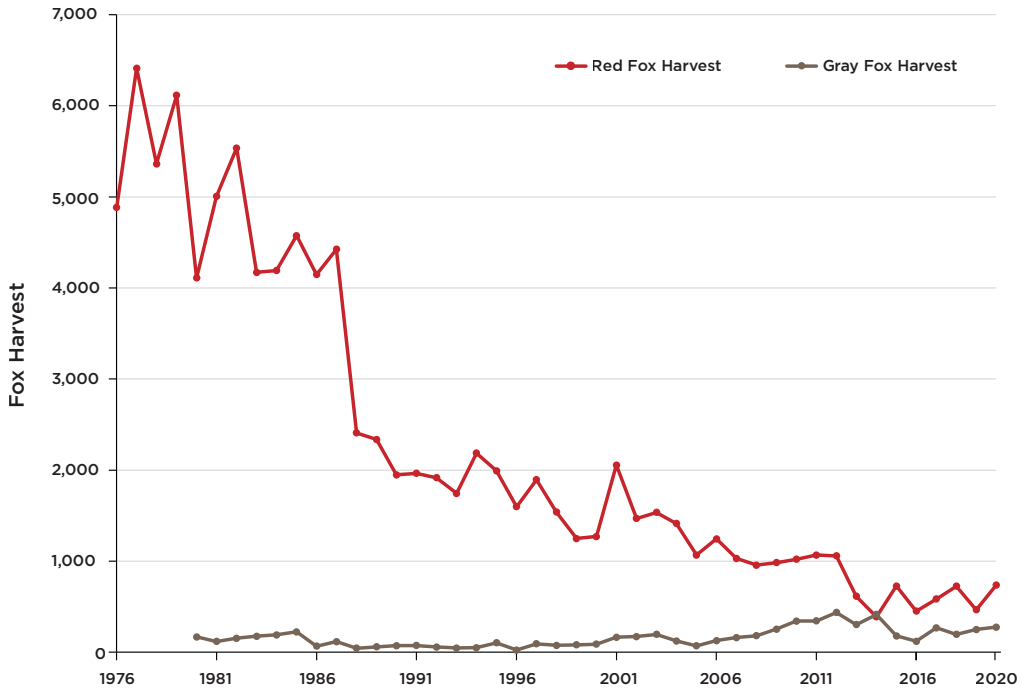


FIGURE 9.3 RED AND GRAY FOX HARVESTED IN MAINE FROM 1976-2020. FOX SPECIES WERE REGISTERED SEPARATELY STARTING IN 1980.

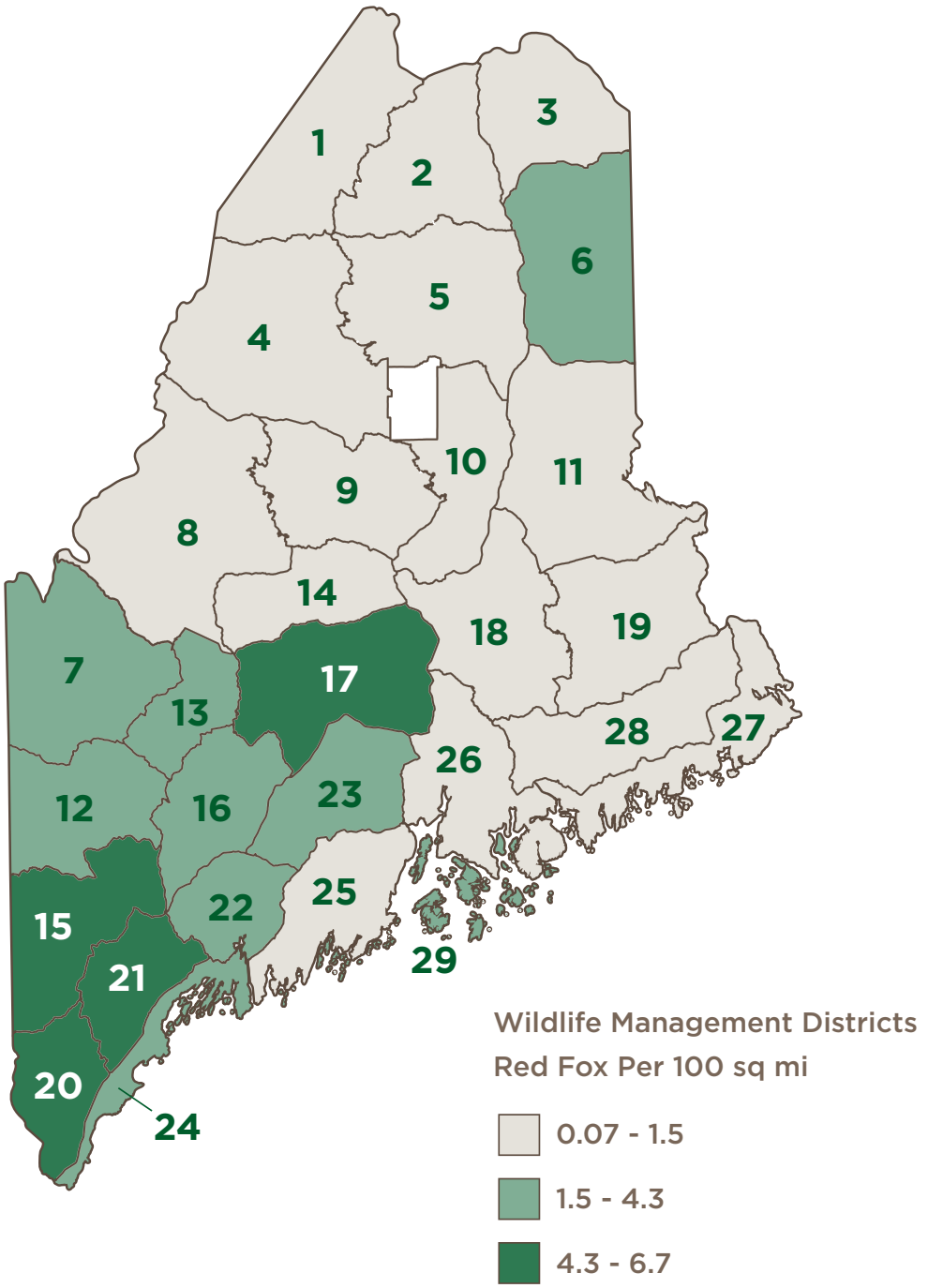


FIGURE 9.4 AVERAGE ANNUAL MAINE RED FOX HARVEST (2015-2019) PER 100 SQUARE MILES BY WILDLIFE MANAGEMENT DISTRICT. THERE IS NO TRAPPING IN BAXTER STATE PARK (WHITE POLYGON).

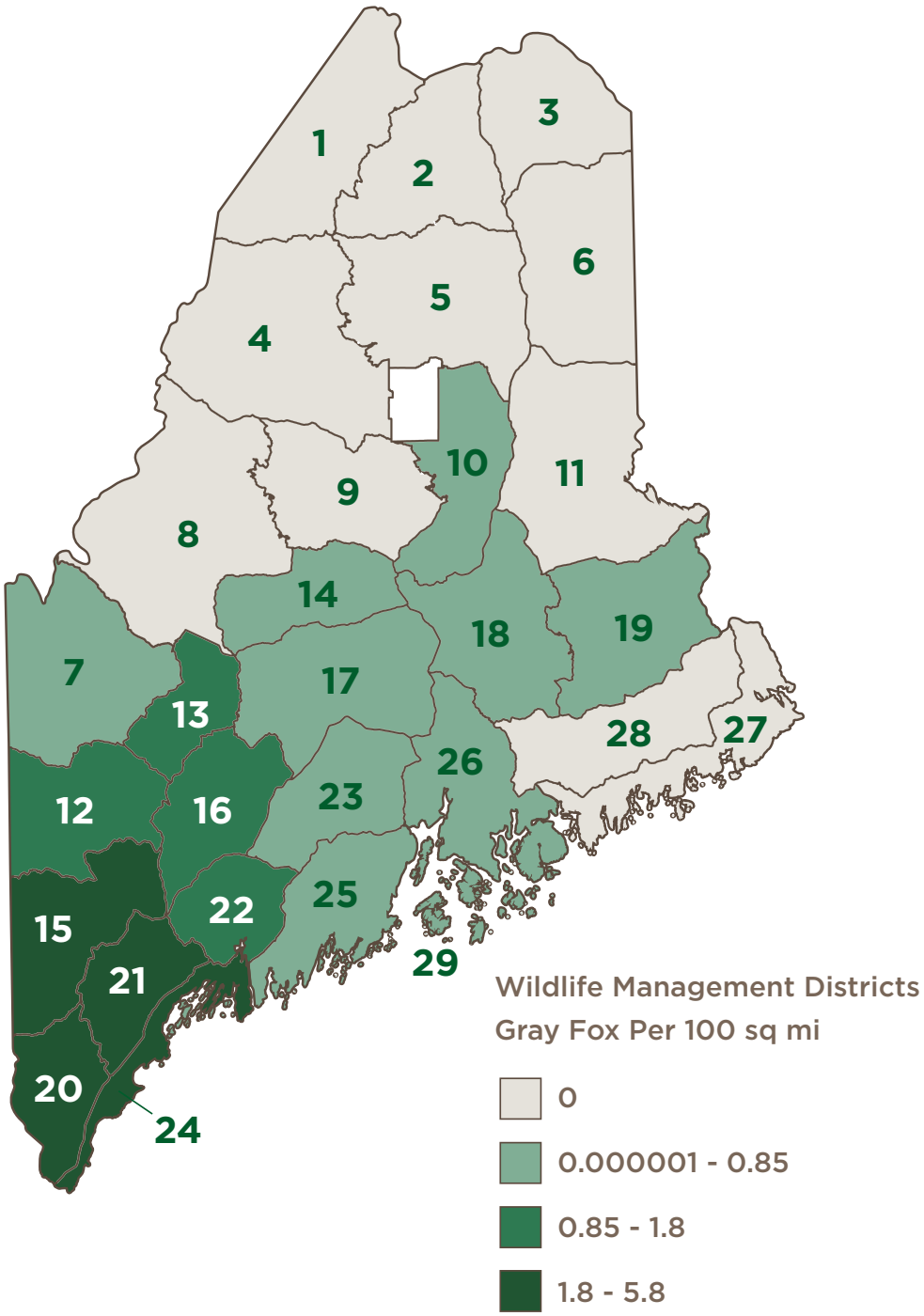


FIGURE 9.5 AVERAGE ANNUAL MAINE GRAY FOX HARVEST (2015-2019) PER 100 SQUARE MILES BY WILDLIFE MANAGEMENT DISTRICT. THERE IS NO TRAPPING IN BAXTER STATE PARK (WHITE POLYGON).

9.4 Public Consultation – 2020 Key Findings

32%	7%	47%	58%
VIEW FOX FAVORABLY	CONSIDER FOX A NUISANCE	THINK FOX POPULATION ABOUT RIGHT	RESIDENT SUPPORT FOR TRAPPING

To streamline the public consultation process, survey respondents were collectively asked a series of questions about fox in Maine. The public generally viewed fox favorably, with 32% of respondents saying they enjoyed seeing or having them around; still, 21% enjoyed having them around but worried about potential problems (Responsive Management 2020). Positive attitudes for fox ranked highest among all furbearer species in the survey and were consistent among respondents (landowners, trappers, hunters, and trapping opponents). When asked about the benefits of fox, Maine residents found them to be a beneficial species (with a score of seven out of ten), but the score was highly variable among respondent type. Maine landowners and trapping opponents viewed fox as more beneficial (ranked second most beneficial) than hunters or trappers (fourth and seventh, respectively). Only seven percent of respondents considered fox to be dangerous or a nuisance, and 16% had no feelings either positive or negative.

Self-reported knowledge of fox was relatively high compared to other species, ranking third out of ten (behind raccoon and skunk), with 42% of respondents reporting they knew a great deal or moderate amount about them. This varied among respondents, with 80% of trappers, 67% of hunters, 65% of landowners, and 53% of trapping opponents claiming to know a great deal or moderate amount.

Most respondents felt the fox population was about right (47%), but opinions varied. Greater proportions of hunters, trappers, and landowners (67%, 63%, and 67%, respectively) believed the fox population was about right, compared with trapping opponents and the general population (47% for both).

Overall resident support for fox trapping was high (58%), but trapping opposition was also higher for fox than any other furbearer species, at 34% (this was followed closely by bobcat at 32% opposition). Among trappers, fox ranked third in popularity for pursuing (27% of respondents), following beaver and coyote. While trappers and hunters were more supportive than other groups, eight percent of hunters still opposed trapping of fox to regulate populations. Despite a very high beneficial index (8.3), trapping opponents seemed to be more supportive of fox trapping (26%) than many other furbearers as a method to manage their populations, with only skunk and coyote having higher support.

9.5 Management Issues & Threats

Fox populations have undergone major fluctuations resulting from changes in public attitudes, habitats, trapping and hunting pressure, diseases, and interactions with other species. Public attitudes towards fox are generally favorable, but they can be mixed as foxes live near people and sometimes conflicts arise. The public consultation survey showed that fox conflicts are common, ranking fourth (after raccoon, deer, and skunk), with 17% of residents (and a similar number of landowners) reporting a fox problem in the past two years (Responsive Management 2020).

The Department receives a high volume of calls from the public about red foxes (558 in 2021, compared with 37 about gray foxes). Of the red fox calls, 38% were determined to be no conflict (many were just providing information), 20% were about sick fox, 18% were related to concerns for human safety, and the rest were related to other conflict types (e.g., fox found injured, killing or bothering livestock or pets, in contact with pets, dead, orphaned, etc.).

Research suggests that humans create the conditions for conflict by deliberately or inadvertently providing food and shelter. Complaints often arise from people seeing a fox out during the day and worrying about human, pet, or small livestock safety. However, many fox conflicts are not true problems and could be solved by learning more about fox ecology, predator-proofing livestock, securing trash, and not feeding wildlife (that includes bird feeders). Providing more information about what normal fox behavior looks like compared to signs of sick or strange acting wildlife behavior could improve public perceptions of foxes.

Parasites like mange and diseases like rabies increase when populations are high, and play important roles in shaping fox populations and corresponding public attitudes. Mange is common in red foxes, and sometimes leads to public expectations to treat infected animals. Rabies is highly infectious and fatal to red foxes. In the 1960s, rabies spread from Quebec into Maine. The Department conducted a trapping program in 1961 to try to reduce its spread, but the annual number of rabid red foxes continued to climb, peaking at 93 in 1971. This led to an unsuccessful poison-based fox density reduction campaign aimed at controlling the spread (Halpin and Bissonette 1986).

Although the fox and bat strain of rabies is endemic to Maine, the raccoon strain was not detected until an outbreak in 1994 that caused a sharp increase from ten to 248 animals (mostly raccoons) testing positive annually for rabies (1994-2000; Maine Rabies Management Guidelines). Since then, the rabies virus has persisted and continues to impact foxes, raccoons, skunks, and other species.

From 2018-2020, the annual number of rabid gray foxes increased; and the situation received attention after several people and pets in the mid-coast area were attacked. A limited trapping effort to reduce high-risk rabies species was conducted in 2020 to protect human safety, along with information and education to reduce future conflicts with foxes (e.g., do not feed wildlife). Fox attacks on people are rare, but resultant media attention can negatively impact public attitudes and increase people's risk perception. To reduce conflicts in the future, management efforts will need to motivate changes in human behavior.

Public interest in, and acceptance of, trapping and hunting will continue to be important, as these management tools are key to maintaining healthy fox populations. One of the biggest fox management challenges is our primary reliance on harvest data to assess their status. Since trapper and hunter effort change over time, it's hard to use harvest as the only population index; and as the 1986 Fox Plan recognized, there is a lack of information on fox populations across the state. To strengthen the management and conservation of red and gray foxes and ensure these species persist into the future, we need to develop multiple new cost-effective population monitoring metrics/indices and prioritize fox research.

9.6 Fox Management Goals & Strategies for 2020-2030

Goal #1. Maintain healthy, abundant red and gray fox populations

- Continue to conduct red and gray fox disease surveillance through the Department's conflict database, rabies reports, trapper harvest reports, opportunistic carcass collections, wildlife rehabilitators, and the public, and conduct further testing when necessary ***(Ongoing; High Priority)***.
- Investigate and implement methods of monitoring red and gray fox populations across a gradient of developed and undeveloped areas (e.g., camera surveys) ***(New; High Priority)***.
- Explore methods to determine habitat factors associated with gray fox occurrence (e.g., forest cover, snow depth, or other climate variables) and those that limit gray fox distribution (e.g., habitat, competition, climate, disease) ***(New; Moderate Priority)***.
- Develop a monitoring program that incorporates fox observations from public volunteers ***(New; Moderate Priority)***.
- Explore the prevalence and effect of rodenticides on the fox population ***(New; Moderate Priority)***.

Goal #2. Maintain sustainable red and gray fox harvests

- Continue to register and tag all red and gray fox that are harvested by hunting and trapping, collecting data on harvest town, date, and method ***(Ongoing; High Priority)***.
- Continue to collect data (i.e., fox harvest registration data, fur prices, trapper success rates, etc.) annually as an index of fox population trends ***(Ongoing; High Priority)***.
- Continue to collect data on red and gray fox trapper effort and success ***(Ongoing; High Priority)***.
- Collect hunting method data at registration to better understand how foxes are taken by hunting (e.g., calling, hounding, incidental) ***(New; High Priority)***.

Goal #3. Maintain fox trapping and hunting opportunities

- Work with partners to develop outreach tools that promote landowner relations and ethics specific to hound hunting ***(New; High Priority)***.
- Explore methods to survey hunters on their motivations and potential interest in fox hunting opportunities ***(New; Moderate Priority)***.
- Work with partners to foster canid trapping mentorship opportunities ***(New; Moderate Priority)***.
- Develop "next step" educational programs for fox trapping and hunting experiences ***(New; Low Priority)***.
- Survey the public, landowners, hunters, and trappers to determine acceptance levels of fox hunting methods ***(New; Low Priority)***.

Goal #4. Increase public understanding of red and gray fox and their management

- Continue to promote the Department's Living with Wildlife website to highlight the physical and behavioral characteristics that differentiate red and gray fox ***(Ongoing; High Priority)***.
- Periodically survey the public, trappers, hunters, and landowners regarding conflicts with fox, perceived population status, and understanding of fox biology and management ***(New; High Priority)***.
- Develop opportunities for the public to learn more about fox populations, behavior, and ecology (e.g., programs at the Maine Wildlife Park, staff presentations, formal school programming) ***(New; High Priority)***.
- Determine which audiences lack understanding and acceptance of fox biology and management and develop an outreach plan to target those audiences ***(New; Moderate Priority)***.
- Develop outreach materials (i.e., backyard wildlife guide) about red and gray fox, including their occurrence/abundance, where/how to view them, and benefits of having them around, while also dispelling myths that cause people to fear them ***(New; Moderate Priority)***.
- Develop outreach materials highlighting interspecific relationships, competition, and exclusion between Maine's canids ***(New; Low Priority)***.

Goal #5. Minimize human-wildlife conflicts

- Continue to communicate actions that prevent and resolve negative human-fox interactions (e.g., intentional feeding; securing trash, compost, and animal food; taking down or cleaning up under bird feeders; and protecting poultry in predator-proof fencing) ***(Ongoing; High Priority)***.
- Continue to promote "A Farmer's Guide for Control of Wildlife Damage to Crops and Livestock," which directs farmers to solutions for common fox and other wildlife conflict issues ***(Ongoing; High Priority)***.
- Keep responding to potential rabid fox reports and promote the Maine Rabies Management Guidelines to keep people and domestic animals safe ***(Ongoing; High Priority)***.
- Monitor fox complaints to identify areas of high human-fox conflicts and evaluate ongoing management efforts ***(Ongoing; High Priority)***.
- Develop communication tips on normal fox behavior vs. issues that people should report to the Department ***(New; High Priority)***.
- Develop shareable graphic materials to give people who complain of human-fox conflicts ***(New; Moderate Priority)***.
- Periodically conduct follow-up surveys with people who report fox conflicts to the Department, and/or conduct a public survey to determine if there is a change in public attitudes, awareness, or behaviors ***(New; Moderate Priority)***.
- Explore ways to contribute to research on the relationship between tick-borne diseases and fox abundance ***(New; Low Priority)***.
- Develop public messaging about the negative effects of rodent poisons on predators, including foxes, and other ways to reduce rodent problems ***(Ongoing; Moderate Priority)***.
- Improve messaging to Animal Damage Control agents on integrative pest management practices for preventing and resolving small mammal problems ***(Ongoing; Moderate Priority)***.

Goal #6. Conservation of other species

- Continue working with USFWS and USDA-WS to address depredation by fox of Endangered, Threatened, and Rare nesting shorebirds ***(Ongoing; Moderate Priority)***.
- Explore options and develop partnerships to address predation of New England cottontails by foxes and other meso-carnivores ***(New; Moderate Priority)***.

Expected Outcomes for Fox Management

Implementing the red and gray fox management strategies outlined in this plan will require adequate staffing, funding, and administrative and public support. It may not be necessary or feasible to carry out all strategies to achieve this plan's goals and objectives.

We anticipate the following fox-related outcomes over the next 10 years (by 2030 unless otherwise noted):

By 2025, outreach and communication efforts will have increased public knowledge from 2019 levels (In 2019, 42% of residents reported that they knew a moderate amount or great deal about foxes).

Public support of regulated trapping to manage fox populations will remain above the 2019 level of 58%.

Through management actions and outreach efforts, public acceptance of fox trapping and hunting will increase.

Through outreach and promotional efforts, public tolerance of gray and red fox will increase from 2019 levels (In 2019, 32% of residents said they enjoy seeing and having fox around).

Statewide fox complaints will be tracked and minimized below 2021 levels.

10.0

BOBCAT

10.0

BOBCAT

Bobcats (*Lynx rufus*) are the most widely distributed wild felid in North America, occurring throughout southern Canada, the contiguous United States, and Mexico (Anderson and Lovallo 2003, Roberts et al. 2010). Maine is near the northern edge of their North American range.

BOBCAT HABITAT

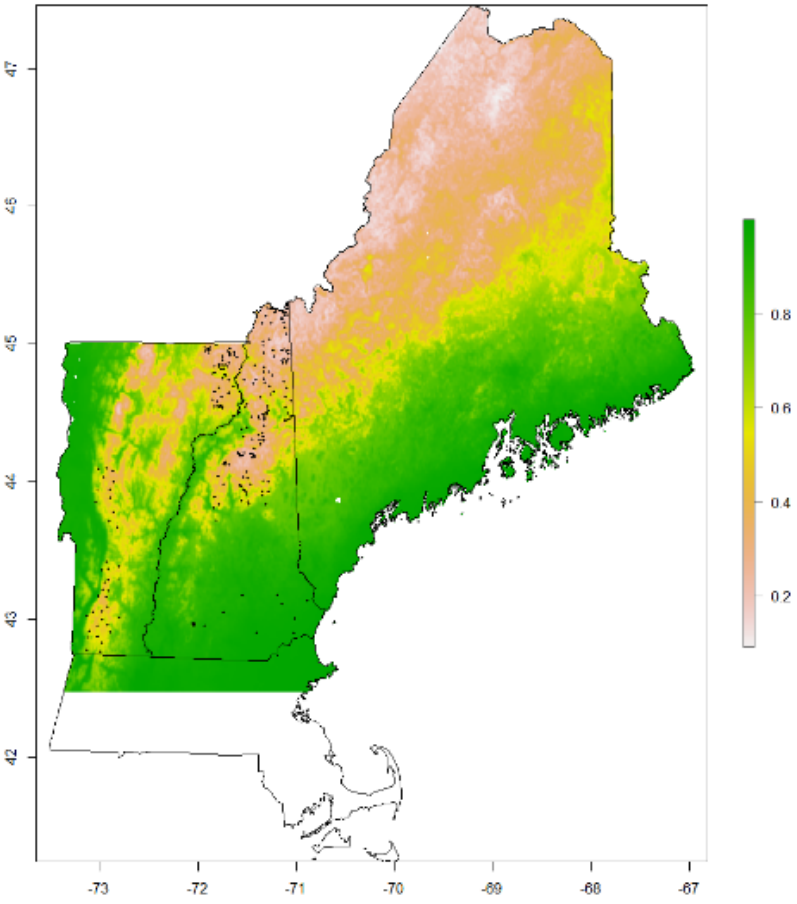


FIGURE 10.1 PREDICTED BOBCAT OCCURRENCE MAP BASED ON CAMERA SURVEYS (BLACK DOTS) CONDUCTED FROM 2014-2019 IN NEW HAMPSHIRE AND VERMONT (SIREN ET AL. 2021). THE MAP IS BASED ON A NEGATIVE ASSOCIATION TO SNOW DURATION (NUMBER OF DAYS SNOW WAS ON THE GROUND) AND POSITIVE ASSOCIATION TO REGENERATING NORTHERN HARDWOODS FOREST. DARKER GREEN INDICATE HIGHER AND LIGHTER COLORS INDICATE LOWER PROBABILITY OF BOBCAT OCCURRENCE.

10.1 Natural History & Population Status

Bobcats are effective predators, taking diverse prey that range from small mammals and birds to larger animals like wild turkey and white-tailed deer. Their predominant prey, however, are snowshoe hares. Male bobcats are larger than females, with adults typically weighing between 10 and 30 pounds (about twice the size of a domestic cat). Large bobcats in the 50-pound range have been documented in Maine, but they are rare. Bobcats breed in late winter and give birth in the spring. Reproductive tract examinations have indicated that about 50% of yearling female bobcats breed, with an average litter size of one kitten (MDIFW 1984). Nearly 75% of adult females breed, with litter sizes that range from one to six kittens and an average of two kittens.

Like many carnivores, male bobcats tend to have larger home ranges than females. Home range size varies widely, but previous research has shown that in Maine, female bobcats ranged from approximately 10 to 15 mi^2 and males from 10 to 80 mi^2 (Litvaitis 1984), with range size influenced by sex, age, habitat, prey, and bobcat population size (Rolley 1987). Typically, range sizes shrink when prey density increases and there is less of a need to travel as far for food.

Bobcat distribution and abundance has fluctuated significantly over time due to habitat changes, prey changes, and historic negative attitudes by humans who viewed them as threats to livestock and game species (Rolley 1987). In the northeastern United States, widespread land clearing for agriculture in the 1700s and 1800s reduced bobcat habitat; but subsequent land abandonment resulted in an early successional forest boom that increased populations of their prey (Litvaitis et al. 2006). Before the Civil War (1861), bobcats were only reported in southern parts of Maine (Hunt 1980); and at the turn of the 20th century, Manley Hardy (1907) reported that the bobcat was rare in the state. But by 1941, Aldous and Mendall reported that bobcats were common here, except in the more developed areas. During the time that wolves were extirpated and before coyotes were well-established, bobcats were recorded throughout northern Maine and were an important white-tailed deer predator (Palmer 1937). Like deer, though, bobcats at the northern edge of their range are limited by deep snow and long winters (Siren et al. 2021, **Figure 10.1, 10.2**). In the past, greater availability of mature forests with thick overhead cover and lower snow depths (like in deer wintering areas) in northern Maine provided bobcats with food (deer) and conditions that allowed them to persist. Although bobcats still occur statewide today, their numbers are much higher in southern, central, and downeast Maine where winters are less severe and the prey base is more diverse **(Figure 10.1, 10.2).**

Competition with other carnivores also likely influences bobcat distribution and abundance. When coyotes became well-established in Maine during the 1970s, they may have initially reduced the number of snowshoe hares and other prey species as well as the amount of carrion available for bobcats (Morris 1986). However, coyote and bobcat habitat use patterns and diets differ, with coyotes shifting to an omnivorous diet in the summer and fall and bobcats being strict carnivores year-round (Litvaitis and Harrison 1989). Although recent competition from Canada lynx for snowshoe hare has been speculated to have contributed to reduced densities of bobcats in northern Maine, less mature forest cover and deep snow conditions likely play more important roles in limiting the bobcats' ability to travel and capture prey efficiently in the winter months. Canada lynx populations have grown recently due to increased clearcutting from spruce budworm salvage operations in the 1970s and 1980s that increased young, forested habitat and enabled higher hare populations (Vashon et al. 2007).

Many factors affect bobcat survival, including winter conditions, prey availability, habitat quality, harvest pressure, and road density.

Conversely, the reduction in mature spruce/fir forest in northern Maine has not only reduced the density of deer — an important winter prey item for bobcats — but also reduced overhead cover and refugia from deep snow. All of this likely contributed to the bobcat decline since the 1970s in northern Maine. Since the 1990s, the Canada lynx range has expanded from northwestern Maine to northeastern, western, and downeast areas **(Figure 10.3, 4).** In southern Ontario, where bobcat and Canada lynx overlap, snow conditions were similar, but bobcat were associated with more diverse habitats and prey, while lynx were found in more homogenous boreal habitats expected to support higher densities of snowshoe hares (Marrotte et al. 2020). Interestingly, hybridization has been documented between bobcat and Canada lynx in Minnesota, Maine, and New Brunswick (Homyack et al. 2008). Hybridized animals had a mixture of bobcat and lynx physical features, and some were able to successfully reproduce.

Many factors affect bobcat survival, including winter conditions, prey availability, habitat quality, harvest pressure, and road density. Severe winters, especially in northern Maine, can reduce bobcat survival. Bobcat have difficulty traveling when they sink more than six inches into the snow (McCord 1974). Severe cold and deep, loose snow may prevent bobcat from using an apparently abundant food base because of the high energetic costs (Petraborg and Gunvalson 1962). Severely emaciated animals have been reported during the winter and some bobcats die of starvation (Major 1983). Adult and yearling male bobcats are heavier than females of the same age, which enables males to have an added advantage to survive severe winters (Litvaitis et al. 1986). Recent research also supports earlier findings that bobcats are generally limited by deep snow and long winters but may be able to persist in cold places, like the Northeast, because of abundant prey (Siren et al. 2021).

Human activity also impacts bobcat survival. For radio-collared bobcats ≥1 year old, mortality from regulated hunting and trapping was 38% in western Maine (Major 1983) and 55% in eastern Maine (Litvaitis et al. 1987). These studies showed that transient bobcats quickly filled the new vacancies after resident bobcats were removed, stabilizing populations (Litvaitis et al. 1987). After legal harvest, vehicle collisions were the next most frequent cause of radio-collared bobcat mortality, accounting for 20% of all mortalities in eastern Maine (Litvaitis et al. 1987). The number of bobcats tagged and registered by MDIFW as roadkill per year ranged from 9 to 25 from 2015 to 2021. In comparison, New Hampshire and Connecticut do not have bobcat hunting or trapping seasons and have reported approximately 50 (NH) and 100 (CT) bobcat mortalities from annual vehicle collisions in recent years (P. Tate and J. Hawley, personal communications).

Although the leading sources of bobcat mortality are human-caused (harvest and vehicles), predation, starvation, and disease also contribute. While bobcats are predators, they also may become prey themselves, especially juveniles. McLellan et al. (2018) reported fisher predation on adult and juvenile Canada lynx in northwestern Maine; and despite their behavioral differences (i.e., bobcats are more aggressive than lynx), the potential certainly exists for fisher to prey on bobcats. Coyotes, foxes, owls, and adult male bobcats kill bobcat kittens; and it is not uncommon for kittens (and adults) to die of starvation, especially during severe winters. Cannibalism has also been documented. In eastern Maine, a bobcat kitten was killed and eaten by an adult female bobcat, which was thought to be related to territoriality (Litvaitis et al. 1982).

Some researchers have suggested that diseases carried by raccoons and feral cats may be important bobcat mortality factors. Twelve infectious diseases have been documented in wild bobcats, including feline panleukopenia (feline distemper), rabies, toxoplasmosis (an intracellular parasite), and cytauxzoonosis (a blood parasite) (Davidson 2006). Bobcats also carry parasites including tapeworms, roundworms, and others common in their prey species (Davidson 2006); and they are susceptible to mange, a skin disease caused by mites. Recent studies in California have shown that bobcats exposed to toxicants (poisons) may have poor immune function, making them more susceptible to mange and other diseases (Serieys et al. 2018). Anticoagulant rodenticides, which are toxicants used to lethally control mice and rats, may have unintended consequences for other species. Predators could ingest rodents who have eaten the toxicant, with toxicants bioaccumulating in the predator as they consume more. While it has been well documented that raptors, such as bald eagles, are highly susceptible to rodenticide poisoning (Niedringhaus et al. 2021), further study is warranted to better understand the substances' prevalence and effects on other predators.

10.2 Bobcat Management History

From 1832 to 1975, there was no closed bobcat hunting or trapping season **(Table 10.1),** and bounties were intermittently paid for them (Palmer 1937). In 1976, separate bobcat hunting and trapping seasons were established.

Through 1978, the hunting season ran from late October to the end of February. It was shortened in 1979 (to Dec. 1 through the end of Feb.); and again in 1990 (Dec. 1 to Jan. 31). In 2005 it was extended to end on Feb. 14; and again in 2016, to Feb. 21.

From 1976 to 1990, the trapping season ran from late October to late November or early/mid-December, with slight variations in opening and closing dates. Since 1990, it has been approximately two months (November and December).

BOBCAT HARVEST TRENDS

Historically, because bobcats were considered a threat to livestock and deer and there were few regulations in place to protect their populations, harvest of bobcats was much higher than it is now. The end of the bounty programs (1975) and the start of a hunting and trapping season (1976) coincided with a rise in bobcat pelt values in the 1970s to more than $100/pelt.

From 1955 to 1975, the annual bobcat harvest ranged from 500 to 1,200, with an average of 700 **(Figure 10.5).** Since 1976, likely due to more regulations on hunting and trapping, the annual average harvest has averaged 250 bobcats with yearly totals ranging from 100 to 450 **(Figure 10.5).**

The number of bobcats taken by trapping tends to vary less than the number taken by hunting, and has been associated with the value of bobcat pelts (and those of other species like coyote and fox) **(Figure 10.6).** Conversely, hunting success is more dependent on good snow conditions, which allow hunting dogs to effectively track bobcats.

The increase in Maine bobcat harvests from the early 1990s to the mid-2000s **(Figure 10.5)** matches trends in nearby jurisdictions like Quebec, Ontario, Nova Scotia, and Vermont (Lavoie et al. 2008) and relates to broader bobcat population increases reported across North America (Roberts et al. 2010).

The annual number of bobcat trappers per land trapper (trappers who caught at least one bobcat / trappers who caught at least one bobcat, coyote, or fox) is an index to gauge the status of the bobcat population. In recent years, increased bobcat trapping success has suggested a growing bobcat population in Maine. **(Figure 10.7).**

In the last decade (2010 to 2019), southern, central and downeast Maine had the highest bobcat harvest density, with Penobscot (14%), Oxford (14%), Washington (12%), Somerset (11%), and York (10%) Counties accounting for the highest percentages of bobcats harvested. Bobcat harvest distribution has changed over time, perhaps related to changes in hunter/trapper effort and/or bobcat population changes. The northern Maine bobcat harvest has generally been low (<1 bobcat/100 sq. mi.), but we have seen a shift to a greater number of northern Wildlife Management Districts (WMD 1-6) with 0 bobcat harvests in recent years (2015-2019; **Figure 10.2**). Meanwhile, although credible lynx sightings have varied, long-term winter track surveys show that lynx are found in a greater number of townships, indicating a growing population since the 1990s **(Figure 10.3, 10.4).**

MAINE COUNTIES WITH HIGHEST BOBCAT HARVEST DENSITY

14%
PENOBSCOT & OXFORD

12%
WASHINGTON

11%
SOMERSET

10%
YORK

Since 2016, trappers and hunters have been required to submit a tooth and tissue sample for each bobcat. The Department uses this information to determine the bobcat harvest's age and sex composition and ensure that it is sustainable. The percentage of adults (≥2 years old) in the bobcat harvest has been comparable between years (averaging 50%) and percentage of females has averaged 27%; but sample sizes have been small (<50% of the annual harvest had viable age and/or sex) and may not represent the population age structure.

TABLE 10.1 SUMMARY OF BOBCAT RESEARCH AND MANAGEMENT ACTIONS (1832-2019)

YEAR	RESEARCH & MANAGEMENT ACTION
1832	There was no closed season on hunting or trapping bobcat. Bounties were paid for bobcats killed.
1939	M. Marston conducted a study on the winter relations of bobcats to white-tailed deer in Franklin and Somerset Counties.
1950	Pollack studied bobcat food habits in Maine and other New England states from carcasses donated by trappers and hunters.
1955	The bounty amount increased to $15 for each bobcat killed.
1975	The bounty on bobcat ended, but there was still no closed hunting season.
1976	Bobcat hunting and trapping seasons were established (Oct. 20-Dec. 15 for trapping and Oct. 20-Feb. 28 for hunting). All Maine bobcats now had to be tagged and registered by MDIFW before being sold or transported out of the state.
1977	An international trade agreement required State Fish and Wildlife agencies to monitor the bobcat harvest more closely. After a review of these assessments, the Endangered Species Scientific Authority issued a quota of federal export permits for bobcats taken in Maine. Additionally, a harvest quota of 400 bobcats was established in Maine, as was a requirement that bobcats taken during the hunting season must be tagged and registered within 72 hours.
1978	Bobcat hunting season was closed in January in WMU 6 to keep the harvest within quota. Bobcat trapping season was Oct. 20-Nov. 25 in WMUs 1-6 and Oct. 25-Nov. 15 in WMUs 7-8.
1979	Bobcat trapping season was Oct. 20-Nov. 25 in WMU 1-3 and 5-6 and Oct. 25-Nov. 10 in WMUs 4, 7 and 8. Bobcat hunting season was Dec. 1-Feb. 28. A series of federal court actions resulted in no Maine bobcat export permits being issued from late 1979 through early 1983, halting international trade of bobcats during this time. J. Major and Sherburne (Maine Cooperative Wildlife Research Unit) led research on habitat relationships and diet of coyotes, bobcats, and red foxes in western Maine as part of Major's PhD work. D. May (University of Maine) conducted a bobcat habitat use study in eastern Maine as part of his MSc thesis. J. Litvaitis (University of Maine) studied diet, habitat use, home range size, and mortality of bobcats in eastern and western Maine as part of his PhD work.

YEAR	RESEARCH & MANAGEMENT ACTION
1980	The bobcat trapping season was Oct. 20-Nov. 30 in WMUs 1-3 and Oct. 28-Nov. 30 in WMUs 4-8. The bobcat hunting season was Dec. 1-Feb. 28. Litvaitis, Clark and Hunt led a bobcat prey selection study in Maine. Trappers and hunters donated bobcat carcasses to determine age class, sex, weight, fat deposits, and stomach contents.
1982	The trapping season was approximately six weeks (Oct. 20-Nov. 30) in WMUs 1 and 2, and four weeks (Oct. 28-Nov. 30) in WMUs 3-8.
1984	The trapping season was approximately six weeks (Oct. 28-Dec. 15) in WMUs 1 and 2, and four weeks (Oct. 28-Dec. 4) in WMUs 3-8. MDIFW conducted a study on bobcat reproduction.
1987	Bobcat hunting season was shortened by one month, open from Dec. 1-Jan. 31.
1990	Bobcat trapping season was approximately six weeks (Oct. 28-Dec. 12) statewide.
1991	Bobcat trapping season was extended two weeks and ran for approximately two months (Nov. 1-Dec. 31).
1999	Bobcat hunting season was expanded by two weeks (Dec. 1-Feb. 15).
2001	Bobcat hunting season was reduced by two weeks (Dec. 1-Jan. 31).
2004	Bobcat hunting season was expanded by two weeks (Dec. 1-Feb. 14).
2014	In WMDs 1-6 and 8-11, foothold trap size restrictions were put in place to protect lynx (traps had to be ≤5 3/8 inch jaw spread).
2015	Various foothold trap-related rules were put in place to protect incidental capture of lynx. Statewide, all foothold traps set on dry land must have three swiveling points and the chain must be centrally mounted at the base of the trap. On all foothold traps, one swiveling point must be at the base of the trap, one mid-way in the chain, and one at the trap's anchoring point. Statewide, foothold traps must not be set above ground or snow level. In WMDs 1-11, 14, 18, and 19, traps must be securely anchored to the ground with no drags permitted, and there must be a clear catch circle around each trap.
2016	Trappers and hunters must submit a tooth and tissue sample so the Department can determine age and sex of the bobcats harvested. Bobcat hunting season was extended by one week to end on Feb. 21.
2019	All bobcat taken by hunting must now be tagged and registered within 10 days (instead of 3 days). Trappers are required to submit annual trapper effort reports.

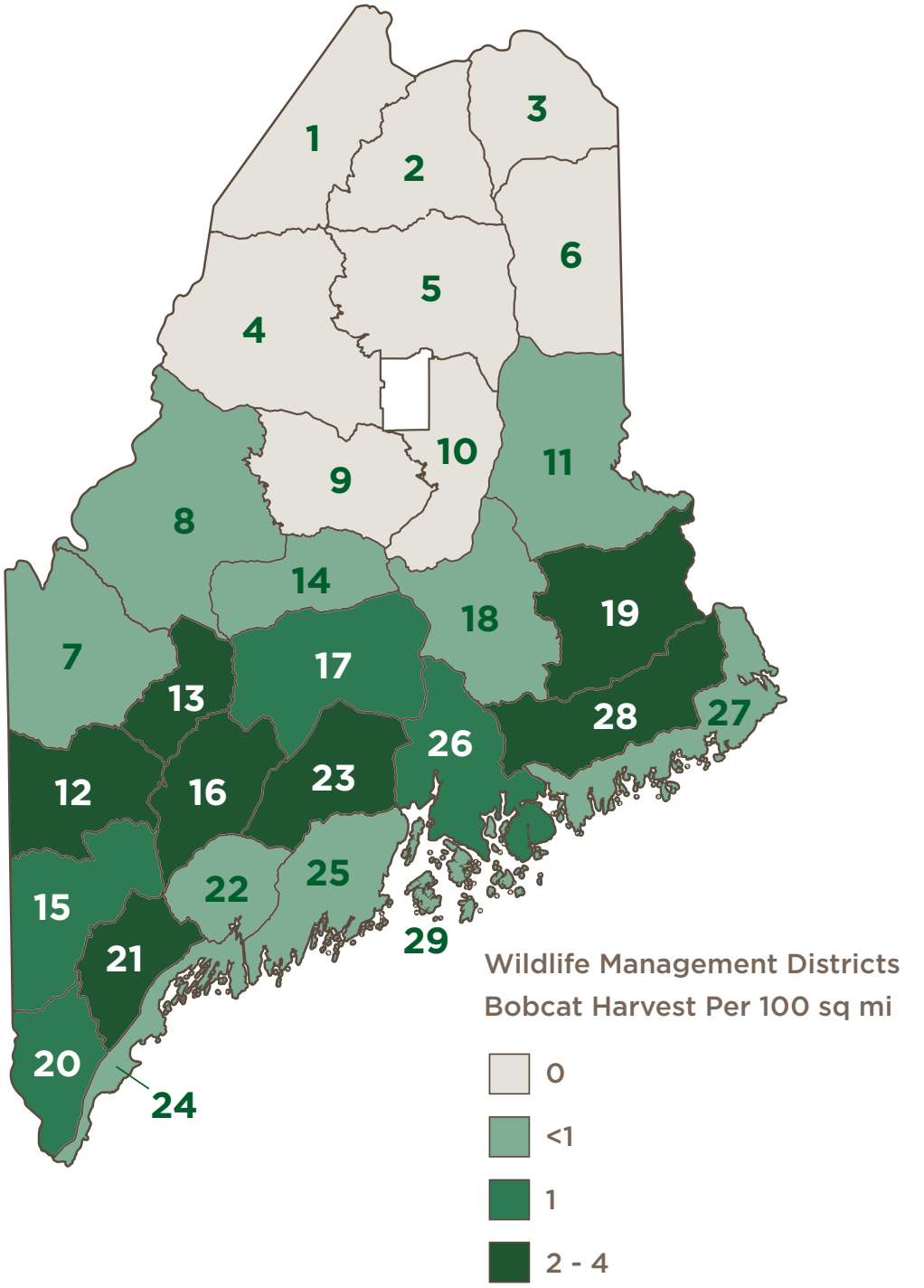


FIGURE 10.2 MAP OF THE AVERAGE ANNUAL MAINE BOBCAT HARVEST (2015-2019) PER 100 SQUARE MILES BY WILDLIFE MANAGEMENT DISTRICT. THERE IS NO TRAPPING IN BAXTER STATE PARK (SOLID WHITE POLYGON).

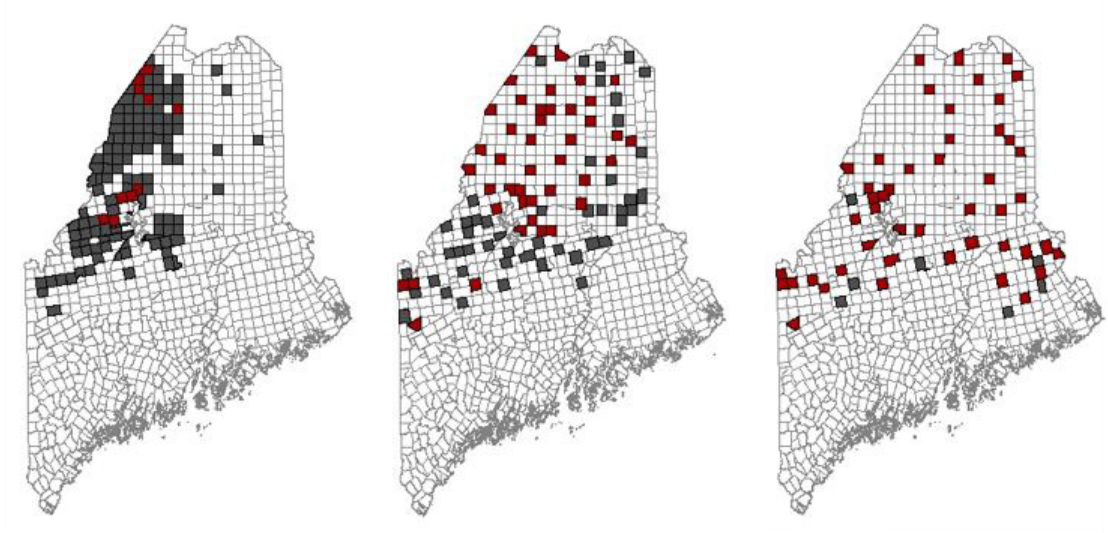


FIGURE 10.3 COMPARISON OF MAINE TOWNSHIPS THAT HAD LYNX (RED POLYGONS) OR NO LYNX (GRAY POLYGONS) DURING WINTER TRACK SURVEYS IN THREE TIME PERIODS (1993-1997 (LEFT), 2003-2008 (CENTER), AND 2015-2019 (RIGHT).

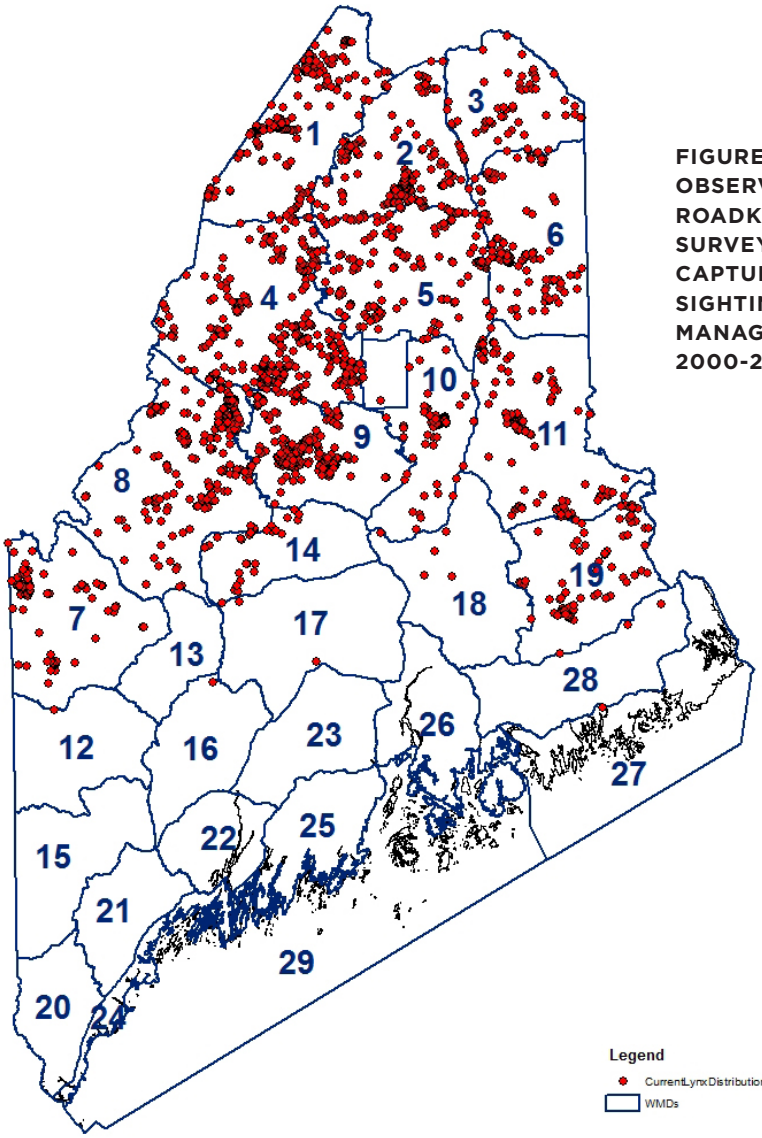


FIGURE 10.4 MAINE LYNX OBSERVATIONS FROM ROADKILLS, WINTER TRACK SURVEYS, INCIDENTAL CAPTURES, AND CREDIBLE SIGHTINGS BY WILDLIFE MANAGEMENT DISTRICT, 2000-2019.

MAINE BOBCAT HARVEST

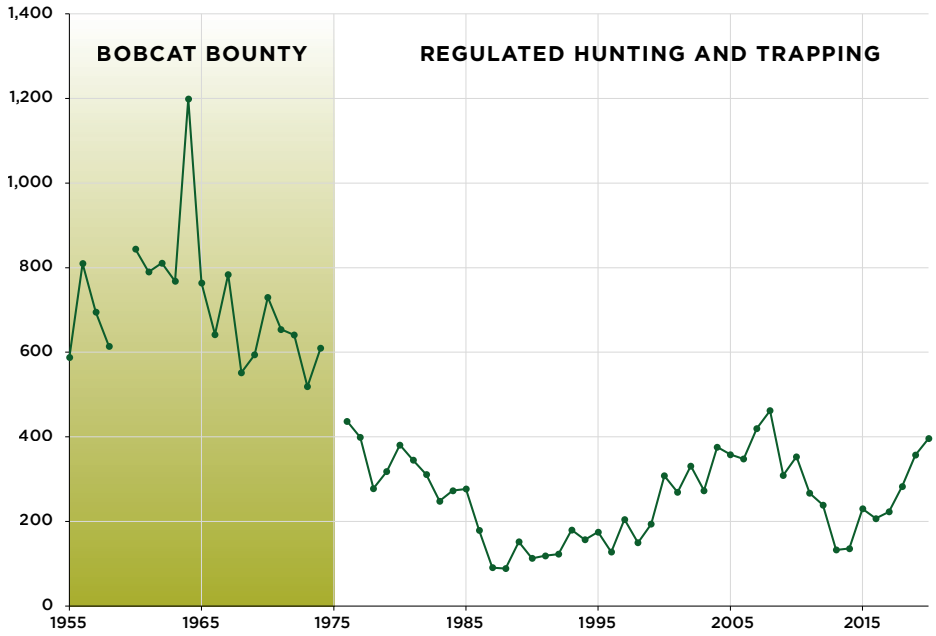


FIGURE 10.5 TOTAL BOBCATS HARVESTED FROM 1955-2020 IN MAINE. THE BOBCAT BOUNTY ENDED IN 1975. BOBCAT HUNTING AND TRAPPING SEASONS AND MANDATORY PELT TAGGING BEGAN IN 1976.

MAINE BOBCATS TAKEN BY HUNTING & TRAPPING

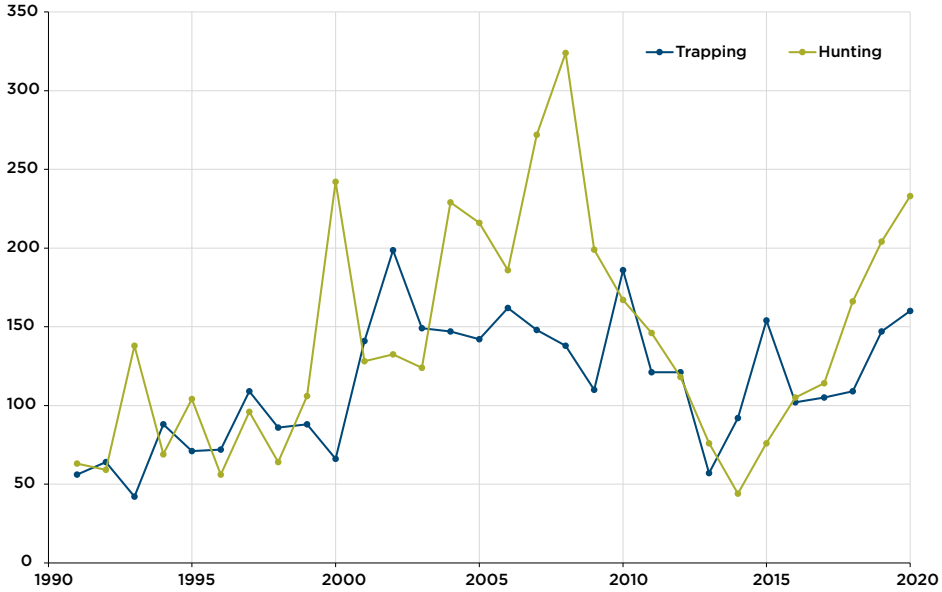


FIGURE 10.6 COMPARISON OF MAINE BOBCATS TAKEN DURING THE HUNTING AND TRAPPING SEASONS FROM 1991-2020.

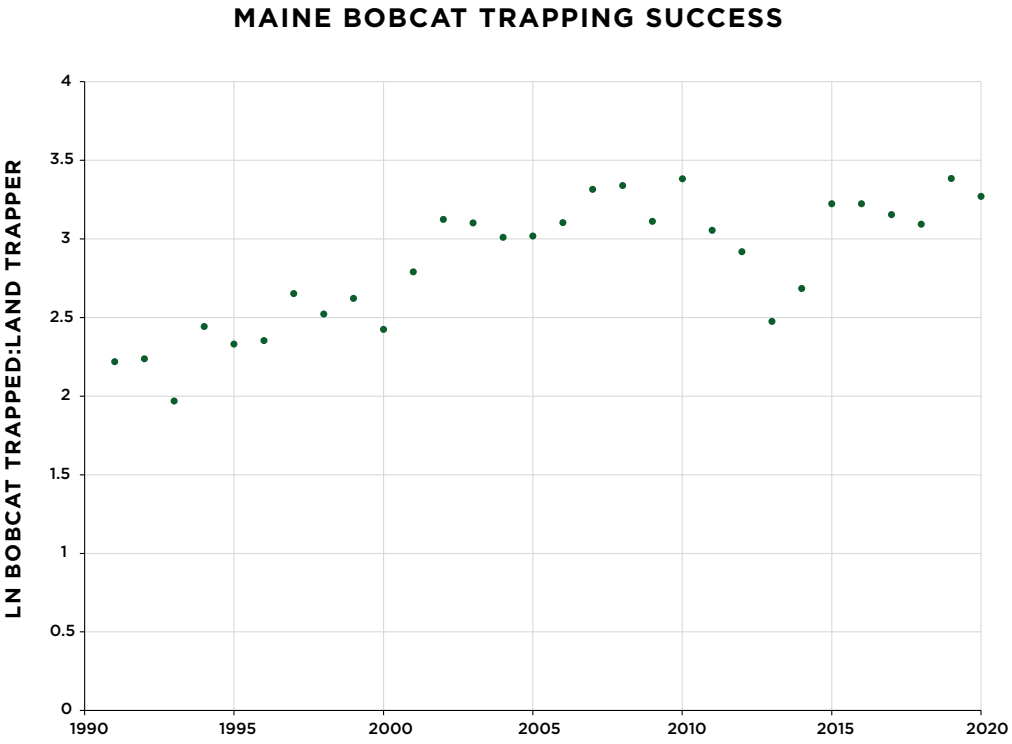


FIGURE 10.7 BOBCAT TRAPPING SUCCESS IS CALCULATED AS THE NUMBER OF TRAPPERS WHO CAUGHT AT LEAST ONE BOBCAT IN EACH YEAR DIVIDED BY THE NUMBER OF LAND TRAPPERS (TRAPPERS WHO TAGGED AT LEAST ONE BOBCAT, COYOTE, OR FOX) THAT SAME YEAR. THE NATURAL LOG (LN) OF THIS RATIO WAS REGRESSED AGAINST TIME (1991–2020) TO CREATE AN INDEX FOR BOBCAT POPULATION CHANGE.

10.3 Regulatory Framework

During the previous bobcat planning process in 1995, a publicly derived management goal based on the best available bobcat data directed the Department to maintain a viable bobcat population while providing opportunity for use.

Toward that end, two bobcat management objectives were developed:

1.) **Abundance Objective:** maintain the fall bobcat population at no lower than 1985 levels (estimated at approximately 1,850 bobcats).

2.) **Use Objective:** maintain hunting and trapping opportunity (season length and timing) at 1985 levels, as long as the abundance objective is met. It was assumed that the habitat was capable of supporting bobcat densities at 1985 levels.

Following the planning process, MDIFW developed a management system to evaluate bobcat population status in relation to the plan's goals and objectives. Management decisions were based on a series of yes or no questions related to 1) bobcat population level, 2) population trends, and 3) the presence of factors causing high mortality (e.g., severe winter weather, excessive harvest). Responses to questions were based on an evaluation of all input criteria, and flow charts guided the manager to the appropriate and/or current management option.

For previous planning efforts, bobcat carrying capacity was considered constant between assessments of habitat quality and quantity, based on the assumption that bobcats are at the northern edge of their range in Maine and the population is expected to fluctuate widely. Since many factors that affect bobcat survival and therefore bobcat numbers (e.g., winter weather, hare abundance, hunting conditions, pelt price) are extremely variable and beyond our control, we cannot expect to maintain unusually high numbers of bobcats indefinitely.

Bobcats are taken by both trapping and hunting. Bobcat trapping is believed to be largely incidental to trapping for other upland furbearers (e.g., coyote, red fox, gray fox) and trapping effort on upland furbearers is primarily regulated in response to concerns for species other than bobcat. The bobcat hunting season is separate from most other hunting seasons and generally contributes between 50% and 80% of the total bobcat take. No reliable hunting effort measures currently exist, but there are some trapping effort measures.

The previous management system recommended keeping a December 1 hunting season start date, but adjusting the end date by two-week intervals to regulate the bobcat take, with the goal of maintaining bobcat numbers at or above 1985 levels. Management proceeded by manipulating hunting harvest size (by adjusting season length) and promoting population growth during periods of low bobcat abundance, and taking advantage of the surplus harvestable animals during temporary population peaks based on changes in trapper success.

Bobcat management is regulated on the state level with an added layer of federal oversight. In 1977, to prevent the international sale of endangered species, countries formed the Convention on International Trade of Endangered Species (CITES). CITES has two lists of species: Appendix 1 for species currently threatened with extinction and Appendix 2 for species that may become threatened without international trade controls or that are similar in appearance to Appendix 1 species (look-alike species). Like the river otter, the bobcat did not meet the primary set of criteria for CITES listing (bobcat populations are not adversely impacted by international trade), but since bobcats resemble protected Lynx species, they are listed under Appendix 2. As such, Maine and other states that permit bobcat trapping and/or hunting are required to:

1. Provide sufficient biological justification that bobcat harvests would not be detrimental to the state's population for the state to participate in the CITES export program.
2. Provide annual justification of non-detriment and legal acquisition.
3. Comply with a bobcat tagging program administered by the USFWS (48 CFR 37494, 18 August 1983).

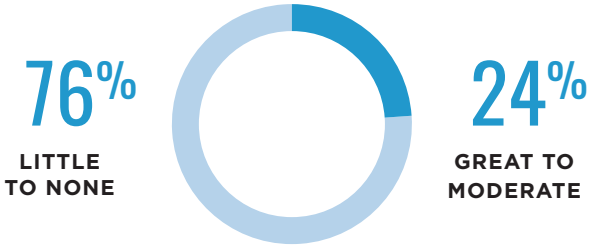
Efforts have been made to delist bobcats from CITES, but none have been successful to date.

10.4 Public Consultation - 2020 Key Findings

As part of the planning process, Responsive Management conducted a public opinion survey on bobcats and other species. Survey results indicate a lack of bobcat knowledge among Mainers, with 24% knowing a great deal to moderate amount about the species and 76% knowing a little to nothing at all (Responsive Management 2020). Still, despite the lack of knowledge, more people enjoy seeing and having bobcats around their home (10%) than consider them dangerous or a nuisance (6%) (Responsive Management 2020). Only 3% of respondents reported having an issue with a bobcat. In general, bobcats are viewed as a very beneficial species; and of Maine's furbearers, they are ranked second only to beaver. Their secretive habits may explain why half of respondents indicated that there were none in their area and why more felt that the population was too low (14%) rather than too high (4%) in the area where they live (Responsive Management 2020).

While regulated trapping has strong support among Maine residents (75% approve and 17% disapprove), trapping bobcats as a management tool had the lowest overall support of the furbearers (48% supported and 32% opposed). This may be related to people's perceptions that the bobcat population is lower than other species because of their elusive nature, lower complaints about them, or likability given how similar they are to domestic cats.

MAINE RESIDENTS KNOWLEDGE OF BOBCAT SPECIES



10.5 Management Issues & Threats

The primary management issue for Maine bobcats is that our current population monitoring indices rely on regulated harvests (primarily the trapping harvest). Trapping effort and success is influenced by several factors such as the weather, pelt values, gas prices, and more. Also, the demographics of the trapping community are changing, with the number of active trappers in decline. This further complicates data analysis, leading to future uncertainty about trapping indices. More information is also needed on hunting methods, effort, and success to better understand the factors that drive bobcat hunting and harvest. While the number of nuisance complaints can be used as an additional population metric for some species, bobcats are very rarely reported as a problem, with only sporadic reports of poultry, livestock, and domestic pet depredation. Better public outreach regarding predator proofing of poultry/livestock facilities may resolve some of these issues.

Public support for regulated trapping exceeds opposition for all species, and most Maine residents support trapping all species, except bobcats. Broader public support of the bobcat harvest is essential for maintaining trapping and hunting opportunities as management tools. Public outreach needs to focus on the status of bobcats, their role in the ecosystem, how harvests are regulated, and how hunters and trappers are using the most humane methods.

It is difficult to predict how changes in climate or habitat conditions may impact bobcat populations in the future. Increased precipitation resulting in higher depth and/or longer duration of snow cover makes it difficult for bobcats to survive in winter. If winters become shorter in duration and/or result in lower snow depths, the distribution of bobcats could shift north. Changes in industrial forest ownership, timber harvest rates, forestry practices, and natural disturbances also create uncertainty for long-term wildlife management planning. The spruce budworm outbreak and timber harvest operations in the 1970s and 80s resulted in large, regenerating clearcuts that supported high densities of hares (and subsequently their predators), but it is uncertain how future insect outbreaks or consumer demands for products will impact the forest industry. A change in forest practices from large, landscape-size clearcutting to the current practice of partial harvesting or thinning may lower the quality of snowshoe hare habitat if conifer stem density is reduced (Robinson 2006). However, the working forest model generally creates younger forests that benefit many wildlife species, including bobcats. Maturing forests in the southern half of the state may lead to a decline of early successional habitats, but more heterogenous habitats also result in more diverse prey.

10.6 Bobcat Management Goals & Strategies 2020-2030

Goal #1. Maintain healthy, abundant bobcat populations that allow for viewing and harvest opportunities, while also ensuring conflicts are minimized.

- Investigate and implement methods to monitor the bobcat population over time (e.g., camera surveys, habitat assessment, integrated population model, etc.) ***(New; High Priority)***.
- If necessary, review and improve the current system to measure annual winter severity index by Wildlife Management District (e.g., snow depth, sinking depth, temperature, other climate variables) ***(New; High Priority)***.
- Explore potential interactions and habitat associations between bobcat, lynx, and other mesocarnivores using sightings, population monitoring surveys, habitat and climate data, and/or other data sources ***(New; Moderate Priority)***.
- Explore methods to monitor limiting factors such as habitat, prey, competition, climate, parasites, and disease at bobcats' northern range limits ***(New; Moderate Priority)***.
- Explore the prevalence and effect of rodenticides on the bobcat population ***(New; Moderate Priority)***.
- Explore methods to document how prevalent bobcat-lynx hybrids are in Maine (e.g., genetic techniques) ***(New; Low Priority)***.

Goal #2. Maintain a sustainable bobcat harvest

- To comply with CITES, continue to have Department staff register and tag all bobcats harvested by hunting and trapping and collect relevant data on harvest town, date, and method ***(Ongoing; High Priority)***.
- Continue to monitor other bobcat mortality sources, such as roadkill and depredation, that are included in the fur registration database and other data sources ***(Ongoing; High Priority)***.
- Continue to collect biological data (age and sex) from harvested bobcats and improve its utility by increasing communications on data needs and results ***(Ongoing; High Priority)***.
- Continue to collect data on bobcat trapper effort and trapping success ***(Ongoing; High Priority)***.
- Ensure that the bobcat harvest remains within a non-detrimental level according to the CITES program ***(Ongoing; High Priority)***.
- Evaluate and, if/as data are available, update the criteria used in the Bobcat Management System, such as population indices and factors that contribute to bobcat mortality ***(New; High Priority)***.
- Explore methods to improve bobcat hunter effort and success estimates (e.g., post-harvest bobcat hunter survey) ***(New; High Priority)***.
- Explore data needed to consider managing the bobcat harvest regionally (in groups of WMDs) so that harvest opportunities could be increased or restricted as necessary in response to population parameters ***(New; Moderate Priority)***.

Goal #3. Maintain bobcat trapping and hunting opportunities

- Work with partners to develop outreach tools to hunters that promote good landowner relations and hound-hunting ethics ***(New; High Priority)***.
- Develop next-step programs that strengthen bobcat trapping interest and participation and provide instruction on responsible and effective bobcat trapping and ways to avoid incidentally capturing lynx ***(New; Moderate Priority)***.
- Develop outreach tools that promote bobcat hunting and help hunters to identify the differences between bobcat and lynx ***(New; Moderate Priority)***.
- Explore methods to survey hunters to better understand behavior, motivations, interests, and desired bobcat hunting opportunities ***(New; Moderate Priority)***.
- Explore ways to determine public opinions of bobcat hunting methods ***(New; Moderate Priority)***.
- Promote bobcat as a healthy source of high-quality organic protein ***(New; Low Priority)***.

Goal #4. Increase public understanding of bobcats and bobcat management

- Continue to share information on how to identify bobcat and lynx and expand reach with more digital communications ***(Ongoing; Moderate Priority)***.
- Periodically survey the public to determine attitudes towards bobcats, perceived population status, and understanding of bobcat biology and management ***(New; High Priority)***.
- Develop opportunities for the public to learn more about bobcat populations, behavior, ecology, and management, such as a presentation at the Maine Wildlife Park, digital communications (social media, email), backyard wildlife guide, etc. ***(New; High Priority)***.
- Promote legal use of trail cameras as a way to observe bobcats and potentially contribute to a citizen science bobcat monitoring study ***(New; Moderate Priority)***.

Goal #5. Minimize human-bobcat conflicts

- Develop outreach tools and partnerships with other organizations to promote co-existence with bobcats and develop predator-proofing strategies, tools, and resources to protect livestock and pets ***(New; High Priority)***.
- Improve estimates on the number and severity of bobcat conflicts to monitor public tolerance of bobcats ***(New; High Priority)***.
- Develop public messaging about the negative effects of rodent poisons on predators, including bobcats, and alternative methods to reduce rodent problems ***(New; Moderate Priority)***.

Goal #6. Conservation of other species

- Continue to monitor the role of predation, including bobcats, on deer mortality in northern Maine ***(Ongoing; Low Priority)***.
- Work within existing MDIFW programs and partners to develop and/or promote tools for management of early successional habitats that benefit bobcats and other species (e.g., Maine Forest Service's What Will My Woods Look Like- Before and After Timber Harvesting) ***(New; Moderate Priority)***.
- Explore options and develop partnerships to address predation of New England Cottontails by bobcats (and other meso-carnivores) ***(New; Moderate Priority)***.
- Examine evidence for competition between bobcat and lynx by monitoring the distribution and relationships between bobcat and lynx over time ***(New; Moderate Priority)***.

Expected Outcomes for Bobcat Management

Implementing the bobcat management strategies in this plan will require adequate staffing, funding, and public support. It may not be necessary or feasible to carry out all strategies to achieve the plan's goals and objectives.

We anticipate the following bobcat-related outcomes over the next 10 years (by 2030 unless otherwise noted):

Having identified appropriate bobcat population monitoring metrics, we will ensure a healthy, abundant bobcat population while allowing for sustainable levels of hunting and trapping.	By 2025, outreach and communication efforts will have increased public knowledge from 2019 levels. (In 2019, 24% of residents reported that they knew a moderate amount or great deal about bobcats).	By 2025, public support of regulated trapping to help manage bobcat populations will remain above the 2019 level of 48%.	By 2025, through outreach and promotional efforts, public awareness and enjoyment of bobcats will exceed 2019 levels. (In 2019, 10% of residents reported that they enjoy seeing and having bobcat around).	Statewide bobcat complaints tracked in a standardized database will be below 2021 levels.

11.0

MARTEN

11.0

MARTEN

Martens are small carnivores in the weasel family that are skilled tree climbers and can even hunt small mammals under the snow. They are about the size of a small housecat and have glossy brown fur.

MARTEN HABITAT

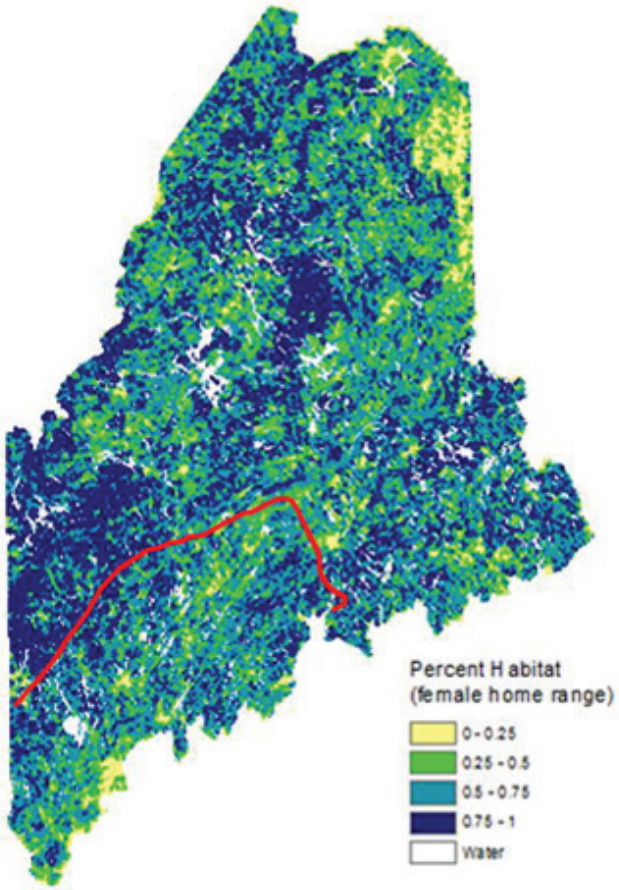


FIGURE 11.1 APPROXIMATE MARTEN DISTRIBUTION (ABOVE RED LINE) AND PERCENT PREDICTED SUITABLE HABITAT IN MAINE (SIMONS-LEGAARD ET AL. 2022).

11.1 Natural History & Population Status

The American marten *(Martes americana)* is a medium sized member of the weasel family (Mustelidae) that is widely distributed throughout northern forests of North America. Historically associated with contiguous stands of old growth boreal forests, marten have been documented over the last several decades in mature coniferous and mixed-wood forest stands. Research has also shown that they can adapt to some level of forest fragmentation (Steventon and Major 1982, Hodgeman et al. 1997, Chapin et al. 1998, Payer and Harrison 2003). Maine is currently at the southern extent of the marten's range in eastern North America. New Hampshire, Vermont, and northern New York also have resident populations of marten, where they are considered a "species of greatest conservation need." In addition to Maine, New York is the only other state in the northeastern United States to have a trapping season for marten.

Marten are prized for their thick, silky pelts and relative ease of trapping. In the 1800s, trapper and fur dealer Manly Hardy reported marten to be common in much of Maine, with high "sable" catches in some areas. Throughout the 1900s, trappers continued harvesting marten in northern Maine's coniferous forests. However, by the 1940s, Aldous and Mendall (1941) reported that the species was only seen rarely in northern and northeastern Maine, namely along the St. John and Allagash rivers and around Baxter State Park. Like many furbearing species, marten populations were overharvested during the height of the fur trapping era and disappeared from many historic ranges which once reached as far south as northern West Virginia and Pennsylvania. Clearing for settlement, agriculture, and timber harvesting also may have influenced population decreases outside of the more remote areas of northern and northwestern Maine (Coulter 1959).

Like several other members of the weasel family, marten are skilled climbers. They use their semi-retractable claws and slender bodies to easily navigate through the canopy in search of prey and to escape from predators. Marten are carnivores, but they feed on a variety of food depending on the season (Soutiere 1979, Lachowski 1997). Small mammals account for more than half of their diet, but they will also feed on reptiles, birds, insects, hard and soft mast like beechnuts and berries, carrion, snowshoe hare, and even other marten given the opportunity. In winter, when many food resources are unavailable, small mammals make up most of their diet. Using their long slender bodies and heavily furred feet, marten can travel in deep snow and hunt under the snow with a technique called subnivean foraging. With this unique foraging strategy, marten are able to access food under the snow that many competitors cannot.

The marten's lean body shape gives it a hunting advantage over other species, but it comes with a price pertaining to temperature regulation and metabolic needs. Long slender bodies have more surface area than rounder bodies of the same weight, making them thermally inefficient. Because of the significant thermal stress this creates (Brown and Lasiewski 1972, Drew and Bissonette 1997, Buskirk and Harlow 1989, Harlow 1994), winter is the hardest season for marten. To survive the winter, marten depend on abundant food resources and a forest structure with large, decayed stumps and logs under the snow to shield them from the elements and from predators.

The marten's spatial requirements are much larger than other similar sized carnivores, and they will alter their territories based on season, prey abundance, and habitat characteristics (e.g., forest age and spatial structure). Males are larger than females in body size and home range size (their ranges are roughly twice as large as females' and often overlap more than one female territory). Unlike other mustelids, marten home range is determined by resource availability, predation risk, and energy requirements, not by access to breeding (Katnik et al. 1994). Because of their high metabolic/energy needs, if food resources are limiting, marten must expand their territory (Fuller 1999). Seasonal/cyclical availability of mast from trees like beech with high seed yields can influence this fluctuation in territory (Jensen et al. 2012).

Marten reproductive rates are low, and their longevity is high by mammalian standards (Buskirk and Zielinski 1997). Male marten become sexually mature around 15 months, but females do not have their first litter until two years of age because of delayed implantation (after breeding, the fertilized eggs don't grow for about seven months). Mating occurs in July and August, and one to five young are born in March or April. Young disperse in late summer/early winter, traveling anywhere from three to 25 miles (5 to 40 km) depending on habitat quality and open territories. Survival rates of adult marten vary by sex and habitat. Numerous radiotelemetry studies throughout the marten's range have documented a variety of survival statistics. In Maine, research in trapped populations found that males had lower survival rates than females; however, in an untrapped population in Baxter State Park, males had higher survival rates. Males are more vulnerable and have higher rates of trapping mortality because of their much larger home ranges (Soukkala 1983, Phillips 1994, Hodgeman et al. 1994, Payer 1999). Other sources of mortality include starvation as well as predation by fisher, coyote, and avian predators. The oldest marten ever harvested in Maine was 12 years old.

To meet their survival and reproductive needs, marten require a complex structure of vertical and horizontal cover in the form of canopy closure, fallen trees, broken limbs, root masses, stumps, and snags.

Healthy, sustainable marten populations are dependent upon an adequate supply of habitat. Marten do not require old growth forest for survival, but they do need relatively large tracts of intact mature forest with adequate overhead cover. Premier marten habitat can be found in places like Baxter State Park in northern Piscataquis County, which boasts 200,000 acres of contiguous mature forest designated as wilderness. Maine Bureau of Parks and Lands manages a network of other sizeable late successional forest tracts as ecological reserves. These parcels range in size from 800 to 11,000 acres, totaling 95,000 acres statewide. While marten are sensitive to landscape changes that fragment habitat, they are also tolerant of a wide range of forest types within their territories (Katnik 1992, Payer 1999, Hepinstall and Harrison 2003, Fuller and Harrison 2005). Because of their specific habitat needs, marten are often referred to as a "umbrella species" or an "indicator species." When you protect an umbrella species, other species with similar habitat needs also benefit. An indicator species is one whose status serves as a measure of environmental condition. To meet their survival and reproductive needs, marten require a complex structure of vertical and horizontal cover in the form of canopy closure, fallen trees, broken limbs, root masses, stumps, and snags. Each plays a vital role in some part of a marten's lifecycle, such as denning for raising young, resting sites for thermal protection, and cover for hunting prey or hiding from predators (Hodgman et al. 1997, Sherburne and Bissonette 1994, Chapin et al. 1997, Wynn and Sherburne 1984).

A large portion of Maine's core marten range overlaps the industrial forests of western and northern Maine **(Figure 11.1)**. In the late 1970s into the early 1980s, controversy around harvesting practices and clear cutting intensity were the primary conservation concerns. During this time, a spruce budworm outbreak significantly impacted northern Maine's spruce/fir forests, resulting in large-scale salvage logging operations throughout the marten's range. In 1989, the Forest Practices Act (FPA) was adopted. This Act was designed to promote sustainable forestry that protects forest management, the forest industry, and Maine's rural communities. It set standards for regeneration in clearcuts and size of clearcuts, and it established separation zones between clearcutting harvests. The FPA required forest managers to submit plans for clearcuts above 35 acres and set standards for basal area of residual stand categories. Since then, partial harvesting has been the predominant silvicultural strategy, accounting for ~10.5 million of the 17.6 million acres cut since 1990. Timber harvesting practices directly impact marten habitat quality. Where large-scale clearcutting initially created extensive areas of unsuitable habitat, partial cutting has had a less direct influence on habitat loss. Instead, it creates fragmented checkerboard patterns of suitable patches, requiring marten to balance the risks of movement with their needs for food and forest cover.

Marten and fisher are closely related, occupy much of the same habitat, and are trapped using similar methods. In addition to competing for similar foods, fisher, being a much larger mustelid, will prey on marten given the opportunity. In some parts of their range, marten occurrence is higher where fisher populations are lower. This has been attributed to decreased threat of predation, less resource competition, and deeper snow benefitting marten (Krohn et al. 1995, Payer 1999). However, camera surveys have documented a high level of marten and fisher co-occurrence throughout western and northern Maine (Evans and Mortelliti 2022).

11.2. Marten Management History

Around 1866, Maine's first regulated "sable" (marten) trapping season ran from mid-October through the end of May (Table 11.1). Specific start and end dates varied slightly in response to low marten population numbers, with end dates progressively shortened until legislative closure in 1937. Gradual marten population increases in their core range allowed for a section of northern Maine to reopen for January in 1973 with a five-animal limit per trapper and fur tagging requirements. A total of 152 marten were harvested that first season. After a few years, the marten season was changed to coincide with trapping of other upland furbearers (roughly mid-October through early December). The bag limit was dropped, and trapping was opened statewide. Through 1985, an upward trend in harvest was documented, as was an expansion of marten into parts of western and central Maine **(Figure 11.2)**. In an effort to supplement natural range expansion, the state initiated a translocation program between 1983 and 1984, with 66 marten moved from north-central and north-western portions of Maine to areas of downeast in T42MD and Moosehorn National Wildlife Refuge. The harvest peaked in 1985, amidst high fur prices and trapper participation. That year, 8,745 marten were harvested.

From the 1985 high through 1992, the marten harvest trended downward. In 1991, in response to concerns over high marten harvests, timber harvest practices, increased road access, and decreased fur prices for most species, the Department placed a 25-animal bag limit on marten. The Department also lengthened the season by two weeks to the end of December, which increased trapping opportunities while also protecting marten from localized overharvest. Marten pelt prices remained relatively steady through this time and trappers shifted some of their efforts to the easy-to-capture marten.

Marten harvest generally follows a cyclic pattern of a high harvest season followed by a low harvest season. This trend is likely linked to the availability of small mammals and hard mast produced by trees such as beech, which influence marten trap-ability (Jensen et al. 2012). On years of high mast production and/or small mammal abundance, marten have plenty of natural foods and are not as interested in the baits at trap sites during the fall months. Consequently, trapper success is lower. Harvest is also influenced by weather, pelt prices, regulations, and trapper effort. Trapper effort on marten has remined relatively high in comparison to other furbearing species due to the species' ease of trapping and preparation of their fur, along with a fairly stable fur price.

In 2007, the marten and fisher trapping season was shortened to four weeks (Nov. 15 – Dec. 15) to reduce the fisher harvest. That same year, the Department instituted regulations on placement of killer-type traps in response to concerns over the incidental catch of Canada lynx, a federally protected species. As part of the Incidental Take Plan for Maine's Trapping Program (ITP), these methods aimed to decrease the possibility of trappers catching lynx and protect them from the repercussions of catching a federally threatened species. Starting that year, trappers needed to use a "leaning pole technique," which meant that traps had to be placed more than four feet off the ground on poles less than four inches thick. The poles had to be placed at more than a 45-degree angle; and to prevent incidental catch of federally protected bald eagles, bait could not be visible from above. These new requirements led to a drop in harvest numbers and a brief break in the cyclical harvest pattern. However, the harvest rebounded by 2012, when 478 trappers harvested 4,048 marten. Fur prices that year also jumped to their highest levels since 1987.

Since 2012, the marten harvest and the number of successful marten trappers have both been on a steady decline **(Figure 11.3)**. An emergency land trapping closure occurred during the November 2014 trapping season when lethal capture of two lynx initiated response protocols set forth in the ITP. Following closure, new regulations required that killer-type traps be placed in exclusion devices which fully encased and recessed the trap, yet provided access for target furbearers. Traps in exclusion devices were allowed to be placed on the ground. The first year of exclusion devices saw the lowest marten harvest since 1975, at just 395 marten taken by 83 trappers. Many trappers decided to not trap that year, and those who did, invested significant time and money into building exclusion devices. Since then, the harvest has remained below historical levels, but does still show the pattern of alternating higher success years.

HIGH HARVEST YEARS

1.08 & 1.60 MARTEN

PER 100 TRAPNIGHTS

LOW HARVEST YEARS

0.78 MARTEN

PER 100 TRAPNIGHTS

Although marten harvest levels have declined, the average marten catch has been somewhat stable in recent years **(Figure 11.4)**. From 2016 to 2020, 61-90% of marten trappers caught ≤10 marten annually, which is comparable to the 76% of trappers who had that level of success in the past (Ritter 1986). There is a small handful of trappers that catch the 25-marten bag limit (one to 12 annually from 2015 to 2019). Compared to the last Marten Assessment in 2009 (Jakubas et al. 2009), the marten harvest has been much lower; but WMDs 1-11, 14, and 19 still comprise the vast majority of the harvest (Table 11.2). The recent marten harvest in western Maine (WMDs 7 and 8) is similar to some of the northern districts (WMDs 1 and 2). Marten and fisher are harvested in 22 of the 29 WMDs, whereas fisher are harvested in all the districts **(Figure 11.5)**. Marten harvests are higher than fisher in 11 of the 22 districts where both species occur, with much higher ratios of marten to fisher in WMDs 5 and 9. Conversely, fisher harvest density is highest in southern Maine (WMD 20) where marten do not occur. More marten are taken than fisher in northern Maine, with the exception of northeastern areas (WMD 3) where there is less forest and more agriculture.

Marten and fisher harvest in eastern Maine (WMDs 26-28) is low, which is consistent with past harvest trends. In general, marten harvest density is highest in western and northern areas of the state (WMDs 1, 2, 4-11, 14, and 19), which provides a good index for marten occurrence **(Figure 11.6)**. Although marten distribution has been similar, the number of marten harvested has declined since 2008, likely due to changes in the regulations, trapper effort or other factors **(Figure 11.2, 11.6)**.

During high harvest years, the statewide catch rate was 1.08 and 1.60 marten per 100 trapnights (1 trap set for 1 night = 1 trapnight), compared to 0.78 marten per 100 trapnights during a low harvest year (2018-2020). For northern areas (WMDs 1-11 and 14), the catch per unit effort has varied from 1.22 to 0.83 and 1.69, compared to southern areas (WMDs 12, 13, 15-29) where rates were 0.86, 0.48, and 1.04 marten per 100 trapnights (2018-2020).

The age and sex of sampled martens has been fairly consistent in recent years. At a statewide level, approximately half of the annual marten harvest is composed of juveniles and only 6% are adult females **(Figure 11.7)**. The average ratio of males to females is 2.3 and the ratio of juveniles to adult females is 8.24 (2016-2020), which is comparable to results reported in the literature. Compared to historic studies in the states, the percent of juveniles was similar, but the ratio of males to females and juveniles to adult females has varied somewhat. Nonetheless, the percent of adult females in the annual harvest has generally been ≤10%.

TABLE 11.1. SUMMARY OF RESEARCH AND MANAGEMENT ACTIONS FOR MARTEN FROM 1866-2021.

YEAR	RESEARCH & MANAGEMENT ACTION
1866	First regulated statewide marten trapping season was instituted, running from mid-Oct. to the end of May. Hunting of marten was not allowed.
1931	Trapping seasons varied slightly by county.
1937	Trapping of marten was closed by statute to allow marten population to recover from heavy trapping pressure.
1972	Marten trapping season was repealed in statute and replaced by regulation.
1973-1975	Trapping season opened for the month of January only in northern Maine, with a five marten per season bag limit and a requirement that pelts be tagged by a fur tagging agent. The first marten planning phase was initiated.
1976	A petition to list eastern American marten for federal protection failed (not warranted).
1978	The marten bag limit was dropped, and trapping season was now Oct. 20 to mid-Nov. (plus an extra week in northern management units). J. Major led a study on marten use of commercially clear-cut forest during the summer as part of his MSc thesis. E. Soutiere completed a study on the effects of timber harvesting on marten in the Moosehead Lake region as part of his Ph.D. thesis. J. Steventon studied the influence on timber harvesting on winter habitat use by marten as part of his MSc thesis.
1979	Marten trapping season opened statewide.
1981	The second marten planning phase occurred. K. Wynne completed a MSc thesis on adult marten summer home range use in northwestern Maine. J. Sherburne and G. Matula conducted predator habitat utilization studies as part of the Dickey-Lincoln School Lakes project in northern Maine.

YEAR	RESEARCH & MANAGEMENT ACTION
1983	Season was extended to early Dec., but varied by region. The first marten translocation effort occurred. A. Soukkala completed a MSc thesis on the effects of trapping on marten populations in Maine.
1984	A second marten translocation effort occurred.
1986	The third planning phase occurred for marten.
1991	The marten bag limit was 25 and the marten trapping season increased by two weeks in December (now Nov. 1 to Dec. 31).
1992	D. Katnik completed a MSc thesis on space use, territoriality, and habitat selection on trapped marten population in Maine's industrial forests.
1994	D. Phillips completed a MSc thesis on social and spatial characteristics and dispersal of marten in Maine.
1995	T. Chapin completed a MSc thesis on the influence of landscape pattern and forest type on habitat use by marten in Maine.
1997	Marten traps must be tended at least every three days in unorganized towns. H. Lachowski completed a MSc thesis on the relationship between prey abundance, habitat, and marten in Maine.
1998	Trappers were required to tag marten with temporary transportation tags. Some northern Maine townships were closed to trapping to support University of Maine marten research.
1999	A. Fuller completed a MSc thesis on the influence of selection harvesting on marten and their prey.
2005	D. Harrison et al. (editors) published a book "Martens and Fishers (Martes) in Human-Altered Environments: An International Perspective".
2007	Marten trapping season was reduced to one month to reduce the fisher harvest. Incidental catch rules took effect with leaning pole set requirements.
2008	Marten trapping season returned to eight weeks (Nov. and Dec).
2014	In November, the land-trapping season was closed as an emergency measure.
2015	Exclusion devices were now required for placement of marten killer traps.
2016	A jaw or canine tooth sample was required to be submitted from all harvested marten.
2019	Trapper harvest reports (covering effort and catch) are mandated for marten and other species.
2020	Temporary transportation tag requirement was removed for marten.
2021	B. Evans completed a Ph.D. dissertation on forest disturbance and occupancy of forest carnivores in Maine. T. Woolard completed a MSc thesis on marten habitat selection and 30 years of forest harvesting in Maine.

TABLE 11.2. MAINE MARTEN HARVEST BY WILDLIFE MANAGEMENT DISTRICT FROM 2007-2020.

WMD	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	107	229	95	189	58	254	66	106	25	69	81	74	23	64	35
2	140	220	265	334	54	236	48	172	32	109	58	49	11	75	51
3	86	94	71	117	42	146	47	61	1	13	10	6	4	20	8
4	292	329	174	351	212	589	114	152	42	88	62	94	50	148	15
5	264	351	370	419	210	490	153	162	31	214	81	121	71	238	85
6	94	209	196	248	127	271	94	110	23	67	39	32	12	84	19
7	158	69	131	274	100	328	44	92	72	83	43	47	14	40	35
8	291	202	196	421	117	277	42	69	29	132	59	124	27	109	60
9	225	60	287	205	77	379	67	34	29	86	31	129	35	74	35
10	155	152	108	231	75	161	52	100	2	50	13	62	4	51	1
11	139	174	255	277	159	355	131	70	28	83	25	40	32	48	24
12	14	1	12	18	3	62	12	18	1	0	3	8	1	9	0
13	15	9	8	17	8	25	1	5	1	1	0	0	0	0	2
14	86	73	133	159	30	116	17	63	10	12	4	25	5	27	7
15	2	0	6	0	1	5	0	1	0	0	0	0	0	0	0
16	8	0	0	1	1	12	0	0	0	0	0	0	0	0	0
17	10	9	46	8	26	28	3	1	8	9	1	7	0	1	0
18	79	26	73	98	38	78	28	2	6	12	2	11	8	6	4
19	212	112	229	225	63	183	113	3	14	34	4	55	18	46	18
20	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0
21	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
23	3	3	3	1	2	16	0	2	0	11	0	0	0	15	0
24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
26	2	7	4	1	0	0	5	0	0	0	0	0	0	0	0
27	0	0	1	2	1	2	0	0	0	1	0	0	0	0	0
28	6	17	19	5	24	10	15	1	5	6	1	9	0	2	1
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

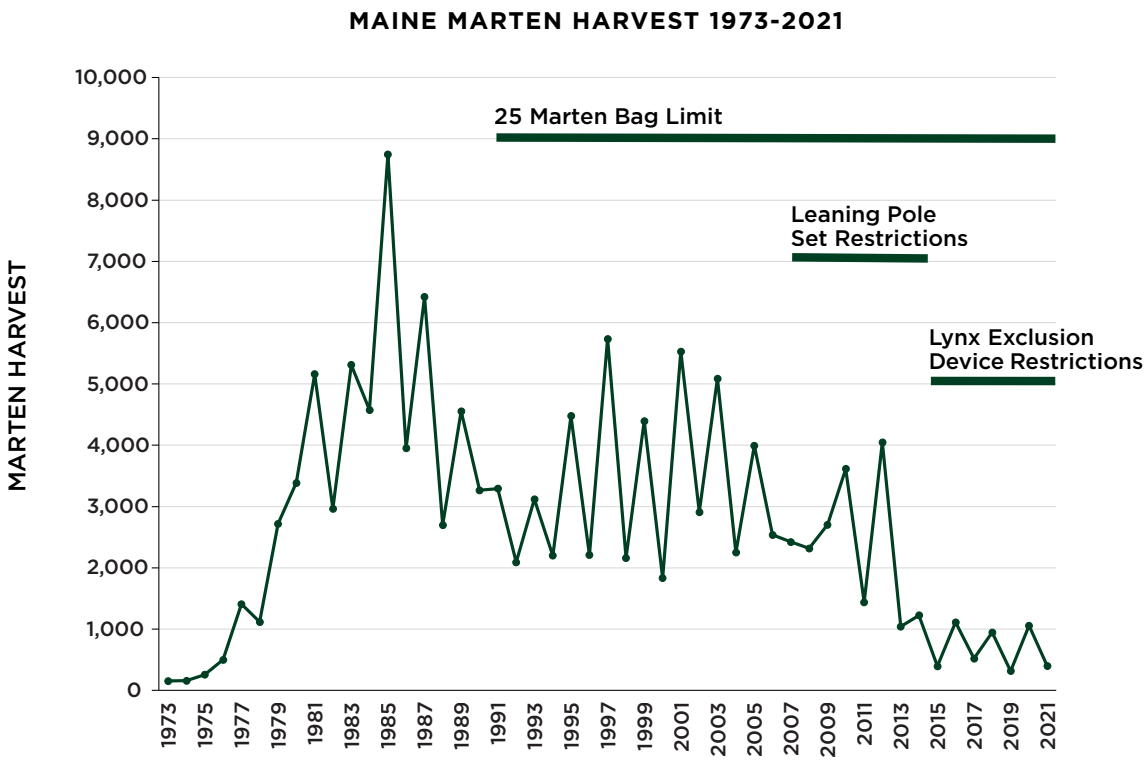


FIGURE 11.2. MAINE MARTEN HARVESTS FROM TRAPPING AND IMPORTANT REGULATORY CHANGES (1973-2021).

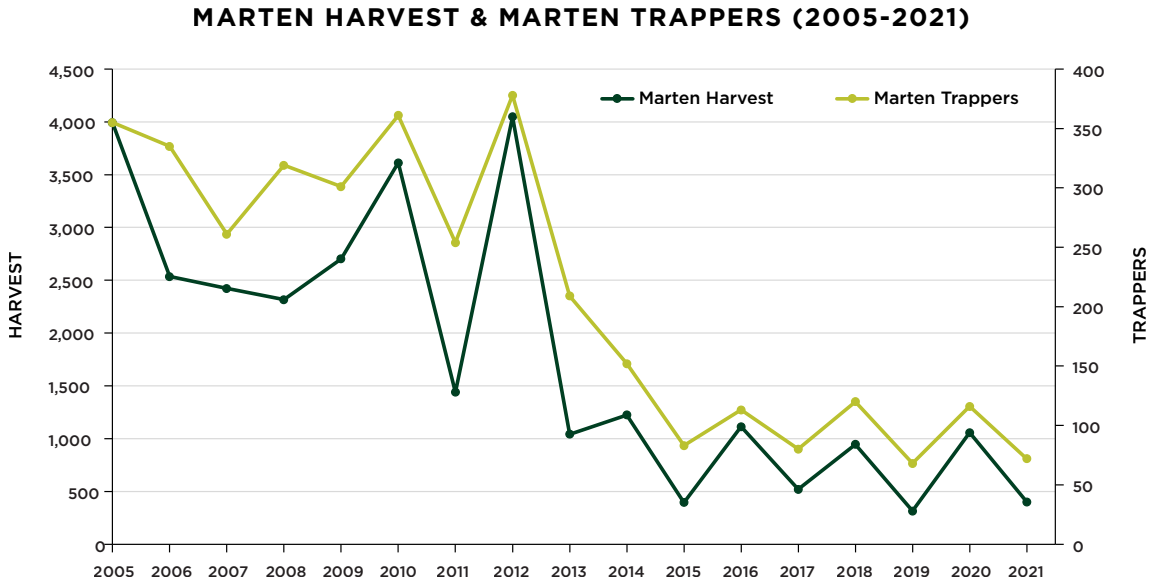


FIGURE 11.3. TRENDS IN MARTEN HARVEST (LEFT AXIS) AND SUCCESSFUL MARTEN TRAPPERS (RIGHT AXIS) IN MAINE (2005-2021).

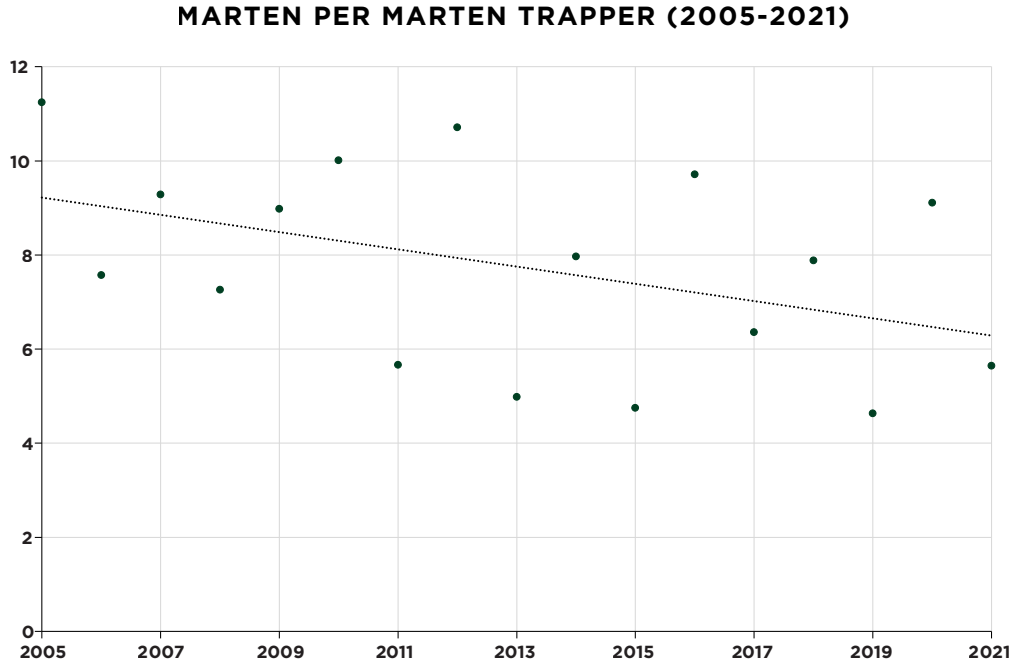


FIGURE 11.4. THE AVERAGE ANNUAL NUMBER OF MARTEN CAUGHT PER TRAPPER IN MAINE (2005-2021).

FISHER AND MARTEN HARVEST BY WMD (2015-2019)

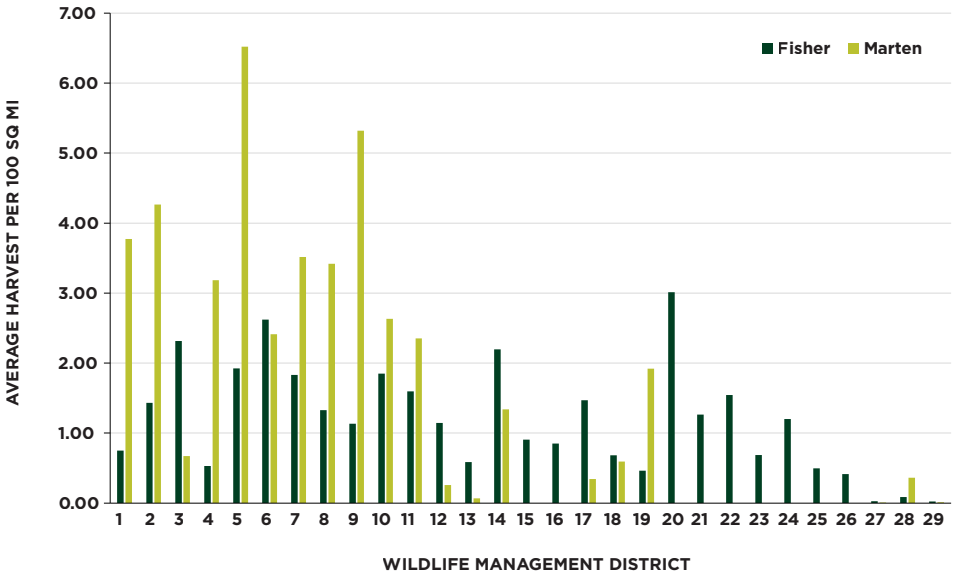


FIGURE 11.5. COMPARISON OF THE AVERAGE FISHER (DARK GREEN BARS) AND MARTEN (LIGHT GREEN BARS) HARVEST PER 100 SQUARE MILES IN EACH WILDLIFE MANAGEMENT DISTRICT IN MAINE (2015-2019).

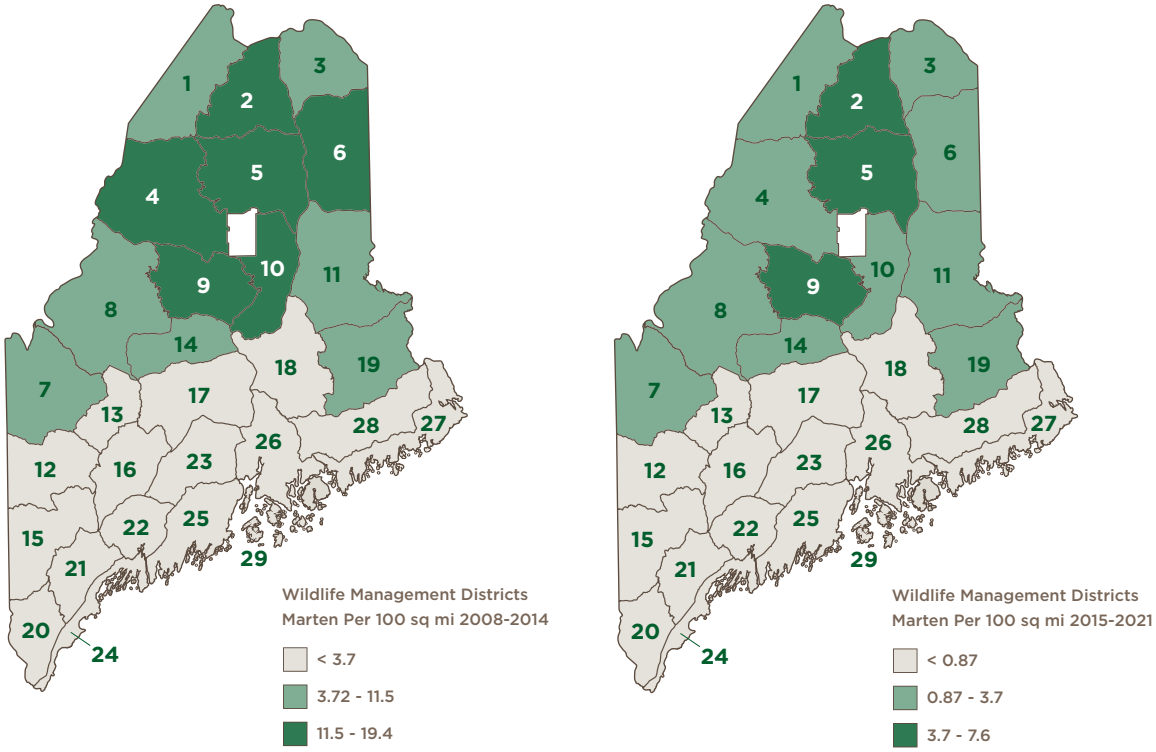


FIGURE 11.6. COMPARISON OF THE AVERAGE NUMBER OF MARTEN HARVESTED PER 100 SQ MI BY WILDLIFE MANAGEMENT DISTRICT DURING TWO TIME PERIODS (2008-2014, LEFT AND 2015-2021, RIGHT) IN MAINE. THERE IS NO TRAPPING IN BAXTER STATE PARK (WHITE POLYGON).

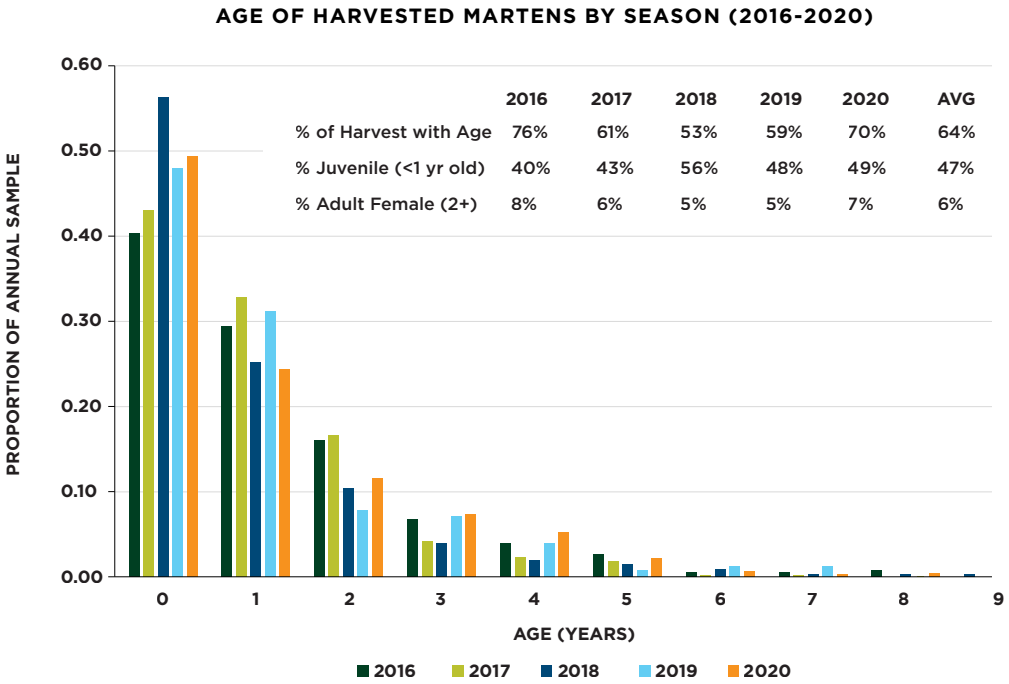


FIGURE 11.7. AGE AND SEX OF THE MARTEN SAMPLED DURING THE 2016 – 2020 TRAPPING SEASONS IN MAINE.

11.3. Regulatory Framework

There were three planning periods prior to this assessment, the first of which was 1975 to 1979. During those years, the goals were to increase abundance and use, and the catch objectives were 1,000 to 1,500 marten. Those objectives were exceeded every year and attributed to underestimation of population due to limited available information at the time.

During the second planning period, from 1980 to 1984, the goal was to maintain 1978 harvest and species abundance levels and encourage expansion of the marten range. The range did expand thanks to natural expansion and translocation efforts; but the harvest objective (1,200 marten/year) was once again exceeded every year and attributed to underestimation of the population that could withstand much higher exploitation levels than originally predicted. Concerns over localized overharvests were expressed.

The third and most recent planning period until now was 1986 to 1990. It had several goals and targets, the first of which was to expand the marten's range into western Maine (WMU 3 or WMD 7, Appendix 3). Marten harvests in western Maine remained low but stable in the mid-1980s to mid-90s, so it appeared that natural range expansion was occurring. The second goal was to maintain marten populations at no lower than 1985 levels throughout their current occupied range. In fall 1985, the statewide marten population estimate (based on estimated available habitat) was 17,645. A slight statewide population decrease to 17,242 marten was forecasted for fall 1990 due to projected habitat declines of 3% in northern Maine and heavy trapping takes. A two-step decision process was used to assess whether management goals were met and what actions were needed to meet these goals. Criteria A involved assessing harvest and long-term trend data compared to the 1985 population target and criteria B was short-term trends to assess population stability.

A maximum allowable harvest was set at one marten per square mile, based on the assumption that marten population density estimates in core habitat was near carrying capacity. Data on the annual harvest numbers, trapping success rates, and effort estimates based on fur prices were all used to assess goals. In 1991, a management action to reduce harvest based on a management trigger was initiated with a season bag limit of 25 marten per trapper. Harvest indices, habitat data, and research findings on mortality and reproductive rates from University of Maine indicated uneven trapping effort with a few trappers catching large numbers of marten and localized marten population declines. By introducing the bag limit, the harvest was reduced to address these concerns while only affecting a small percentage of trappers. Several changes to trapping regulations, habitat quality and quantity, and trapper effort have influenced the marten harvest since that time, but numbers have remained below the allowable harvest target based on the 1985 criteria (1,200 marten).

The Marten Management System relies primarily on trapping indices from northwestern Maine (WMU 2, which is roughly equivalent to WMDs 1, 2, 4, 5, and northern parts of 8, 9, and 10). In 1998, the Marten Management System was reviewed in order to clarify the harvest objective, review population equations, and assess whether pelt price was a good indicator of trapper effort. The harvest objective was updated to 3,000 marten (WMU 2) based on the 1996 species assessment update, and it was decided to use more recent data (past 10 years) in the regressions, exclude data prior to the 25-marten bag limit to predict long-term population trends, and use alternate-year averages to control for harvest fluctuations linked to beechnut production. The Department stopped using pelt price as an index for trapper effort because it did not relate to changes in the marten harvest, and used a voluntary trapper effort survey instead.

11.4 Public Consultation – 2020 Key Findings

As part of the planning process, the Department worked with Responsive Management to conduct a public opinion survey on marten and other species. Marten was the species which the highest percentage of the general public (86%) indicated they knew little to nothing, with 42% saying they didn't believe marten lived around their homes. Even though marten are a northern species, there were no regional differences in marten awareness. When asked how beneficial they considered various furbearer species on a scale of 0 (not beneficial) to 10 (extremely beneficial), people ranked marten in the middle, at an average of 6.2. Only 1% of respondents perceived marten as dangerous, and 5% as a nuisance. This mirrors the lack of complaints about marten recorded by the Department.

Even though Maine residents strongly support regulated trapping (75% approve and 17% disapprove), marten trapping had the second-lowest level of support among furbearers (bobcat was lowest), with only 57% of people strongly or moderately supporting regulated trapping to help manage the population. While a large percentage indicated there were no marten in their area (42%) or they didn't know if the population was too high or low (35%), of the remaining respondents, 15% said the populations were just right and 6% said the populations were too low. Many of these results from the general public indicate a lack of knowledge of the species and reflect its tendency to be a secretive deep woods species, less likely to come in contact with people.

Responsive Management also polled trappers to gain their opinions on furbearer management. While 71% of trappers said they were satisfied with MDIFW's furbearer management, 23% of those who were unsatisfied indicated it was because of lynx exclusion devices. Exclusion devices have influenced marten and fisher trappers directly, with just 14% of trappers reporting that they trapped for marten during the 2018 season and 65% decline in the number of successful marten trappers (2009-2014 vs. 2015-2020).

11.5 Management Issues & Threats

The primary threat to marten across their range is habitat loss and fragmentation. Extensive research over the past couple of decades has shown that marten can tolerate a wide range of habitat conditions and that individuals can shift their home ranges to some degree to utilize available resources. However, the majority of the species' range is within privately owned, intensely managed industrial forestland, and the owners of that land are ever-changing. While MDIFW can recommend habitat enhancements for marten and other species, we cannot easily predict how private land will be managed, and timber harvesting regimes are ultimately subject to landowner goals. Timber harvesting and marten populations can co-exist as long as there is enough suitable habitat on the landscape. Patch size, residual basal area, mean stand height, and mean stem diameter all factor in to suitable habitat. Maintaining resource connectivity is also important, so that marten can easily shift and adapt. With enough connectivity, marten can disperse from higher quality refugia (population sources) such as Baxter State Park or Bureau of Parks and Lands ecological reserves to suitable but potentially fewer ideal habitats elsewhere on the landscape. As the forest mosaic constantly changes, it's important that we monitor changes in habitat supply and configuration on the landscape so that we can predict future marten persistence.

A stable population relies on habitat features, but is also sensitive to trapping pressures. And while MDIFW cannot directly manage private lands, we can regulate the harvest. Marten are susceptible to overharvest due to their ease of capture, with high road densities adding to the potential trapping pressure. Current population metrics rely on trapper compliance with harvest surveys, fur registrations, and biological samples. However, many factors including pelt prices, accessibility, and weather can influence trapper effort and success. If trapper effort continues to decline, these data could become less available and less reliable in the future. For that reason, we need to explore new methods of monitoring populations (such as camera surveys and DNA) so that we can continue to make informed management decisions that maintain a healthy marten population.

Climate change could also influence marten, though how that will look is largely unknown. Maine's marten are already on the southern fringe of their North American range, so they could be susceptible to climate-related changes in forest composition, temperature, precipitation (snow) events, and/or shifts in competitors (Carroll 2007). Because of these unknowns, managers will need to continue monitoring climatic variables and utilizing modeling techniques for species susceptibility to help anticipate potential populations trends.

11.6 Marten Management Goals & Strategies for 2020-2030

Goal #1. Maintain healthy, abundant marten populations

- Continue to support research and monitoring to assess marten occurrence over time (e.g., camera surveys, habitat models, radio-telemetry, integrated population models, etc.). ***(Ongoing; High Priority)***
- Continue to study potential interactions and associations between marten and fisher occurrence, forest cover, fragmentation, snow, prey, and other factors. ***(Ongoing; Moderate Priority)***
- Continue research on marten habitat associations in relation to forest harvest intensities and changing timber harvest practices. ***(Ongoing; Moderate Priority)***
- Continue research to assess the amount and distribution of large suitable marten habitat patches and work with landowners to conserve these areas in ways that meet biodiversity objectives. ***(Ongoing; Moderate Priority)***
- Develop a factsheet for small and large woodlot landowners and other partners (NRCS, The Nature Conservancy, Bureau of Parks and Lands, etc.) that explains how to maintain optimal habitat conditions for marten and other wildlife ***(New; Moderate Priority)***
- Increase collaboration with partners (e.g., NOAA) to investigate and/or develop important marten climate variables that incorporate winter severity, snow depth, snow cover, etc. ***(New; Moderate Priority)***
- Explore ways to identify and monitor limiting factors for martens at the southern extent of their range, such as competition, climate, etc. ***(New; Low Priority)***
- Study and monitor the relationship between deep, persistent snow cover and marten. ***(New; Low Priority)***
- Explore the prevalence and effects of rodenticides on the marten population. ***(New; Low Priority)***
- Work cooperatively with landowners, forest certification, and/or U.S. Forest Service to collect more timber harvest data at multiple scales to help map forest conditions for marten and other wildlife in the state. ***(New; Low Priority)***

Goal #2. Maintain a sustainable marten harvest

- Continue to require registration and pelt tagging of marten to collect data on harvest town, date, and trapping method. ***(Ongoing; High Priority)***
- Continue to collect and improve biological data (age and sex) from harvested martens. ***(Ongoing; High Priority)***
- Continue to collect and monitor catch per unit effort trends of martens at multiple spatial scales (e.g., WMD, Regions). ***(Ongoing; High Priority)***
- Explore ways to incorporate harvest and biological data into a marten population model. ***(New; High Priority)***
- Evaluate and update the criteria used in the Marten Management System, such as population indices. ***(New; High Priority)***

Goal #3. Maintain marten trapping opportunities

- Review lynx exclusion device regulations and ensure building instructions are easy to follow. ***(Ongoing; High Priority)***
- Work with partners to promote next step trapping experiences, including hands-on demos for building lynx exclusion devices for marten. ***(New; High Priority)***

Goal #4. Increase public understanding of martens and marten management

- Develop outreach materials and opportunities for the public to learn more about marten distribution, behavior, ecology, and management (e.g., Maine Wildlife Park presentation). ***(New; High Priority)***
- Promote legal use of trail cameras as an opportunity to observe martens. ***(New; Moderate Priority)***
- Promote the characteristics that differentiate marten and fisher. ***(New; Moderate Priority)***

Goal #5. Minimize human-wildlife conflicts

- Continue to monitor marten conflicts and increase outreach and communications if complaint levels increase. ***(Ongoing; Low Priority)***

Goal #6. Conserve other species

- Work with partners to develop and/or promote late successional habitat and forest structure management tools that benefit martens and other wildlife species. ***(New; Moderate Priority)***
- Consider land purchases that benefit white-tailed deer wintering areas and suitable marten habitat. ***(New; Moderate Priority)***

Expected Outcomes for Marten Management

Implementing the marten management strategies outlined in this plan will require adequate staffing, funding, and public support. It may not be necessary or feasible to carry out all strategies to achieve the plan's goals and objectives.

We anticipate the following marten-related outcomes over the next 10 years (by 2030 unless otherwise noted):

We will develop appropriate marten monitoring metrics that will ensure a healthy, abundant population while allowing viewing and sustainable harvest/trapping opportunities.	By 2025, outreach and communication efforts will have increased public knowledge from 2019, when 9% of residents reported that they knew a moderate amount or great deal about martens.	Public support of regulated trapping to help manage marten populations will remain above the 2019 level of 58%.	Through outreach and promotional efforts, public awareness of martens will increase from 2019, when 10% of residents reported that they enjoyed seeing and having marten around.	Statewide marten complaints will be tracked and maintained at or below 2021 levels.

12.0

FISHER

12.0

FISHER

One of the few predators of porcupine, fishers are an interesting and important carnivore in the ecosystem. Despite their name, they do not eat fish or even swim very often, but prefer hunting snowshoe hares, squirrels, small mammals, and birds on the ground or in trees. Fishers are common, occurring in all Maine counties using a wide variety of forested habitats that provide adequate cover, prey, and denning sites.

FISHER HABITAT

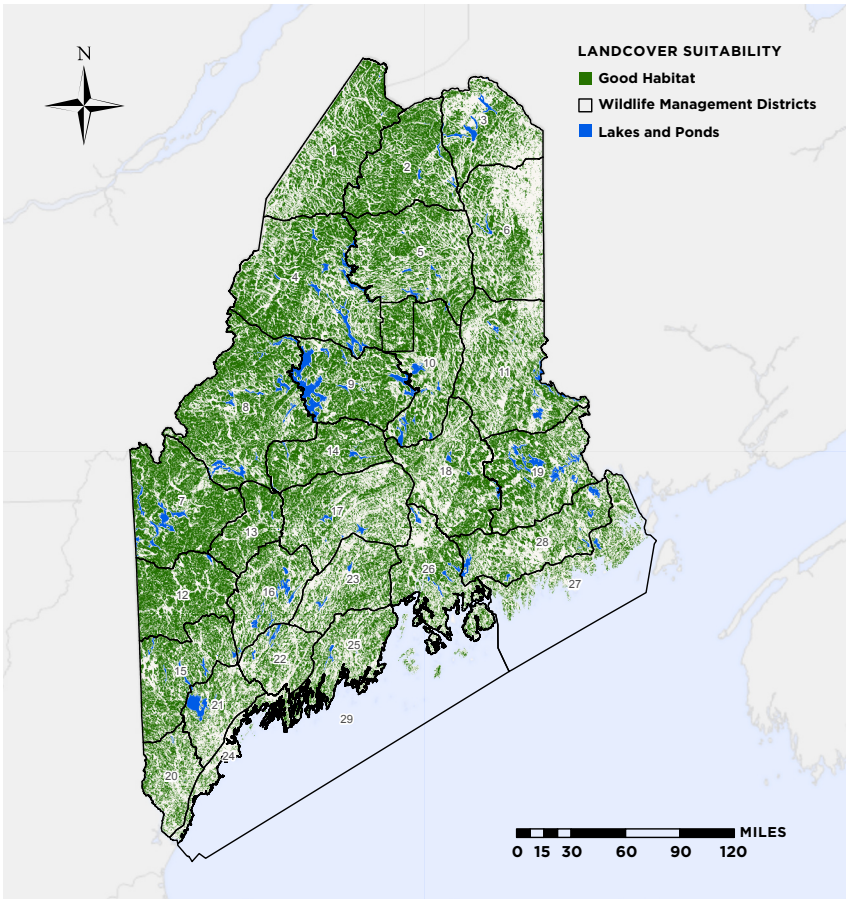


FIGURE 12.1. FISHER HABITAT SUITABILITY BASED ON BROAD FOREST COVER TYPES IN MAINE.

12.1 Natural History and Population Status

Formerly classified in the genus Martes with six species of marten, the fisher *(Pekania pennanti)* is now the only member of the genus *Pekania* (Sato et al. 2012). Fisher is an adaptation of the name fitchew or fitchet, which was given to the species by early colonists because that was the common name for the similar-looking European polecat (Powell et al 2003). In some areas, including Maine, they are called fisher cats, which may be a holdover from the historical common name of black cat. They are significantly larger than marten, but share the typical long, thin weasel body shape with stocky legs. Males are larger than females, with adult males typically ranging from eight to twelve pounds and 35-47 inches compared to four to six pounds and 30-37 inches for females (Ruggiero et al. 1994). The heaviest recorded fisher was a 20-pound male from Maine (Blanchard 1964). Fishers are covered in dark brown fur that can look black from a distance, and often have light-colored blazes on the chest and groin that are unique to each individual (Ruggiero et al. 1994).

Fishers in captivity have lived to an age of ten, but in the wild are much less likely to reach that age (Powell 1993), although an eleven-year-old fisher was recently harvested in Maine with its age being verified by reading the cementum annuli from its tooth (MDIFW, unpublished data). Fishers have few instances of disease or parasites compared to other carnivores, but can still be affected by sarcoptic mange, rabies, and canine distemper. While healthy adult fishers are not often killed by predators, sick or weakened adults may be killed by other carnivores and fishers are not immune to porcupine quill infections.

Fishers become sexually mature at two years of age and mate around late March or April, but implantation is delayed until the following February, with birth occurring around late March. Fishers are born with closed eyes and are dependent on milk for about seven weeks. They remain dependent on the adult female for food until four months old, when they begin to hunt on their own and will kill prey even without the presence of an adult. By five months, the young begin to disperse, although they may remain within the adult female's territory until the following spring (Powell 1993). Litter size at birth is between one and six kits, although a litter of more than four is extremely rare and the average is closer to three. Average litter size at time of dispersal is about two individuals (Frost and Krohn 2004). The natural sex ratio of wild populations is likely 50:50, but traditionally trapping is much more likely to remove juveniles of either sex and adult males, which can skew the sex ratio of harvested populations (Krohn et al. 1994). On average, juveniles make up around half of all known age trapped fisher in Maine, while adult females (≥ two years old) make up about 15% (2016-2020; MIDFW unpublished data).

Fishers are adept climbers, with semi-retractable claws and the ability to rotate their hind feet nearly 180°, which allows them to descend trees headfirst (Powell 1977). While their larger body size may limit their ability to travel from one tree to the next like squirrels and American marten, they prefer to rest in tree nests and cavities more than burrows and are rarely encountered resting on the ground (Arthur et al. 1989).

It is their climbing skill, especially being able to descend headfirst, that makes them especially effective at killing porcupines. Contrary to popular belief, fishers usually kill porcupines by repeatedly biting their face, not by flipping them over and attacking their abdomen (Powell 1993). While porcupines may be seen more often in the scat of fishers than that of other predators, porcupines rarely dominate a fisher's diet.

Historically, fishers spanned North America from forested areas just south of the arctic circle to mountainous areas of South Carolina, Utah, and southern California.

Fisher stalk prey by travelling in a diagonal search pattern on the ground until they intercept prey or sign and can begin to stalk/pursue. Snowshoe hare, squirrels, and other regionally available mammals such as raccoons or carrion of larger mammals often dominate a fisher's diet, though they will also kill Canada lynx (McLellan et al. 2018), marten, and other fishers. Small mammals, birds, insects, reptiles, and vegetation typically make up the rest of their diet, although some large mast crops such as apples or beech nuts may be utilized when plentiful. The generalist nature of their diet likely reduces competition with other mesocarnivores, as does their tendency not to hunt in open areas frequented by other carnivores, despite the higher likelihood of encountering prey in those spots (Arthur et al. 1989, Brown and Will 1979, McNeil et al. 2017, Powell 1993).

Historically, fishers spanned North America from forested areas just south of the arctic circle to mountainous areas of South Carolina, Utah, and southern California. This range significantly contracted northward after European settlement expanded human populations across the continent; but thanks to more recent reintroduction efforts and natural range expansion, it has slowly begun to expand southward, inhabiting some of their former range (Lewis et al. 2012).

Prior to the implementation of trapping regulations, Maine's fisher population suffered from widespread overharvest, largely due to the high value of pelts and ease of trapping. Widespread logging made matters worse by dually reducing habitat and increasing trappers' access (Powell 1993). These factors, along with other land conversion trends, eventually limited the fisher's range to the most remote portions of the Moosehead Plateau and the North Maine Woods (Coulter 1960).

In the late 1700s, fisher pelts were listed as cargo being shipped from Machias; but by the late 1800s, guidebooks noted that furbearer populations, including fisher, were so low in the Moosehead area that "trappers now say it does not pay to go after them" (Krohn and Hoving 2010). Trapping regulations and the increase in forest cover following widespread farm abandonment enabled the range to expand again statewide, although the population remains lower along the downeast coast (Coulter 1959; **Figure 12.1**).

In most of their range, except for the Pacific Northwest where they are tied to mature conifer forests, fisher can be found in most forest types except those with low cover value. Assuming they can find appropriate denning and resting sites, fisher seem to prefer the abundance of prey more than tree species composition or age. Gibilisco (1994) found that use of mixed forests was common, especially patches with around 20% hardwood and high canopy closure. Mixed forests appear ideal, with hardwood trees offering cavity nests for resting and denning, and coniferous trees making great tree nests. A blend of forest types with small forest openings nearby may be ideal for fisher, although dense conifer is important during winter in areas with deep snow that make travelling more difficult (Arthur et al. 1989, Powell 1993, Ruggiero et al. 1994).

12.2 Fisher Management History

Around 1866, Maine's first regulated trapping season for fisher was established. It ran from mid-October to the end of May (Table 12.1) and allowed for both trapping and hunting (unlike marten, which could only be trapped). In the following decades, exact season dates varied slightly, but the season generally grew shorter as relatively high fur prices incentivized fisher hunting and trapping – especially in the 1920s and '30s when pelts were valued around $100 each. By 1937, fisher were reported to be rare or absent in all but two warden districts, so the legislature closed the hunting and trapping seasons. They remained closed until 1950, when a one-month (January) season was opened with mandatory tagging. During that first year of re-opening, 124 fisher were harvested. The season was closed again for the next four years, until 1955 when a one-month (mid-Nov. to mid-Dec.) season was established, but only for the northwestern portion of the state. As fisher began to re-populate other areas of the state, the trapping seasons expanded statewide, fluctuating between one and three months, until the Department gained regulatory authority in 1972. Harvest numbers in the 1960s were strong, peaking in 1969 with the harvest of 3,524 fisher **(Figure 12.2)**. During the 1970s, the first fisher plan was implemented. The five-year plan (1975-79) set a goal to increase fisher abundance and harvest in Maine's northwestern and central areas, while also establishing fisher populations Downeast. During this first planning effort, tagging of pelts became mandatory. MDIFW also implemented actions that reduced fisher take to boost populations (e.g., prohibition of hunting, strict limit of three fisher, and the prohibition of bodygrip traps on land). In 1978, the fisher bag limit was removed; and around the same time, to help bolster the Downeast population, seven fisher were translocated to Millbridge.

From the late 1970s to late 1980s, despite high pelt values (up to $130/fisher), both the fisher harvest and the number of successful trappers (700 to 1,000 trappers caught at least one fisher) was relatively steady with some periodic fluctuations, though the fisher harvest per land trapper (the number of fisher caught by a trapper who has registered at least one other upland furbearer) varied.

The last fisher management system was drafted in 1990, and has been in effect, more or less, since then.

During the second planning period (1980-84), the goal was to maintain the previous period's harvest numbers. However, after 1987 the number of successful trappers declined by nearly half. While the overall harvest declined, it did rebound again in the 1990s along with greater fluctuation in the number of successful trappers **(Figure 12.3)**. The last fisher management system was drafted in 1990, and has been in effect, more or less, since then. From 1988 to 2000, the statewide harvest tripled from roughly 1,000 to 3,000 fishers per year.

In the early 2000s, those numbers began to decline **(Figure 12.3, 12.4)** and anecdotal concerns about canine distemper in the New Hampshire fisher population led to fears of a potential declining population in Maine. In 2007, the marten and fisher trapping season was shortened to four weeks (Nov.15-Dec 15), but record snowfall that winter could have also reduced trapper effort. At the same time, concern over the possible incidental catch of Canada lynx, a federally protected species, led the Department to adopt rules around the placement of body grip traps. In 2008, the fisher season was expanded to nine weeks with bag limit of ten, and fisher harvest seemed to rebound.

Then, in 2014, two Canada lynx were killed by accidental lethal capture. This caused MDIFW to close the trapping season early in November and conduct a review of trapping protocols. These actions were required by the Incidental Take Plan that the Department had entered into with the U.S. Fish and Wildlife Service to reduce potential take (a broad term that includes capture) of lynx. The review prompted new statewide regulations that all baited body grip traps set on land must be placed in an exclusion device. Such devices are designed to prevent lynx from accessing body-gripping traps.

As a result, the following year's fisher harvest and number of trappers targeting fisher both dropped, despite an increase in the total number of land trappers who caught at least one coyote, fox, bobcat, fisher or marten **(Figure 12.4)**. While we have seen a moderate rise since those 2015 numbers, fisher harvests are still below their 10-year average, with totals from 2015 to 2021 often equaling half of what they were from 2008 to 2014 **(Figure 12.5)**. These low harvests are likely not due to a lower fisher population, as camera studies and citizen observations indicate that fisher are still present and generally abundant statewide (Evans and Mortelliti 2022). Rather, they likely have more to do with waning fisher trapping interest due to the added burden of exclusion devices, changes in the trapping community, rising fuel prices, etc.

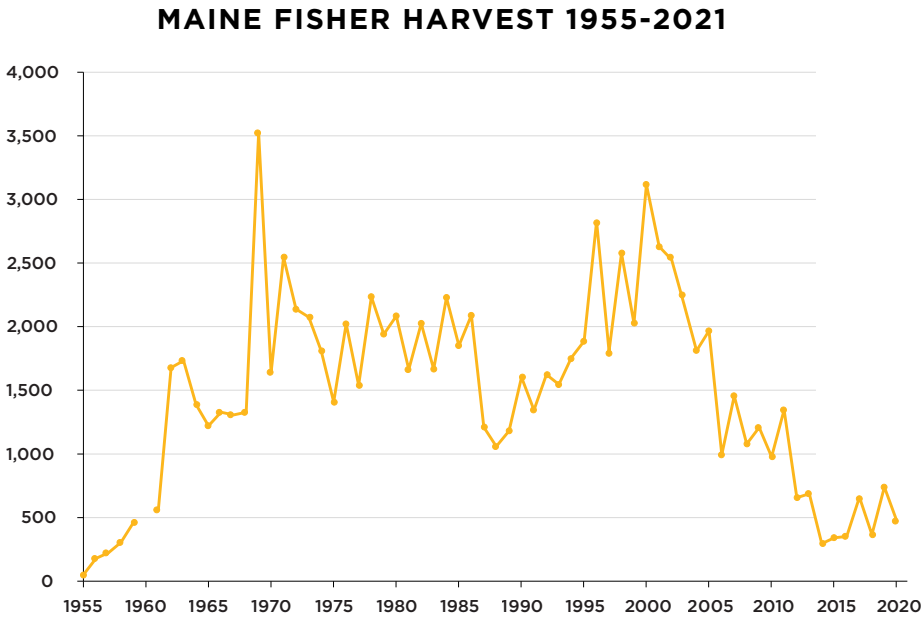


FIGURE 12.2. ANNUAL FISHER HARVESTS IN MAINE (1955-2021).

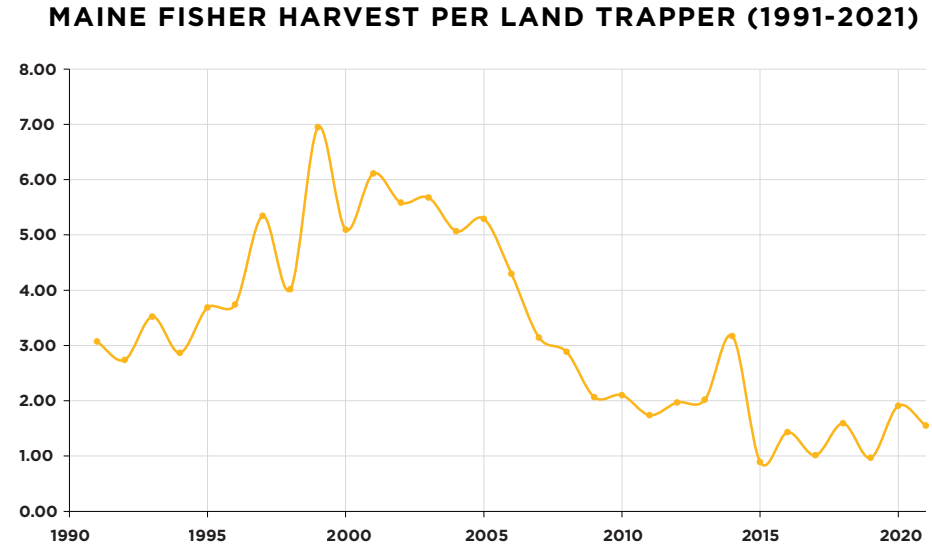


FIGURE 12.3. FISHER HARVEST PER LAND TRAPPER (TRAPPERS WHO CAUGHT AT LEAST ONE COYOTE, BOBCAT, FOX, MARTEN, OR FISHER) IN MAINE (1991-2021).

MAINE FISHER HARVEST TRENDS & IMPORTANT REGULATION CHANGES

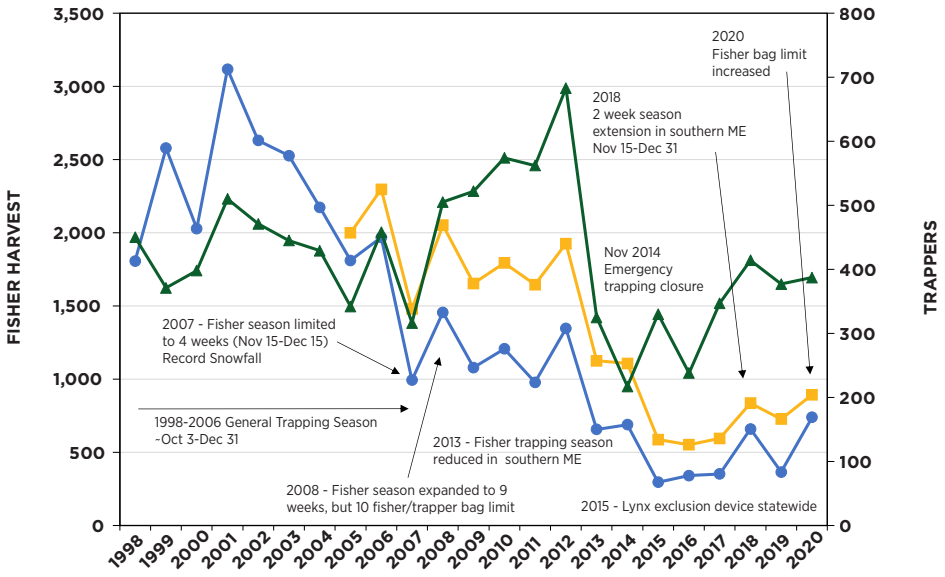


FIGURE 12.4. FISHER HARVEST TRENDS, TRAPPER SUCCESS, AND REGULATORY CHANGES OVER TIME IN MAINE (1998-2020).

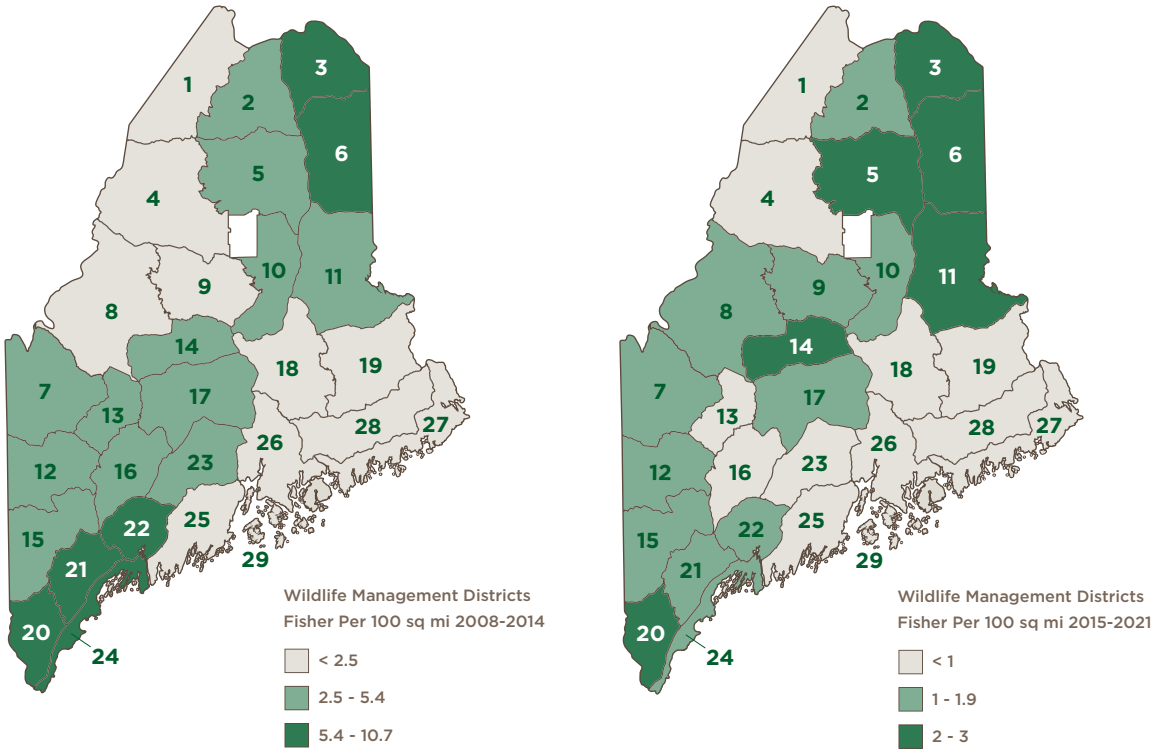


FIGURE 12.5. COMPARISON OF THE AVERAGE NUMBER OF FISHER HARVESTED IN MAINE PER 100 SQ MI BY WILDLIFE MANAGEMENT DISTRICT DURING TWO TIME PERIODS (2008-2014, LEFT AND 2015-2021, RIGHT). NOTE THAT THE LEGEND COLOR PATTERNS ARE THE SAME, BUT THE VALUES DIFFER BETWEEN THE TIME PERIODS. THERE IS NO TRAPPING IN BAXTER STATE PARK (WHITE POLYGON).

TABLE 12.1. SUMMARY OF FISHER RESEARCH AND MANAGEMENT ACTIONS (1866-2021).

YEAR	RESEARCH & MANAGEMENT ACTION
1866	Fisher trapping seasons were set, fluctuating from four to 7.5 months in length, depending on the year and/or county. Fisher hunting was allowed during open seasons.
1936	Fisher trapping season was shortened to 45 days.
1937	Fisher hunting and trapping was closed by statute due to low population.
1950	A one-month (Jan.) season was set with mandatory tagging. 124 fishers were trapped that year.
1951	Fisher hunting and trapping was closed by statute.
1955	A one-month fisher season (mid-Nov. to mid-Dec.) opened in the Northwest region only.
1957	The fisher season shifted to the month of November statewide.
1963	The fisher season expanded to three months (Nov., Jan., Feb.).
1965	The fisher season was reduced to two months (Nov., Dec.).
1971	The fisher season was reduced to one month (Nov.) with mandatory tagging.
1972	MDIFW gained regulatory authority and kept the same November season with mandatory tagging.
1976	Hunting of fishers was prohibited, trapping season was moved to Oct. 20 to Dec. 15, a bag limit of three fishers per trapper was introduced, and use of body-grip traps on land was prohibited.
1978	The fisher bag limit was removed and trapping season was altered to Oct. 20 to Nov. 25 in WMUs 1-6 and Oct. 25 to Nov. 15 in WMUs 7 and 8.
1980	Fisher were included in the general trapping season, but exact dates varied by zone (Northern, Southern, Western, Eastern, and Central) and body-grip traps had to be four feet above the ground or snow.
1984	P. Rego completed a study on factors influencing fisher harvest in south-central and southeastern Maine as part of his master's degree at the University of Maine.
1987	Fisher were included in the general trapping season without zone-specific restrictions. S. Arthur completed a five-year study on home range, habitat use, diet, and activity patterns of radio-collared fishers in south-central Maine, as part of his Ph.D. thesis at the University of Maine.

YEAR	RESEARCH & MANAGEMENT ACTION
2007	To protect lynx, leaning pole sets were required for body-grip traps in WMDs 1-11, 18, and 19. The fisher trapping season was also limited to four weeks.
2008	Fisher season was expanded to nine weeks with a 10-fisher bag limit.
2012	Lynx exclusion devices were required in WMDs 7, 14, 18, and 19.
2013	Fisher season was limited to four weeks in Southern Maine.
2014	Two Canada lynx were accidentally killed in leaning pole sets, triggering an emergency trapping season closure.
2015	New lynx exclusion devices were required statewide.
2016	A canine tooth or lower jaw was required from all tagged fisher to monitor harvest age and sex data.
2018	The Southern Maine trapping season was extended by two weeks.
2020	The temporary transportation tag requirement was dropped for marten and fisher, and the annual fisher bag limit increased to 25 per trapper.
2021	The fisher season returned to the general trapping season statewide. Drs. Evans and Mortelliti, University of Maine, completed a large-scale camera study to inform future MDIFW monitoring efforts.

SEE APPENDIX 3 FOR WMU/WMD MAP COMPARISON.

12.3 Regulatory Framework

The first fisher planning period (1975-1979) aimed to increase both the population and harvest of fisher by encouraging trapping in areas with a surplus of individuals and by establishing populations in areas with lower numbers (such as Downeast). The plan's goal of 1,000 trappers harvesting 4,000 fisher statewide was not met. This harvest goal estimated that all available habitat was fully occupied, which was probably too optimistic.

For the second planning period (1980-1984), the management goal was to maintain the actual statewide harvest and species abundance achieved from 1976-78. This translated to a harvest of 1,600 fisher spread across management units. This number was exceeded in every one of the first few years; so in 1981, the goal was increased to 1,900. The second part of the objective was to increase harvest in management units with surplus populations and decrease use in units with excessive demand. This objective was partially met. Pelt price increases and longer seasons helped to offset a decrease in license sales; and likewise, the harvest of fisher per successful fisher trapper increased during this time.

The third planning period (1985-1990) set goals to maintain the harvest and species abundance numbers in all management units at no lower than 1985 levels. In 1990, the Fisher Management System was developed using the same goals from the 1985 plan. This was the last fisher planning effort until the 2020 review. The total harvest objective for the 1990s of 3,100 individuals annually was not exceeded and was subsequently reduced in 1996 to 2,180. Also in 1996, pelt price was removed as a proxy for trapper effort, as it did not correlate with harvest levels. Additionally, there was an objective to ensure that the harvest within a management unit should not exceed 25% of the unit's potential population based on available habitat. Harvests increased in the late 1990s before starting to drop in the early 2000s. In response, MDIFW shortened the 2007 season to four weeks, and then expanded it in 2008 to nine weeks, but with a 10-fisher bag limit. Since the early 2000s, a combination of factors have kept harvest numbers far below the 1996 objective, although there have been some gains recently. Fisher harvests in the north are still nearly double those in the south.

12.4 Public Consultation – 2020 Key Findings

In our 2020 survey, members of the public had more unfavorable opinions of fisher than they did of most other furbearers, with about 25% of surveyed residents believing that fisher were either a nuisance or dangerous. Only two other species were viewed more unfavorably: coyotes (38%) and skunks (26%).

25%	9%	4%
RESIDENTS	HUNTERS	TRAPPERS

VIEW FISHER AS A NUISANCE OR DANGEROUS

These attitudes were not uniform across the state, however, with the North/East region having the highest rates of tolerant responses (18%) and the Central and South Regions having the highest rates of negative responses (34% and 20%, respectively). When asked to rank how beneficial it was to have each species in Maine, fisher ranked second to last with an average score of 5.4 out of 10. Again, this ranking varied across regions with a slightly more favorable 5.9 in the North/East compared to a 4.8 in the Central region. Interestingly, despite the unfavorable view, there are not many recorded human-wildlife conflict calls for fishers (66 out of 13,220 calls since 2020). When residents who reported having issues with wildlife in the last two years were asked which species caused the problems, only six percent reported fisher as the suspected conflict animal.

When asked how much a person knew about fishers, only 27% responded that they knew a moderate amount or a great deal. Interestingly, the Southern and Central Regions had the highest claimed knowledge of fishers (29% and 27%) compared to the North/East. Statewide, 66% of residents responded that they supported trapping as a method to manage fisher populations, while only 18% opposed it. Support for trapping fisher was highest in the North/East and Central regions and opposition was highest in the South region. These numbers align with the perception of fishers being a nuisance that needs to be controlled, despite a high percentage of respondents believing the fisher population in their area was about right (22%) or nonexistent (40%).

27%	42%	71%
RESIDENTS	HUNTERS	TRAPPERS

REPORTED TO KNOW A MODERATE AMOUNT TO A GREAT DEAL ABOUT FISHERS

Hunters and trappers were also surveyed; and not surprisingly, they reported to be much more knowledgeable. 71% of trappers and 42% of hunters said they knew a moderate amount to a great deal about fishers. Additionally, many hunters (36%) and trappers (47%) believed the fisher population level in their area was about right. Of those that felt the population wasn't on target, more felt that it was too low versus too high. Only a very small percentage of hunters (7%) or trappers (4%) felt that there were no fishers in their area. Very few hunters (9%) or trappers (4%) viewed fisher as a nuisance or dangerous. Trappers ranked fisher (8.1) as the second most beneficial species behind marten (8.2), and hunters ranked it as the fifth most beneficial species (7.1). In both cases, the average scores were much higher than the 5.9 reported by the public. Fishers continue to be desirable to trappers, and are their third most pursued furbearer (47%) behind top-ranking coyote (60%). When those who had experienced conflicts with wildlife in the past two years were asked to name the problem species, only 3% of hunters and 5% of trappers said fishers were to blame.

The difference in fisher perception between the public and hunters/trappers indicates a need for additional education and outreach regarding fisher and their role they play in a natural ecosystem. Likewise, there is an obvious need to dispel common misconceptions about this small but mighty predator.

12.5 Management Issues and Threats

As a forest dwelling species, fisher generally avoid large openings without canopy cover. However, they are not restricted to a particular Maine forest type, and can flourish in a landscape with diverse forest types and relatively small openings (<5ha), although they may need larger diameter trees for dens and resting structures (Arthur et al. 1989, Zielinski et al. 2004). Maine is ~90% forest, making us the most forested state in the country. Most land in the state is owned by private landowners, often in relatively small parcels with a wide variety of forest management regimes. This results in good quality fisher habitat over a large percentage of the state. Probably the greatest threat to fisher populations is the conversion of forest land into non-forested land uses, including urban, suburban, or ex-urban development. This is occurring more rapidly in the southern and coastal portions of the state around existing large-scale development, where increased habitat fragmentation is likely to make some areas inhospitable to fishers.

While unregulated trapping and habitat conversion contributed to past fisher population declines, modern-day trapping is highly regulated and monitored. Still, it is vital to have reliable data to enact reasonable regulations, as the species has been shown to be vulnerable to overharvest. To estimate population changes, the Department collects data from trappers through effort reports and tooth submissions. Trapper reporting compliance has been reasonable, but the downward trend in the number of trappers on the landscape could jeopardize current monitoring efforts. It is important that we develop alternative methods of estimating fisher population trends and indices, such as the use of remote cameras, hair snares, track surveys, or eDNA to name a few.

The fisher's pervasively negative public perception likely stems from publicized instances or assumptions that fisher kill domestic and feral cats, even though no study has documented cats being important in fisher diets. More effort is needed to increase knowledge and appreciation of fisher as a beneficial predator and to dispel common misconceptions.

Climate change is predicted to affect many species, and its impact on Maine's fisher populations is unknown.

Rodenticides are commonly used to reduce rodent populations around businesses and dwellings. There is increasing evidence that these chemicals are reaching other wildlife populations through the direct consumption of rodenticide baits, consumption of live and dead rodents that have consumed the baits, or possibly by other means (e.g., water sources). Recently, the Department has been involved with a study on fisher population health in the Northeast, including the prevalence of rodenticides in fisher. More than half (53%) of the 110 samples from Maine fisher tested positive for at least one rodenticide compound. Four of the 11 rodenticide compounds tested were found in the livers of Maine fisher, with Brodifacoum and Bromadiolone (second-generation anticoagulants with long half-lives) being the most common. Most of the rodenticide-positive fishers had one or two compounds, while four had a combination of three compounds and one had trace amounts of four different compounds. Twenty-six of the 46 males (57%) and 30 of the 60 females (50%) had at least one compound.

Fishers with rodenticides were detected throughout the state, including remote areas. Some towns had a mix of individuals that tested negative and positive for compounds. Still, rodenticide levels appear to be much lower in Maine than in New York, where 79% of sampled fishers tested positive for one or more rodenticide compound, and Vermont, where 90% did (S. Smith and K. Royar, personal communications). More study is necessary to better understand how wildlife are getting exposed to rodenticides, what the prevalence is in other species, and what levels are harmful to individuals or populations. Given the widespread availability of rodenticides to consumers, increased outreach is needed on integrated pest and rodent management strategies, including removal of attractants and promotion of using poison alternatives (e.g., rodent snap traps).

Climate change is predicted to affect many species, and its impact on Maine's fisher populations is unknown. Although we can expect changes in forest composition and prey species abundance under altered climate regimes, fishers in Maine are not at the southern edge of their range (unlike the marten and lynx), and can be found as far south as Virginia. In fact, reduced snow depth and persistence in northern Maine may actually favor fisher abundance, as deep snow has been shown to limit fisher mobility. MDIFW will need to continue our monitoring efforts to understand how changes in habitat, prey abundance, and competitor abundance are affecting fisher populations — all factors that will inform our species management decisions.

12.6 Fisher Management Goals and Strategies for 2020-2030

Goal 1: Maintain healthy, abundant fisher populations

- Continue to research and implement fisher population monitoring methods at multiple scales over time (e.g., camera surveys, habitat models, radio-telemetry, integrated population models, etc.). ***(Ongoing; High Priority)***
- Continue to study potential interactions and associations between marten and fisher occurrence, including forest cover, fragmentation, snow, prey, and more. ***(Ongoing; Moderate Priority)***
- Continue research on fisher habitat associations in relation to forest harvest intensity and changing timber harvest practices. ***(Ongoing; Moderate Priority)***
- Explore the prevalence and effects of rodenticides on the fisher population. ***(Ongoing; Moderate Priority)***
- Continue to explore interspecific interactions between fisher and other mesocarnivores. ***(Ongoing; Low Priority)***
- Develop factsheets for small and large woodlot landowners, NRCS, Nature Conservancy, etc. that explain how to optimize habitat conditions for the maintenance of habitat for fisher and other wildlife. ***(New; Moderate Priority)***
- Explore methods to identify and monitor limiting factors for fisher such as competition, snow, disease, etc. ***(New; Low Priority)***

Goal 2: Maintain a sustainable fisher harvest

- Continue to require registration and pelt tagging to collect fisher harvest town, date, and trapping method data. ***(Ongoing; High Priority)***
- Continue to collect, improve, and monitor biological data (age and sex) from harvested fishers. ***(Ongoing; High Priority)***
- Continue to collect and monitor catch per unit effort trends of fishers at multiple spatial scales (e.g., WMD, Regions). ***(Ongoing; High Priority)***
- Explore methods to incorporate harvest and biological data into a fisher population model. ***(New; High Priority)***
- Evaluate and update the criteria used in the Fisher Management System, such as population indices. ***(New; High Priority)***

Goal 3: Maintain fisher trapping opportunities

- Review lynx exclusion device regulations and ensure corresponding public communications/ messages are easy to follow. ***(Ongoing; High Priority)***
- Work with partners to promote next-step fisher trapping experiences, including hands-on demonstrations for building lynx exclusion devices. ***(New; High Priority)***
- During the Trapping Best Management Practices research program, encourage additional testing of foothold traps that target fishers. ***(New; Moderate Priority)***

Goal 4: Increase public understanding of fisher and fisher management

- Increase communications about fisher distribution, behavior, ecology, and management (e.g., social media posts, Maine Wildlife Park presentations). (***Ongoing; High Priority)***
- Conduct outreach to increase public understanding, appreciation, and support of fishers. ***(New; High Priority)***
- Promote legal use of trail cameras as a way to observe fishers. ***(New; Moderate Priority)***
- Promote the characteristics that differentiate marten and fisher. ***(New; Moderate Priority)***

Goal 5: Minimize human-wildlife conflicts

- Continue to monitor fisher conflicts and increase outreach and communications if complaint levels increase. ***(Ongoing; Low Priority)***

Goal 6: Conservation of other species

- Work with partners to develop and/or promote tools for management of late successional habitats and forest structures that benefit fishers and other wildlife species. (***New; Moderate Priority)***

Expected Outcomes for Fisher Management

Implementing the fisher management strategies outlined in this plan will require adequate staffing, funding, and public support. It may not be necessary or feasible to carry out all strategies to achieve the plan's goals and objectives.

We anticipate the following fisher-related outcomes over the next 10 years (by 2030 unless otherwise noted):

We will develop fisher population monitoring metrics that will ensure a healthy, abundant population while allowing sustainable trapping/harvest opportunities.

By 2025, outreach, education, and communication efforts will have increased public knowledge from 2019, when 27% of residents reported that they knew a moderate amount or great deal about fishers.

Public support for regulated trapping to help manage fisher populations will remain above the 2019 level of 66%.

Through education, outreach, and promotional efforts, we will increase public awareness of fishers from 2019, when just 8% of residents reported that they enjoy seeing and having fisher around. Residents will also rank fisher as more beneficial to Maine than they did in 2019 (mean of 5.4).

Statewide fisher complaints will be tracked and minimized below 2021 levels.

13.0

OTHER SPECIES

13.0

RACCOON, STRIPED SKUNK, VIRGINIA OPOSSUM, SHORT AND LONG-TAILED WEASEL, AND RED SQUIRREL

These species are generally well-known and easily recognized by their unique colorations, smells, and other features. Collectively, they are highly adaptable to living in diverse habitats, including in close proximity to people.

HABITAT

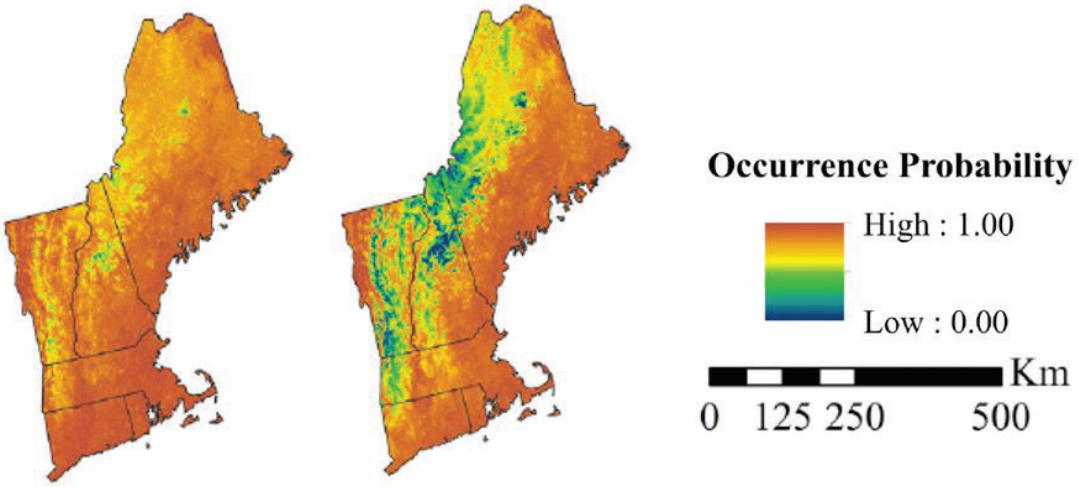


FIGURE 13.1. ESTIMATED OCCURRENCE OF RACCOON (ON LEFT) AND STRIPED SKUNK (ON RIGHT) BASED ON EXPERT OPINION (WHERE RED = HIGH PROBABILITY AND BLUE = LOW PROBABILITY OF OCCURRENCE) IN THE NORTHEASTERN UNITED STATES (PEARMAN-GILLMAN ET AL. 2020).

13.1 Natural History and Population Status

RACCOON

Maine is home to the eastern raccoon *(Procyon lotor)*, one of 22 raccoon subspecies worldwide (Wilson 2005). With its characteristic black mask and ringed tail, this iconic furbearer may be the most easily recognized wildlife species. Raccoons are excellent climbers and swimmers and are found statewide in both wooded and urban environments. While they prefer large tree cavities, raccoons also den in hollow logs, rock crevices, caves, brush piles, buildings, and abandoned woodchuck or fox dens. Raccoons are solitary, but in the winter, they have been known to den communally with other raccoons, opossums, or even skunks. Riparian areas adjacent to woodlands offer the best raccoon habitat, frequently supporting greater population densities. Due to the raccoon's adaptability, it has been very successful in finding suitable habitat conditions in urban and agricultural settings.

Though primarily nocturnal, it is not uncommon to see raccoon during the day taking advantage of a variety of food sources. A true omnivore, the raccoon's diet frequently consists of invertebrates, plants, and animals (MacClintock 1981). Amphibians and crustaceans also make up a large component of a raccoon's diet. In Maine, raccoons do not hibernate, but go into a winter rest or torpor, considerably reducing their activity as snow cover makes searching for food more difficult. A raccoon's diet shifts with the seasons: it utilizes insects, worms, eggs, and other animals in the spring, then transitions to fruits and nuts later in summer and autumn to build up much-needed fat for the winter (MacClintock 1981). In the winter, a raccoon lives off its fat reserves and may lose up to half its body weight during certain periods when it stops eating (Mech et al. 1968).

Raccoons mate during a period of increasing daylight between January and March. After roughly two months of gestation, a litter of up to six young are born in the spring. Young raccoons typically stay with their mother through their first winter.

While raccoons may live up to 20 years in captivity, their life expectancy in the wild ranges from one to three years, depending on local conditions such as traffic, hunting, trapping, disease, food availability, and weather severity (MacClintock 1981). The most frequent natural cause of death in North American raccoon populations is canine distemper, which can reach epidemic proportions and result in local population declines (Davidson and Nettles 1997). Raccoons' primary natural predators are bobcats, coyotes, and owls, the latter mainly preying on young raccoons but capable of taking adults as well (MacClintock 1981).

STRIPED SKUNK

The striped skunk *(Mephitis mephitis)* is a small omnivore whose range extends from northern Mexico throughout the continental United States and into southern Canada (Wade-Smith and Verts 1982). Throughout its range, this habitat generalist can be found in woodlands, open fields, and agricultural lands, and has also adapted to urban and suburban environments. Striped skunks are distinguished by their unique fur color pattern, consisting of a black base with a white stripe that varies in length and width, runs from head to tail, and splits across the back (Verts 1967). Skunks are perhaps best known for their distinctive smell, which is produced by two large scent glands near the anus. When threatened and to ward off predators, they can spray it up to several meters. Skunks are opportunistic feeders with a diverse diet that depends on seasonal food availability. They eat insects and small invertebrates such as beetles, grubs, and worms; small vertebrates such as mice and voles; small chicks and eggs of ground nesting birds; amphibians; reptiles; carrion; fish; and fruits, nuts, vegetables, and berries. Their sharp claws help them dig den sites and small holes (often evident in lawns) to forage for grubs and worms. Skunks are generally nocturnal and solitary, except females caring for young. They breed from February through April and females have three to 10 (five or six on average) kits (Saunders 1998). Skunks also provide an important food source to predators such as owls, eagles, bobcats, coyotes, and foxes.

Since they use such a wide variety of habitats, skunks are abundant statewide **(Figure 13.1)**, with populations previously estimated between 13,000 and 40,000 (Hunt and Blanchard 1976). Skunks are less common in the western mountains, northwest, and some areas of eastern Maine.

VIRGINIA OPOSSUM

A relative newcomer to the state of Maine and North America's only marsupial, the Virginia Opossum *(Didelphis virginiana)* is becoming more common in southern, mid-coast, and parts of central Maine but is a rare visitor to our more northern and downeast counties. The opossum is easily distinguished by its long snout with 50 teeth, naked prehensile tail (which means it can grasp onto branches), and opposable thumbs on its hind feet. Opossums prefer to inhabit riparian woodlands in rural settings but are also quite comfortable in agricultural and residential areas that provide abundant food and cover. The opossum is highly opportunistic, eating a wide variety of animal and vegetable foods. Carrion and insects are their primary diet, but fruits, berries and grains, green vegetation, earthworms, fungi, eggs, and small mammals are also important (Gardner 1982). Although opossums are good groomers, they are not tick vacuums as they are often portrayed.

A limited study of ticks placed on five captive opossums has led to misinformation that opossums are aggressive tick consumers and thus may provide a natural tick (and subsequent disease) control method. A comprehensive analysis of opossum stomach contents in Illinois and an exhaustive literature search clearly demonstrate that ticks are not a preferred diet item (Hennessey and Hild 2021).

The opossum is nocturnal and most active from dusk to dawn. During periods of extreme cold, they may exhibit some diurnal activity. They are less active in winter, and may remain inactive in their burrow for several days. In the fall, they accumulate fat which they use as an energy reserve when food is limited (Hamilton 1958). Winter food availability and winter severity are important factors that may limit range expansion (Gardner 1982).

The opossum has a unique reproductive system: the male has a forked penis and females have a divided uterus. During the mating season, the male attracts the female by making clicking sounds with his mouth. Males reach sexual maturity at about eight months of age and females don't typically breed until they are a year old (Reynolds 1952). Virginia opossums can have up to two litters per year, breeding from January-March and again from May-July. Their 12-day gestation period is short by mammal standards. Female opossum have about eight offspring (called Joeys) per litter. If she loses her first litter, the female will return to estrus and breed again. The thumbnail-sized young are born undeveloped and must climb up into their mother's pouch to nurse, not emerging again for two months.

Accurate documentation on when the Virginia opossum arrived in Maine is elusive. The species did not appear to occur in New England prior to 1900, and a description of opossum was not included in Maine's mammal or game species reports in the early 1900s (Hardy 1907, Palmer 1937, Aldous and Mendall 1941). Like eastern coyotes, opossums expanded into Maine through natural dispersal. Trapper observations indicate that the first opossum was seen in southern Maine during the 1970s. These reports correspond to when opossums were added to the list of furbearers in the summary of hunting and trapping laws, although there was no open season for opossums in the 1970s to 1980s. It wasn't until the 1990s and early 2000s that the opossum population was well established and more widely recognized by the public in the southern half of the state. Since then, opossums have continued to expand, with the northernmost observation recorded in 2021 in the town of Weston (Aroostook County).

WEASELS

Two weasel species occur in Maine: short-tailed weasels *(Mustela richardsonii)*, commonly referred to as ermine or stoat, and long-tailed weasels *(Neogale frenata)*, commonly called big stoat or masked ermine. Weasels are thin, long-bodied, terrestrial carnivores, measuring 7-14 inches (for short-tailed) or 11-22 inches (long-tailed). Males are generally larger than females, with a larger home range and the ability to consume larger prey items (Erlinge 1979, Linnell et al. 2017). Both of Maine's weasel species undergo two molts per year, changing from a brown coat with black tail tip in the summer to all-white in the winter except for the black tip on the tail.

Weasels will den around rocks or large brush piles, under barns or other structures, or in hollow logs or other animals' tunnels and cavities.

Short-tailed weasels occur in the northern United States, Canada, Europe, and Asia, while the long-tailed weasel ranges from Canada through most of the continental United States into Mexico, Central and South America. In Maine, these weasels are found statewide in open woods, meadows, edge habitats, wetlands and suburban areas, with recent research indicating that short-tailed are more common than long-tailed weasels (Evans and Mortelliti 2022). Weasels will den around rocks or large brush piles, under barns or other structures, or in hollow logs or other animals' tunnels and cavities.

While they may feed throughout the day or night, weasels are considered nocturnal hunters. They will actively hunt subnivean (under-snow) mammals such as mice or voles, navigating their prey's tunnels and even using their prey's fur and burrow space for warmth. In addition to small rodents, they will also feed on snowshoe hare, rats, chipmunks, nesting birds, insects, fruit, and berries. The weasel's long, thin body causes it to lose heat, especially in winter. Weasels compensate for this with a high metabolism — they consume 20 to 40% or more of their body weight daily (Sheffield and Thomas 1997).

Weasels breed in late spring to summer and give birth the following spring following delayed implantation of the fertilized eggs. This reproductive strategy is common in the mustelid (weasel) family and is thought to benefit weasels by delaying birth until food sources are more plentiful. Litter sizes range from one to 14 young for both species, though the average litter size is six. Because of their cryptic color pattern, speed and agility, weasels are not a common prey item of other species; but when they are, their typical predators include owls, hawks, other weasels, coyotes, and foxes (Saunders 1998).

RED SQUIRREL

Red Squirrels *(Tamiasciurus hudsonicus)*, commonly referred to as pine squirrels or chickarees, are small diurnal tree squirrels averaging 10 to 15 inches long (between the size of a chipmunk and a gray squirrel). They are easily recognized by their reddish-brown fur with white underbelly, dark lateral line across their midsection, and prominent white eye ring. Red squirrels range from Alaska to Canada's northern tree line, through the Rocky Mountains to the eastern seaboard north of Georgia. In Maine, red squirrels are found statewide and are most abundant in dense evergreen stands or mixed deciduous/ evergreen forests. They feed on spruce, fir, hemlock, pine, and deciduous tree seeds, as well as fruit, mushrooms, maple sap, tree buds, and occasionally insects.

Red squirrels are a dominant nest predator of forest nesting birds, eating both eggs and young birds (Mahon and Martin 2005, Luepold et al. 2015, Siepielski 2006). They cache and defend food for the winter in larder hoards or middens (piles), which have been known to contain over 8,500 spruce cones (Smith 1968, Goheen and Swihart 2003), and they'll spend months or even years accumulating large middens of food scrapes (from stripping cones and seeds).

Aside from females with young, red squirrels tend to be solitary animals. Both the male and female are territorial, defending non-overlapping territories (Larsen and Boutin 1994, Kemp and Keith 1970). Red squirrels are very vocal, making rattling, screeching, and chattering sounds, and growling when threatened, to deter intruders, or to defend their territory (Siracusa et al. 2017). They nest in tree cavities, underground chambers, or rock and brush piles, and typically have up to two litters (spring and summer) of three to five young per year (Saunders 1998, Kemp and Keith 1970). Red squirrels are an important prey item for many species of owls, hawks (particularly northern goshawks), and mammals including fisher, marten, ermine, bobcat, Canada lynx, fox, and coyote (Squires and Ruggiero 2007, Smithers et al 2005).

13.2. Management History

Maine has a long and complex history of management actions for this group of species, starting in 1913 when the raccoon was recognized as a furbearer and afforded protection under state law (Connolly 1986; Table 13.1). Furbearers are managed through a combination of statute set by the legislature and regulations established by the Department. Harvest regulations such as hunting and trapping season dates, bag limits, and types of traps have evolved through various iterations as the Department sought to maintain or enhance existing wildlife populations or to protect other species, such as fisher and marten (Connolly 1986).

Nationally, raccoons have historically been one of the most sought-after furbearer species, with 62% of trappers targeting them. In 2015, they ranked in the northeast region's top four targeted species (Responsive Management 2015). However, more recent surveys show that interest in raccoons has fallen. The relationship between pelt prices and trapper effort is complicated. No such data exists for Maine, but an Illinois study looked at trapper numbers relative to pelt prices in that state from 1976 to 2018. The study found that from 1976 to 1990, the number of trappers declined in response to lower pelt prices; but after 1990, the number of trappers remained stable and was not significantly affected by pelt price (Bauder 2020). Similar dynamics may exist in Maine. However, the current market for raccoon pelts is at an all-time low, and a very abundant item with low demand and high processing costs is difficult to sell at any price. Future management actions may require adjustments to reflect how changes in trapper effort and pelt demand are influencing Maine's raccoon populations.

Currently, raccoon, skunk, opossum, and red squirrel can all be trapped or hunted, while weasel can only be trapped during the general trapping season. The open season to hunt raccoons is established by the Commissioner and must be consistent across the state. A big game hunting license is required to hunt for raccoon, whereas skunk, opossum and red squirrel can be hunted with a small or big game license. Raccoon dog field trials are allowed during any time of year, but the Commissioner must be notified in advance. Hunting dogs may be trained on raccoon from July 1 through March 31. Raccoon may be hunted at night during the open season when the hunter is accompanied by a dog, uses a rifle or handgun with .22 caliber long rifle ammunition, and loads gun only when dispatching the raccoon that is identified by a light.

HARVEST TRENDS

A variety of methods have been used to estimate harvest over time, including historical reports, hunter and trapper questionnaires (1955-1976), mandatory tagging records (1977-1988), and trapper harvest reports (1990-current).

Raccoon harvests varied in the past, with anywhere from 230 to 3,284 raccoons harvested annually from 1928 to 1935 (Palmer 1937). Raccoon demand increased considerably from 1970 to 1979, when pelt values rose from $3.00 to $34.00. 1973 marked the highest annual raccoon harvest in history, at nearly 90,000 raccoons (Table 13.2). By the late 1980s, demand for raccoons dropped, resulting in a harvest of less than 1,000 racoons per year — about what it is today. In the 1970s and 1980s, the annual raccoon harvest was divided almost equally between trapping and hunting, although some years (1979-1982, specifically) hunting made up a greater proportion of the total.

Based on recent trapper harvest reports and fur auction data (2018-2021), we estimate that up to 50 opossum, 100 skunks, 200 weasels, and 300 raccoons are harvested during Maine's regulated annual trapping season.

Skunks have always held an important place in the fur industry. Demand for skunk pelts has varied, with certain color variations becoming particularly valuable from time to time. Skunk essence has been consistently important in the lure-making business. From 1928 to 1935, 5,374 skunks were taken on average each year in Maine, with a low of 2,714 and high of 10,932 (Palmer 1937). From 1955 to 1975, when pelt prices varied from $0.40 to $4.00, Maine's estimated annual skunk catch varied from 17 to 988 (Hunt 1976).

The fur trade has never differentiated the weasel species and weasel fur has never been particularly valuable. On average, 5,611 weasels were caught each year from 1928-1935 in Maine (Palmer 1937). From 1955 to 1974, when pelt prices ranged from $.40 to $1.00, trapper reports estimated the annual catch at between 293 and 1,210 (Hunt 1976).

Recent surveys conducted by Responsive Management (2020) indicate that 1% of Maine hunters and 13% of trappers pursue raccoons, 6% of hunters target squirrels (including red and gray), and few hunters target skunk and opossum. Hunters from central Maine seem more interested in hunting raccoons than hunters from southern, northern, or eastern Maine.

Based on recent trapper harvest reports and fur auction data (2018-2021), we estimate that up to 50 opossum, 100 skunks, 200 weasels, and 300 raccoons are harvested during Maine's regulated annual trapping season. Species removed due to human/wildlife conflicts are expected to far exceed those numbers. Recent regulatory changes (i.e., lynx exclusion devices) have also likely reduced the regulated raccoon harvest from trapping.

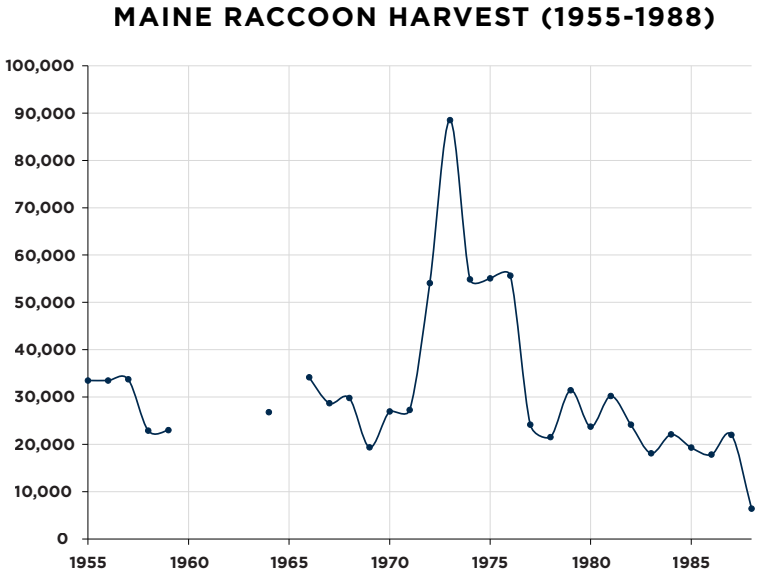


FIGURE 13.2. ESTIMATED RACCOON HARVEST (1955-1988) FROM HUNTING AND TRAPPING IN MAINE.

TABLE 13.1. SUMMARY OF SPECIES MANAGEMENT ACTIONS (1913-2015).

YEAR	RESEARCH & MANAGEMENT ACTION
1913	Raccoon is classified as a furbearer and protected by state law.
1914	Skunk is classified as a furbearer and protected by state law.
1920	There was an open season on raccoons from Aug. 15 to Feb. 28.
1925	No night hunting of wildlife is permitted, except for skunks and raccoons (all counties, Oct. 1-Feb. 28).
1930	The open season to trap or hunt furbearers was Nov. 16 to Jan. 31. Night hunting regulations were refined (must have a dog, small caliber rifle or pistol, and light; allowed from Oct. 1 to Dec. 15; in nine counties only).
1945	The open season for raccoon was Oct. 16 to Feb. 15. No more than two raccoons could be taken by one party in a night. The season bag limit was 20 raccoons/hunter.
1950	The furbearer trapping season, including raccoon, skunk, and weasel, was 2.5 months (Nov. 1 to Feb. 15). Hunting at night with dogs was allowed for raccoon (Aug. 15 to Dec. 15) and skunk (Sept. 1 to Dec. 15). The commissioner may issue an annual permit to keep captive skunk or raccoon.

YEAR	RESEARCH & MANAGEMENT ACTION
1965	The raccoon hunting season was shortened by one month (now Sept. 15 to Dec. 15).
1971	The raccoon trapping season was shortened to the month of November. Raccoon pelt values start to climb (from $3 to $30 in the 1970s).
1972	Raccoon seasons were repealed in statute and replaced by regulations.
1976	The raccoon trapping and hunting season was Oct. 20 to Dec. 15 and the skunk hunting season was Nov. 1 to Feb. 15. Maine's first Raccoon Management Plan was completed, and the Skunk and Weasel Management Plans were drafted. Some areas had a raccoon bag limit. Some raccoon-related regulations were changed to reduce the fisher harvest.
1977	Tagging of raccoons became mandatory and bag limit was removed. Weasel and opossum were added to list of furbearers and the red squirrel was considered upland game.
1978	Trapping and hunting seasons were now tied to WMUs*. The raccoon trapping (Oct. 20 to Nov. 25) and hunting (Oct. 20 to Nov. 30) seasons were approximately one month (northern zones opened a week earlier). New raccoon trapping regulations were added to protect fisher.
1980	The Raccoon Management Plan was updated. High demand for raccoon pelts continued. There was no open season for opossum and no closed hunting season for red squirrel (or woodchuck, or porcupine). Night hunting was limited to raccoons.
1984	The furbearer trapping season (including raccoon, skunk, and weasel) was approximately 1.5 months long (Oct. 28 to Dec. 4 or 15). The raccoon hunting season was also 1.5 months long (Oct. 28 to Dec. 15).
1986	The Raccoon Management Plan was revised.
1989	Raccoons taken by trapping or hunting no longer needed to be registered or tagged.
1991	The raccoon, skunk, and opossum hunting season lasted two months (Oct. 28 to Dec. 31), which was similar to the general trapping season (Nov. 3 to Dec. 31). Trappers were allowed to keep raccoon or skunk caught incidentally while coyote or fox trapping, and keep raccoon caught incidentally while muskrat trapping.
1992	The raccoon hunting season was extended to three months (Oct. 1 to Dec. 31). Red squirrel added to the list of furbearers under the general trapping season (Oct. 31 to Dec. 31).
1994	The skunk and opossum hunting season was lengthened (now Oct. 17 to Dec. 31). Opossum was added to the species that trappers could keep if caught incidentally while coyote or fox trapping.
2011	Wooden-base rat traps may now be set on land for trapping weasel and red squirrel if recessed in a wooden box with a hole no larger than two inches in diameter.
2015	Statewide, body grip killer traps of a certain size must be enclosed in lynx exclusion devices when set on dry land.

SEE APPENDIX 3 FOR WMU/WMD MAP COMPARISON.

13.3 Regulatory Framework

This group of species is abundant, with favorable habitat projections and low trapping pressure. With that in mind, management actions have been less restrictive than those of other furbearers, with past management goals mostly focused on providing harvest opportunities.

The major goal of the previous raccoon plan (1986) was to maintain the statewide population through 1990 at the 1985 level (estimated at 78,800 to 162,400 raccoons), while also allowing fluctuations among wildlife management units. The 1985 population estimate was based on a calculation of available habitat and the assumption that the raccoon population was at carrying capacity (the maximum number of individuals that an area can support).

The previous weasel and skunk plans (1976) considered alternative management goals to maintain abundance with variable use, including several harvest scenarios of varying intensity. There were no concerns that an increase in catch would be detrimental to the population, given ample habitat statewide. For skunks, it was recognized that a higher harvest intensity would be desirable to reduce human/wildlife conflicts and disease outbreaks.

13.4 Public Consultation – 2020 Key Findings

Of the 10 furbearer species, members of the general public reported that they knew the most about skunk and raccoon (Responsive Management 2020), with over half of respondents saying that they knew a great deal or moderate amount about them. In terms of which furbearers were viewed as the most beneficial, though, raccoon and skunk scored 7th and 8th of the 10, with people in the southern region viewing them as more beneficial than people from central and northeast Maine.

More than a third of Maine residents have experienced a problem with wildlife in the past two years, with the most problems reported in the northeast region. Raccoons caused most (27%) of the problems, followed by deer (19%) and skunk (19%). The proportion of respondents who viewed skunks and raccoons as dangerous or a nuisance was larger than the group that enjoyed seeing or having them around their home. The majority (53-61%) of 25+ acre landowners surveyed in each region said they had experienced conflicts with wildlife in the past two years. Landowners in the northern and eastern regions stated raccoons caused the most problems (28%) of any animal, compared to the central region where they caused 16% of the problems and the south region where they caused 15%. Skunks caused more problems with landowners in the south (16%) than central (11%) or the northeast (9%).

FURBEARERS WITH HIGHEST RATED PUBLIC SUPPORT FOR TRAPPING

68%	69%	71%
RACCOON	SKUNK	COYOTE

More of the public thought skunk and raccoon populations were too high (17% for skunk, 14% for raccoon) than too low (12% for skunk, 9% for raccoon), although the majority of the public thought their population levels were about right (55% for skunk, 53% for raccoon). More hunters (43%) and trappers (55%) in the northeast region thought raccoon populations were too high compared to hunters and trappers in the central and southern region. The majority of hunters (50-68%) and trappers (55-72%) in every region thought skunk populations were about right, as did most landowners (45-78%). Most landowners (59-68%) also thought raccoon population levels were about right.

The general public was very supportive of trapping for skunk (with 69% approving of it) and raccoon (with 68% approving). The only animal that got a higher trapping support rate was the coyote, at 71%. In general, respondents from the northeast and central regions had higher levels of support for trapping as a population management tool than respondents in the southern region did.

13.5 Management Issues & Threats

This group of species' ability to adapt to both urban and rural environments provide ample opportunity for interactions with the public throughout the state. In an urban setting, ample food and shelter can lead to high populations that are difficult to manage through regulated hunting and trapping, because of the close proximity to human development and pets. As a result, urban populations may rise to levels that increase disease transmission, leading to severe localized population fluctuations.

High populations can also lead to more conflicts and change public perception of a species from beneficial and valuable to more of a nuisance. Of all the species that members of the public call us to report conflicts with, raccoons are near the top of the list (similar to red fox). In 2021, 13% of human-wildlife conflict calls were about raccoons, while only 6% were about skunks. Raccoon, skunk, opossum, and red squirrel are attracted to free meals at bird feeders, garbage containers, compost piles, and gardens. Skunks tend to get themselves into trouble when foraging for grubs in people's lawns or interacting with dogs, while raccoons and red squirrels are great at getting into roofs, chimneys, and abandoned buildings. Female raccoons, in particular, seek out these safe den sites to whelp and raise their young during the breeding season. In agricultural settings, raccoons damage crops (especially corn) and outbuildings. Raccoons and weasels will occasionally kill poultry, and all five species will consume eggs of domestic fowl.

The best way to avoid problems with this group of species is to take preventative measures that exclude or deter them from the areas you don't want them to access, including the removal of food sources. Per state law, anyone who sets a trap must have a trapping license and to trap an animal outside of the legal trapping seasons, members of the public must have permission from the Department. This is because the trapping and relocation of wildlife by the public raises serious concerns around disease spread and proper humane trapping techniques. Alternatively, Maine citizens may hire state certified animal damage control (ADC) agents to address wildlife problems that occur throughout the year.

Raccoon, skunk, opossum, weasel, and red squirrel are important predators. However, targeted predator management is often necessary to increase nest productivity and recruitment for state-listed endangered species like piping plovers and least terns.

Many human-wildlife encounters lead to requests for wildlife rehabilitation, particularly those involving sick animals or orphaned offspring (often a result of "improper" evictions of the mother from a home or outbuilding). Maine has a limited number of wildlife rehabilitators that are often overwhelmed by the volume of incoming patients. Some rehabilitation facilities become overloaded, and small, congregated (often in-home) settings can increase the likelihood of diseases like parvovirus and distemper. In some circumstances, infected wildlife may not show symptoms at the time of release and can inadvertently spread disease on the landscape.

These five species' populations are generally considered robust in Maine; but with the potential for increased public health concerns, emerging disease issues, and human-wildlife conflicts, we still need to find ways to monitor them. Additionally, recent research suggests that weasels (of all species) may be declining across North America, but methods to detect and monitor the species occurrence and range shifts are lacking (Jachowski et al. 2021). And finally, it would be beneficial to monitor and track the opossum range expansion in Maine to ensure a viable population continues.

Because of the diverse habitats they occupy statewide, it can be challenging to estimate or survey these species' populations. The fact that their pelts are not required to be tagged further limits the Department's ability to monitor harvest trends or develop population indices based on annual harvest. That said, as trapping efforts and fur prices have declined over the years, we believe current trapping efforts are having a negligible impact, and that these species' populations are primarily influenced by disease, road kill, nuisance wildlife trapping, natural predation, and habitat.

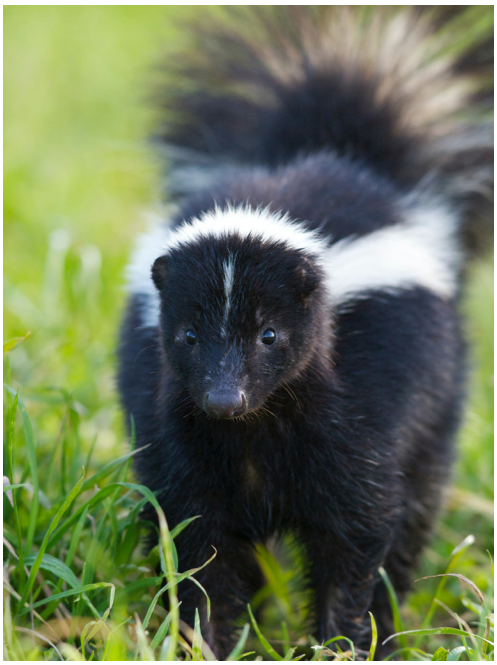
We are looking at new and innovative ways to track the status of these species, including trapper harvest reports, citizen science projects, camera surveys, roadkill surveys, rabies database, i-Naturalist, improved GIS and habitat suitability indices, and our wildlife conflict database.

IMPORTANT DISEASE CONSIDERATIONS

Raccoon & Skunk

Wildlife living in close proximity to people present important public health concerns, including zoonotic diseases (wildlife diseases that can be transmitted to people) as well as parasites and diseases that can spread to domestic pets and livestock.

Rabies is a preventable viral disease in humans, most often transmitted through the bite of an infected animal. Wild animals account for 91% of all cases in the United States, with raccoons (31%), bats (31%), and skunks (19%) representing the most frequently reported rabid wildlife species (Ma et al. 2022). In 2020, there were 4,479 reported cases of rabies in wild animals in the United States. Of the 89 cases reported from Maine, raccoons were the primary reservoir (Ma et al. 2022).



Baylisascaris procyonis, the raccoon roundworm, is a rare but serious disease that can infect birds and mammals, causing neurologic and ocular disease in humans (Davidson and Nettles 1997). Skunks carry a similar intestinal roundworm. The raccoon roundworm completes its life cycle within the raccoon and passes its eggs through the raccoon's feces, creating an opportunity for humans to accidentally ingest infective eggs from the environment (e.g., child in sandbox). Though rare, this can be extremely dangerous, as the parasite's larvae can migrate into the brain and cause sometimes-fatal neurological damage. According to the Center for Disease Control, raccoon roundworm is widespread among raccoons in the United States, appearing to be especially prevalent in the mid-Atlantic, midwest, and western coast.

Raccoons and skunks are also frequent hosts of leptospires, which cause the bacterial disease Leptospirosis (Davidson and Nettles 1997). Transmission is believed to occur in urine contaminated food, water, and soil. Exposure to these excretions can occur through an open cut or orally. Though rare, if left untreated, Leptospirosis can lead to serious illness in people.

Skunks and especially raccoons are susceptible to canine distemper. This disease is cyclical and can spread quickly, resulting in high raccoon mortality. The disease is transmitted through airborne droplets, direct contact with body fluids, saliva, or droppings, and causes respiratory distress, coughing, sneezing, runny eyes and nose, diarrhea, and neurological signs that sometimes resemble rabies (Davidson and Nettles 1997). There is no treatment for distemper and infected animals are normally euthanized. When this disease rises to epidemic levels in local populations, particularly in urban or suburban communities, it can impact pets.

Parvovirus enteritis, or raccoon parvovirus, causes diarrhea, dehydration, and depression followed by death (Davidson and Nettles 1997). Parvoviruses are hardy and can survive in feces for weeks. Transmission occurs when the feces of an infected animal is ingested by another animal (from the environment or from preying on an infected animal). There is no treatment for parvovirus, only supportive care for the animal. Mortality can be significant in raccoon populations, and we have seen periodic outbreaks of parvovirus in Maine wildlife rehabilitation facilities. This disease can also affect pets.

Virginia Opossum

Like other mammals, opossum can get and transmit the rabies virus, although it is uncommon (Davidson and Nettles 1997). However, these marsupials carry a variety of other pathogens that can impact humans, domestic animals/pets, and wildlife (Bezerra-Santos et al. 2021). They are reservoirs for a wide range of endoparasites (like *Trichinella spiralis*), ectoparasites (like ticks and fleas), and other disease-causing pathogens, and they can act as the intermediate and definitive host of *Sarcocystis neurona*, a parasite that can cause fatal neurological disease in horses. Similar to raccoon and skunk, opossums are also susceptible to Leptospirosis.

13.6 Other Species Management Goals and Strategies for 2020-2030

Goal 1: Maintain healthy, abundant populations

- Continue to research and implement methods to monitor species populations over time (e.g., camera surveys, rabies database, wildlife conflicts, trapper harvest reports, i-Naturalist, etc.). ***(Ongoing; High Priority)***
- Continue to work with partners on new research initiatives and surveillance efforts to monitor existing and emerging disease issues. ***(Ongoing; High Priority)***
- Continue to monitor the status and distribution of opossum at the northern extent of their geographic range. ***(Ongoing; Low Priority)***
- Explore the prevalence and effects of rodenticides on species populations. ***(Ongoing; Low Priority)***
- Implement camera surveys to better understand the status, distribution, and population trends for short and long tailed weasels. ***(New; High Priority)***
- Gauge public interest in a citizen science study that would gather additional wildlife species data. ***(New; Moderate Priority)***

Goal 2: Maintain sustainable harvest

- Continue to collect trapper harvest reports and monitor species catch per unit effort as a species population index. ***(Ongoing; High Priority)***
- Continue to monitor fur harvest sales from Fur Harvesters Auction as an index for species' status. ***(Ongoing; Moderate Priority)***
- Periodically survey trappers for local knowledge on the status of species populations. ***(New; Moderate Priority)***
- Research ways to estimate incidental lethal take of species aside from regulated trapping and hunting (e.g., public surveys, wildlife conflict database, wildlife rehabilitation, etc.). ***(New; Low Priority)***

Goal 3: Maintain trapping and hunting opportunities

- Use licensing data to better understand the demographics of raccoon hunters. ***(New; Moderate Priority)***
- Survey interest in trapping and/or hunting opportunities for other species. ***(New; Moderate Priority)***
- Work with partners to promote next-step trapping and hunting experiences for other species. ***(New; Moderate Priority)***
- Promote raccoon as a high-quality local protein source. ***(New; Moderate Priority)***
- Promote various uses of other species (e.g., home-tanning, lures, crafts, skulls, rendered fat). ***(New; Moderate Priority)***
- Explore existing statutes for the use of enclosed foothold traps and landowner permission to trap in built-up areas. ***(New; Low Priority)***

Goal 4: Increase public understanding of species and species management

- Increase communications about species distribution, behavior, ecology, disease, management, and myths (e.g., Maine Wildlife Park presentation). ***(Ongoing; High Priority)***
- Expand messaging on regulated trapping and hunting as management tools that address predation and/or reduce disease outbreaks. ***(Ongoing; High Priority)***
- Develop a factsheet on the regulations and considerations around trapping and releasing wildlife. ***(New; High Priority)***
- Promote the characteristics to differentiate short- and long-tailed weasels. ***(New; Moderate Priority)***
- Promote the legal use of trail cameras as a way to observe species. ***(New; Low Priority)***

Goal 5: Minimize human-wildlife conflicts

- Continue to monitor, provide technical assistance for, and respond when necessary to species conflicts. ***(Ongoing; High Priority)***
- Continue to increase human-wildlife conflict prevention outreach efforts and communications. ***(Ongoing; High Priority)***
- Continue working with partners to implement the Maine Rabies Management Guidelines. ***(Ongoing; High Priority)***
- Continue messaging on how to differentiate between normal and strange acting wildlife behavior and when to call for help. ***(Ongoing; High Priority)***
- Develop training opportunities for becoming and/or recruiting quality Animal Damage Control Agents to address human-wildlife conflicts. ***(New; High Priority)***
- Develop training opportunities for becoming and/or recruiting trained wildlife rehabilitators to address increase in demand. ***(New; High Priority)***
- Work with partners to develop and implement consistent messaging for addressing human-wildlife conflicts. ***(New; High Priority)***
- Work with partners to develop priorities and share educational resources and important considerations for wildlife rehabilitation. ***(New; High Priority)***
- Develop a factsheet outlining best practices for preventing wildlife conflicts when raising small livestock. ***(New; High Priority)***
- Develop a factsheet outlining best practices for bird feeding. ***(New; High Priority)***
- Work with partners to provide further training opportunities for wildlife professionals on safely handling rabies vector species. ***(New; High Priority)***
- Work with partners to share educational resources on preventing conflicts and provide considerations for wildlife translocation. ***(New; High Priority)***

Goal 6: Conserve other species

- Continue to work with partners to address predation of Endangered and Threatened shorebirds like piping plovers and least terns. ***(Ongoing; High Priority)***

Expected Outcomes for Raccoon, Skunk, Opossum, Weasel and Red Squirrel Management

Implementing the management strategies outlined in this plan will require adequate staffing, funding, and public support. It may not be necessary or feasible to carry out all strategies to achieve the plan's goals and objectives.

We anticipate the following outcomes over the next 10 years (by 2030 unless otherwise noted):

By 2025, outreach and communication efforts will have increased public knowledge of raccoon and skunk from 2019, when of 52% of residents reported that they knew a moderate amount or great deal about the species.

Overall public support of regulated trapping to help manage this group of species will remain above the 2019 level of 68%.

Through outreach and promotional efforts, public awareness of these species will increase from 2019 levels.

Statewide human-wildlife complaints associated with these species will be tracked and the severity of complaints will be minimized below 2021 levels.

Metrics and monitoring system for tracking disease reports throughout the state will be developed.

Appropriate metrics to monitor these species' populations will be developed, ensuring healthy, abundant populations, while allowing sustainable harvest/trapping opportunities.

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References

Acheson, J. M. 2006. Public access to privately owned land in Maine. Maine Policy Review 15(1): 18-30.

Ahlers, A. A., and E. J. Heske. 2017. Empirical evidence for declines in muskrat populations across the United States. Journal of Wildlife Management 81(8): 1408-1416.

Aldous, C. M., and H. L. Mendall. 1941. The status of big game and fur animals in Maine. Maine Coop. Wildlife Research Unit, University of Maine, Orono. 24 pp.

American Sportfishing Association, Responsive Management, Oregon Department of Fish and Wildlife, and Southwick Associates. 2013. Exploring Recent Increases in Hunting and Fishing Participation. Final Report. 168 pp.

Anderson, E. M. and M. J. Lovallo. 2003. Bobcat and Lynx. In: Feldhamer GA, Thompson BC, Chapman JA (eds) Wild mammals of North America: biology, management, and conservation, 2nd ed. Johns Hopkins University Press, Baltimore. 758–786pp.

Arthur, S.M., Krohn, W.B., Gilbert, J.R. 1989. Habitat use and diet of fishers. Journal of Wildlife Management. 53: 680-688.

Bailey, T. N. 1974. Social organization in a bobcat population. Journal of Wildlife Management. 38:435-446.

Baker, R.O. and Timm, R.M. 2017. Coyote attacks on humans, 1970-2015: implications for reducing the risks. Human–Wildlife Interactions 11(2):3.

Ballard, W. B., H. A. Whitlaw, S. J. Young, R. A. Jenkins, and G. J. Forbes. 1999. Predation and survival of white-tailed deer fawns in northcentral New Brunswick. Journal of Wildlife Management, 63(2):574-579.

Balluffi-Fry, J., Nowell, L.B. and Humphries, M.M. 2020. Eastern Coyotes (Canis latrans var.) consuming large ungulates in a multi-ungulate system. Canadian Field-Naturalist, 134(1):45-51.

Bauder, J. M., K.W. Stodola, T.J. Benson, C.A. Miller, and M.L. Allen. 2020. Raccoon pelt price and trapper harvest relationships are temporally inconsistent. Journal of Wildlife Management 84(8):1601-1610.

Benson, J.F. and Patterson, B.R. 2013. Moose (Alces alces) predation by eastern coyotes (Canis latrans) and eastern coyote× eastern wolf (Canis latrans× Canis lycaon) hybrids. Canadian Journal of Zoology 91(11):837-841.

Bezerra-Santos, M.A., R.A.N. Ramos, A.K. Campos, F. Dantas-Torres, and D. Otranto. 2021. Didelphis spp. Opossums and their parasites in the Americas: A One Health perspective. Parasitology Research 120:4091-4111.

Blanchard K. 1964. Weight of a large fisher. Journal of Mammalogy 45:487- 88.

Boutin, S., and D. E. Birkenholz. 1987. Muskrat and round-tailed muskrat. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources, Toronto, Canada, 314-325.

Bowen, W. D. 1981. Variation in coyote social organization: the influence of prey size. Canadian Journal of Zoology 59:639-652.

Bozarth, C. A., S. L. Lance, D. J. Civitello, J. L. Glenn, and J. S. E. Maldonado. 2011. Phylogeography of the gray fox (Urocyon cinereoargenteus) in the eastern United States. J. of Mammalogy 92(2): 283-294.

Bragina, E.V., Kays, R., Hody, A., Moorman, C.E., Deperno, C.S. and Mills, L.S. 2019. Effects on white-tailed deer following eastern coyote colonization. Journal of Wildlife Management, 83(4):916-924.

Breck, S.W., Poessel, S.A., Mahoney, P. and Young, J.K. 2019. The intrepid urban coyote: a comparison of bold and exploratory behavior in coyotes from urban and rural environments. Scientific reports, 9(1):1-11.

Brown, J.H. and R.C. Lasiewski. 1972. Metabolism of weasels: Cost of being long and thin. Ecology 53:939-943.

Brown, M.K., and G. Will. 1979. Food Habits of the Fisher in Northern New York. New York Fish and Game Journal. 26: 87-92.

Buie, D. E. 1980. Seasonal home range and movement patterns of the bobcat on the Savannah River Plant. M. S. Thesis, Clemson Univ., Clemson, SC. 68pp.

Buskirk, S.W. and H.J. Harlow. 1989. Body-fat dynamics of the American marten in winter. Journal of Mammalogy 70:191-193.

Buskirk, S.W. and W.J. Zielinski. 1997. American marten ecology and conservation. Pages 17-22 in J.E. Harris and C.V. Ogan, editors. Mesocarnivores of northern California: biology, management, and survey techniques workshop manual. Humboldt State University, Arcata, California, USA. The Wildlife Society, California North Coast Chapter, Arcata, California.

Carlos, A., and F. Lewis. "Fur Trade (1670-1870)". EH.Net Encyclopedia, edited by Robert Whaples. March 16, 2008. URL http://eh.net/encyclopedia/the-economic-history-of-the-fur-trade-1670-to-1870/

Caron, M. 1986. Red fox assessment. Maine Dept. of Inland Fisheries and Wildlife. Bangor, ME. 46 pp.

Carroll, C.A. 2007. Interacting effects of climate change, landscape conversion, and harvest on carnivore populations at the range margin: marten and lynx in the northern Appalachians. Conservation Biology 21:1092-1104.

Caughley, G., and A.R.E Sinclair. 1994. Wildlife Ecology and Management. Blackwell Scientific, Cambridge, Mass

Chapin, T.G. 1995. Influence of landscape pattern and forest type on use of habitat by marten in Maine. Thesis. University of Maine.

Chapin, T.G., D.J. Harrison, and D.M. Phillips. 1997. Seasonal habitat selection by marten in an untrapped forest preserve. Journal of Wildlife Management 61:707-717.

Chapin, T.G., D.J. Harrison, and D.D. Katnik. 1998. Influence of landscape pattern on habitat use by American marten in an industrial forest. Conservation Biology 12:96-227 .

Cherry, M.J., Morgan, K.E., Rutledge, B.T., Conner, L.M. and Warren, R.J. 2016. Can coyote predation risk induce reproduction suppression in white-tailed deer? Ecosphere, 7(10):e01481.

Connolly, J.M. 1986. Raccoon Assessment. Maine Dept. Inland Fisheries and Wildlife, Bangor, ME.

Coulter. 1959. Some records of marten in Maine. Maine Field Naturalist 15:50-53.

Coulter, M.W. 1959. The fisher: wanderer of the woodland. Maine Fish and Game.

Coulter, M.W. 1960. The status and distribution of fisher in Maine. Journal of Mammalogy. 41: 1-9.

Davidson, W.R., Appel, M.J., Doster, G.L., Baker, O.E. and Brown, J.F. 1992. Diseases and parasites of red foxes, gray foxes, and coyotes from commercial sources selling to fox-chasing enclosures. Journal of Wildlife Diseases 28(4):581-589.

Davidson, W. R., and V. F. Nettles. 1997. Field manual of wildlife diseases in the Southeastern United States (2nd edition). Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia, Athens, GA. 417 pp.

Davidson, W. R. 2006. Field manual of wildlife diseases in the southeastern United States, Third edition. Southeastern Cooperative Wildlife Disease Study, Department of Population Health, College of Veterinary Medicine, The University of Georgia, Athens, Georgia, USA.

Drew, G.S. and J.A. Bissonette. 1997. Winter activity patterns of American marten: rejection of the hypothesis of thermal-cost minimization. Can. J. Zoology 75(5):812-816.

Dubec, L. J., W. B. Krohn, and R. B. Owen Jr. 1990. Predicting occurrence of river otters by habitat on Mount Desert Island, ME. Journal of Wildlife Management 54: 594-599.

Eagle, T. C., and J. S. Whitman. 1987. Mink. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources, Toronto, Canada. 615–624.

Elmhagen et al. 2017. Homage to Herstein and Macdonald: climate warming and resource subsidies cause red fox range expansion and Arctic fox decline. Polar Research 36(3): 1-15.

Erb, J., and H. R. Perry Jr. 2003. Muskrats. in G. A. Feldhamer, B. C. Thompson, and J. A. Chapman (Eds.). Wild Mammals of North America: Biology, Management, and Conservation, 2nd ed. The Johns Hopkins University Press. Baltimore, Maryland, 311-348pp.

Erlinge, S. 1979. Adaptive significance of sexual dimorphism in weasels. Oikos 33: 233–245.

Evans, B.E. and A. Mortelliti. 2022. Forest disturbance and occupancy patterns of American ermine and long-tailed weasel: results from a large-scale natural experience in Maine, United States. J. of Mammalogy 103(6): 1338-1349.

Evans, B.E. and A. Mortelliti. 2022. Effects of forest disturbance, snow depth, and intraguild dynamics on American marten and fisher occupancy in Maine, USA. Ecosphere. 13:e4027.

Faber-Langendoen, D., J. Nichols, L. Master, K. Snow, A. Tomaino, R. Bittman, G. Hammerson, B. Heidel, L. Ramsay, A. Teucher, and B. Young. 2012. NatureServe Conservation Status Assessments: Methodology for Assigning Ranks. NatureServe, Arlington, VA.

Feldhamer, G. A., B. C. Thompson, and J. A. Chapman (eds). 2003. Wild Mammals of North America: Biology, Management, and Conservation, 2nd ed. The Johns Hopkins University Press. Baltimore, Maryland, 1216 pp.

Fisher, J. T., B. Anholt, S. Bradbury, M. Wheatley, and J. P. Volpe. 2013. Spatial segregation of sympatric marten and fishers: the influence of landscapes and species-scapes. Ecography 36(2): 240-248.

Fortin, D., Beyer, H.L., Boyce, M.S., Smith, D.W., Duchesne, T. and Mao, J.S. 2005. Wolves influence elk movements: behavior shapes a trophic cascade in Yellowstone National Park. Ecology, 86(5):1320-1330.

Fritzell, E. K. 1987. Gray fox and island gray fox. Edited by Novak et al. Pages 409-420 in: Wild Furbearer Management and Conservation in North America. Ontario Trappers Association. Ontario, Canada.

Frost, H., and W. Krohn. 2004. Postnatal growth and development in fishers. Pp. 253–263 in Martens and fisher (Martes) in human altered environments: an international perspective (D. J. Harrison, A. K. Fuller and G. Proulx, eds.). Springer Science+Business Media, New York.

Fryxell, J. M. 2001. Habitat suitability and source–sink dynamics of beavers. Journal of Animal Ecology 70(2): 310-316.

Fuller, A.K. 1999. Influence of selection harvesting on American marten and their primary prey in northcentral Maine. Thesis. University of Maine.

Fuller, A.K., D.J. Harrison, and H.J. Lachowski. 2004. Stand scale effects of partial harvesting and clearcutting on small mammals and forest structure. Forest Ecology Management 191: 373-386 .

Fuller, A.K. and D.J. Harrison. 2005. Influence of partial timber harvesting on American martens in north-central Maine. Journal of Wildlife Management 69:710-722.

Fuller, A.K. 2006. Multi-scalar responses of forest carnivores to habitat and spatial pattern: case studies with Canada lynx and American marten. Ph.D. dissertation. University of Maine.

Ganoe, L. S., J. D. Brown, M. J. Yabsley, M. J. Lovallo, and W. D. Walter. 2020. A review of pathogens, diseases, and contaminants of muskrats (Ondatra zibethicus) in North America. Frontiers in Veterinary Science, 7, 233.

Gardner, A.L. 1982. Virginia opossum. Pages 3-36 in J.A. Chapman and G.A. Feldhamer, eds. Wild mammals of North America. Johns Hopkins Univ. Press, Baltimore, MD. 1147pp.

Gasaway, W.C., Stephenson, R.O., Davis, J.L., Shepherd, P.E. and Burris, O.E. 1983. Interrelationships of wolves, prey, and man in interior Alaska. Wildlife Monographs 120:1-50.

Gese, E.M., Rongstad, O.J. and Mytton, W.R. 1988. Relationship between coyote group size and diet in southeastern Colorado. Journal of Wildlife Management 52(4):647-653.

Gese, E.M., Schultz, R.D., Rongstad, O.J. and Andersen, D.E. 1991. Prevalence of antibodies against canine parvovirus and canine distemper virus in wild coyotes in southeastern Colorado. Journal of Wildlife Diseases, 27(2):320-323.

Gibilisco, C.J. 1994. Distributional dynamics of American martens and fishers in North America. In: Buskirk, S.W.; Harestad, A.; Raphael, M., comps. eds. Martens, sables and fishers: biology and conservation. Ithaca, NY Cornell University Press: 59-71.

Gier, H. T., S. M. Kruckenberg, and R. J. Marler. 1978. Parasites and diseases of coyotes. pages, 37-71 in M. Bekoff, editor. Coyotes biology, behavior and Management. Academic Press, San Diego California.

Goheen, J.R. and R.K. Swihart. 2003. Food-hoarding behavior of gray squirrels and North American red squirrels in the central hardwoods region: implications for forest regeneration. Canadian Journal of Zoology, 81(9), pp.1636-1639.

Gompper, M.E. 2002. Top Carnivores in the Suburbs? Ecological and Conservation Issues Raised by Colonization of North-eastern North America by Coyotes: The expansion of the coyote's geographical range may broadly influence community structure, and rising coyote densities in the suburbs may alter how the general public views wildlife. Bioscience, 52(2):185-190.

Greenhorn, J. E., C. Sadowski, J. Holden, and J. Bowman. 2017. Coastal wetlands connected to Lake Ontario have reduced muskrat (Ondatra zibethicus) abundance. Wetlands 37(2): 339-349.

Greer, K. R. 1955. Yearly food habits of the river otter in the Thompson Lakes Region, northwestern Montana, as indicated by scat analyses. American Midland Naturalist 54: 299-313.

Gulsby, W.D., Kilgo, J.C., Vukovich, M. and Martin, J.A. 2017. Landscape heterogeneity reduces coyote predation on white-tailed deer fawns. The Journal of Wildlife Management, 81(4): 601-609.

Gustafsen, K. A. 1984. The winter metabolism and bioenergetics of the bobcat in New York. M.S. Thesis, State Univ. New York, Syracuse. 112pp.

Hamilton, W.J., Jr. 1958. Life history and economic relations of the opossum (Didelphis marsupialis virginiana) in New York State. Cornell Univ. Agric. Exp. Sta. Mem. 354:1-48.

Hardy, M. 1907. As cited in Hunt 1980.

Harlow, H.J. 1994. Trade-offs associated with size and shape of American martens. Pages 391-403 in S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York.

Harrison, D.J. 1992a. Dispersal characteristics of juvenile coyotes in Maine. Journal of Wildlife Management 56(1):128-138.

Harrison, D.J. 1992b. Social ecology of coyotes in northeastern North America: relationships to dispersal, food resources, and human exploitation. Ecology and Management of the Eastern Coyote. Wildlife Research Unit, University of New Brunswick, Fredericton, NB, Canada, pp.53-72.

Harrison, D.J., A.K. Fuller, and G. Proulx eds. 2005. Martens and fishers in human-altered environments: An international perspective. New York, NY: Springer.

Harrison, D.J., J. A. Bissonette, and J. A. Sherburne. 1989. Spatial relationships between coyotes and red foxes in eastern Maine. Journal of Wildlife Management 53(1): 181-185.

Hennessy, C. and K. Hild. 2021. Are Virginia opossums really ecological traps for ticks? Groundtruthing laboratory observations. Ticks and Tick-borne Diseases 12(5): 101780.

Henry, J. D. 2013. Red fox: the catlike canine. Smithsonian Books. 174 pp.

Hepinstall, J.A. and D.J. Harrison. 2003. Draft: final contract report to Maine Outdoor Heritage Program, Maine Cooperative Research Unit and Maine Inland Fisheries and Wildlife. 120pp.

Hildebrand, M. 1954. Comparative morphology of the body skeleton in recent Canidae. University of California Press. 469 pp.

Hilton, H. 1976. The physical characteristics, taxonomic status and food habits of the eastern coyote in Maine (Doctoral dissertation, University of Maine).

Hilton, H. 1978. Systematics and ecology of the eastern coyote. Pages 209-228 in in M. Bekoff, editor. Coyotes biology, behavior and Management. Academic Press, San Diego California.

Hilton, H. 1986. Beaver assessment. Maine Department of Inland Fisheries and Wildlife. 39pp.

Hodgdon, K. W. and J. H. Hunt. 1953. Beaver management in Maine. Maine Department of Inland Fisheries and Wildlife. Game Division Bulletin No. 3. 102 pp.

Hodgman, T.P., D.J. Harrison, D.D. Katnik, and K.D. Elowe. 1994. Survival in an intensely trapped marten population in Maine. Journal of Wildlife Management 58:593-600.

Hodgman, T.P., D.J. Harrison, D.M. Phillips, and K.D. Elowe. 1997. Survival of American marten in an untrapped forest preserve in Maine. Pages 86-99 in G. Proulx et al., editors. Martes: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Canada.

Homyack, J. A., J. H. Vashon, C. Libby, E. L. Lindquist, S. Loch, D. F. McAlpine, K. L. Pilgrim, and M. K. Schwartz. 2008. Canada lynx-bobcat (Lynx canadensis × L. rufus) hybrids at the southern periphery of lynx range in Maine, Minnesota and New Brunswick. American Midland Naturalist 159(2): 504–508.

Hunt, J. 1980. Bobcat Management Plan. Pages in Planning for Maine's Inland Fish and Wildlife, Vol. IV, Upland Furbearers. Maine Dept. of Inland Fisheries and Wildlife, Augusta.

Hunt, J.H. 1976. Draft Skunk Management Plan. Maine Dept. Inland Fisheries and Wildlife.

Hunt, J. H. 1986a. Mink Assessment. Maine Department of Inland Fisheries and Wildlife. 36 pp.

Hunt, J. H. 1986b. Muskrat assessment. Maine Department of Inland Fisheries and Wildlife. 29pp.

Hunt, J.H. and H. Blanchard. 1976. Draft Weasel Management Plan. Maine Dept. Inland Fisheries and Wildlife.

Hunt, J.H. and H. Hilton. 1980. Raccoon Management Plan. Pages 460-478 in Planning for Maine's Inland fish and wildlife. Volume 1, Part 1. Maine Dept. Inland Fish and Wildlife, Augusta.

Hunter, M.D. and Price, P.W. 1992. Playing chutes and ladders: heterogeneity and the relative roles of bottom-up and top-down forces in natural communities. Ecology 73(3): 724-732.

Hunter, P. R., and Thompson. R. A. 2005. The zoonotic transmission of Giardia and Cryptosporidium. International journal for parasitology 35(11-12):1181-1190.

Hurley, F.B. and J.H. Hunt. 1975. Raccoon Management Plan. In Planning for Maine's Fish and Wildlife Resources. Volume IV: Upland Furbearers. Maine Dept. Inland Fish and Wildlife, Augusta.

Ingle, M.A. 1990. Ecology of red foxes and gray foxes and spatial relationships with coyotes in an agricultural region of Vermont (Doctoral dissertation, University of Vermont).

Jachowski, D., R. Kays, A. Butler, A.M. Hoylman, and M.E. Gompper. 2021. Tracking the decline of weasels in North America. PLoS ONE 16(7):e0254387.

Jensen, P.G., C.L. Demers, S.A. McNulty, W.J. Jakubas, and M.M. Humphries. 2012. Marten and fisher responses to fluctuations in prey populations and mast crops in northern hardwood forest. Journal of Wildlife Management 76:489-502.

Jensen, P.G. and M.M. Humphries. 2019. Abiotic conditions mediate intraguild interactions between mammalian carnivores. Journal of Animal Ecology 88:1305-1318.

Johnson, R.H. 1937. Life history and management studies of raccoons in Maine. M.S. Thesis, Univ. of Maine, Orono. 70 pp.

Kamler, J. and W. Ballard. 2002. A review of native and nonnative red foxes in North America. Wildlife Society Bulletin 30(2): 370-379.

Katnik, D.D., D.J. Harrison, and T.P. Hodgman. 1994. Spatial relations in a harvested population of marten in Maine. Journal of Wildlife Management 58:600-607.

Katnik, D.D. 1992. Spatial use, territoriality, and summer-autumn selection of habitat in an intensely harvested population of martens on commercial forestland in Maine. Thesis. University of Maine.

Kemp, G.A., and L.B. Keith. 1970. Dynamics and regulation of red squirrel (Tamiasciurus hudsonicus) populations. Ecology, 51(5), 763-779.

Kilgo, J.C., Ray, H.S., Ruth, C. and Miller, K.V. 2010. Can coyotes affect deer populations in southeastern North America? Journal of Wildlife Management, 74(5):929-933.

Krohn, W.B., and C.L. Hoving. 2010. Early Maine Wildlife: Historical Accounts of Canada Lynx, Moose, Mountain Lion, White-tailed Deer, Wolverine, Wolves, and Woodland Caribou, 1603-1930. University of Maine Press.

Krohn, W.B., K.D. Elowe, and R.B. Boone. 1995. Relations among fishers, snow, and martens: development and evaluation of two hypothesis. The Forest Chronicle 71:97-105.

Krohn, W.B., S.M. Arthur, and T.F. Paragi. 1994. Mortality and vulnerability of a heavily trapped fisher population. Pages 137–145 in S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Lachowski, H.J. 1997. Relationships among prey abundance, habitat, and American marten in northern Maine. Thesis. University of Maine.

Larsen, K.W. and S. Boutin. 1994. Movements, survival, and settlement of red squirrel (Tamiasciurus hudsonicus) offspring. Ecology, 75(1), pp.214-223.

Lavigne, G. 1995. A study of eastern coyotes and their impact on white-tailed deer in Maine. A report to the 117th Legislature Pursuant told 793 12 MRSA. December 1995. 23 pp.

Lavigne, G. R. 1992. Sex/age composition and physical condition of deer killed by coyotes during winter in Maine. Pages 141 to 149 In: Boer, A. H., ed. Ecology and Management of the Eastern Coyote. Wildlife Research Unit, Univ. of New Brunswick, Fredericton, N.B., Canada.

Lavin, S.R., Van Deelen, T.R., Brown, P.W., Warner, R.E. and Ambrose, S.H. 2003. Prey use by red foxes (Vulpes vulpes) in urban and rural areas of Illinois. Canadian Journal of Zoology 81 (6):1070-1082.

Lavoie, M., P. Y. Collin, F. Lemieux, H. Jolicoeur, P. Canac-Marquis, and S. Larivière. 2008. Understanding fluctuations in bobcat harvest at the northern limit of their range. Journal of Wildlife Management 73(6): 870–875.

Lawrence, W. H. 1952. Evidence of the age of beaver ponds. Journal of Wildlife Management 16(1): 69-79.

LeBlanc, F.A., D. Gallant, L. Vasseur, and L. Léger. 2007. Unequal summer use of beaver ponds by river otters: influence of beaver activity, pond size, and vegetation cover. Canadian Journal of Zoology, 85(7): 774-782.

Lewis, J.C., R.A. Powell, and W.J. Zielinski. 2012. Carnivore Translocations and Conservation: Insights from Population Models and Field Data for Fishers (Martes pennanti). PLOS ONE 7(3): e32726. https://doi.org/10.1371/journal.pone.0032726

Linnell, M.A., C.W. Epps, E.D. Forsman, and W.J. Zielinski. 2017. Space use, movements, and rest site use by short-tailed weasels Mustela erminea in managed forests of western Oregon. Wildlife Biology 2017(1).

Little, S.E., Davidson, W.R., Howerth, E.W., Rakich, P.M. and Nettles, V.F. 1998. Diseases diagnosed in red foxes from the southeastern United States. Journal of wildlife diseases 34(3):620-624.

Litvaitis, J. A., J. A. Sherburne, M. O'Donoghue, and D. May. 1982. Cannibalism by a free-ranging bobcat, Felis rufus. Canadian Field-Naturalist 96(4): 476-477.

Litvaitis, J. A. 1984. Bobcat movements in relation to prey density. Ph.D. Thesis. University of Maine, Orono. 103pp.

Litvaitis, J. A., A. G. Clark, and J. H. Hunt. 1986. Prey selection and fat deposits of bobcats (Felis rufus) during autumn and winter in Maine. Journal of Mammalogy 67(2): 389–392.

Litvaitis, J. A., J. T. Major, and J. A. Sherburne. 1987. Influence of season and human-induced mortality on spatial organization of bobcats (Felis rufus) in Maine. Journal of Mammalogy 68:100–106.

Litvaitis, J. A. and D. J. Harrison. 1989. Bobcat–coyote niche relationships during a period of coyote population increase. Canadian Journal of Zoology 67(5): 1180–1188.

Litvaitis, J. A., J. P. Tash, and C. L. Stevens. 2006. The rise and fall of bobcat populations in New Hampshire: relevance of historical harvests to understanding current patterns of abundance and distribution. Biological Conservation 128: 517–528.

Luepold, S.H.B., Hodgman, T. P., McNulty, S. A., Cohen, J., Foss, C. R., 2015. Habitat selection, nest survival, and nest predators of Rusty Blackbirds in northern New England, USA. The Condor 117(4):609-623.

Ma, X. et al. 2022. Rabies surveillance in the United States during 2020. J. American Veterinary Medical Association 260(10):1157-1165.

MacClintock, D. 1981. A Natural History of Raccoons. Caldwell, New Jersey: Blackburn Press.

Mahon, L.C., Martin, K., 2006. Nest Survival of Chickadees in Managed Forests: Habitat, Predator, and Year Effects. Journal of Wildlife Management 70(5): 1257-1265.

Maine Climate Council Scientific and Technical Subcommittee (MCC STS). 2020. Scientific assessment of climate change and its effects in Maine. A report by the scientific and technical subcommittee of the Maine Climate Council. Augusta, Maine. 369 pp.

Maine Dept. Inland Fisheries and Wildlife (MDIFW). 1984. Annual Performance Report Appendix. Small Game-Furbearer Project, Jobs 106 and 129, W-69-R-15.

Major, J. T. 1983. Ecology and interspecific relationships of coyotes, bobcats and red foxes in western Maine. Ph.D. Thesis. University of Maine, Orono. 64pp.

Major, J.T. and Sherburne, J.A. 1987. Interspecific relationships of coyotes, bobcats, and red foxes in western Maine. Journal of Wildlife Management 51(3):606-616.

Manley, H., and W. B. Krohn. 2005. Manly Hardy (1832-1910): The Life and Writing of a Maine Fur-buyer, Hunter, and Naturalist. Maine Folklife Center.

Manville, R. H. 1966. The extinct sea mink, with taxonomic notes. Proceedings of the United States National Museum.

Marrotte, R. R., J. Bowman, and S. J. Morin. 2020. Spatial segregation and habitat partitioning of bobcat and Canada lynx. FACETS 5: 503–522.

Masters, H. M. 2020. Using stable isotopes and diet analysis to assess the potential for competition and coexistence among coyotes (Canis latrans), red foxes (Vulpes vulpes), and gray foxes (Urocyon cinereoargenteus) in Maine. Masters thesis, Univ. of Southern Maine, Portland. 60 pp.

May, D. W. 1981. Habitat utilization by bobcats in eastern Maine. M.S. Thesis, University of Maine, Orono, Maine. 36pp.

McAlpine, D. F., J. Cormier, and I. G. MacLean. 2016. Second report of the Gray Fox, Urocyon cinereoargenteus, in New Brunswick. Canadian Field-Naturalist 130(2): 164–166.

McCaskill, G. L., T. Albright, C. J. Barnett, B. J. Butler, S. J. Crocker, C. M. Kurtz, W. H. McWilliams, P. D. Miles, R. S. Morin, M. D. Nelson, R. H. Widmann, and C. W. Woodall. 2016. Maine Forests 2013. Resource Bulletin. NRS-103. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 103 pp.

McCord, C. M., and J. E. Cardoza. 1982. Bobcat and lynx. Pages 728-766 In J. A. Chapman and G. A. Feldhamer (eds). Wild Mammals of North America. John Hopkins Univ. Press, Baltimore, MD.

McLellan, S. R., J. H. Vashon, E. L. Johnson, S. M. Crowley, and A. D. Vashon. 2018. Fisher predation on Canada lynx in the northeastern United States. Journal of Wildlife Management 82: 1775–1783.

McNeil, D.J., C.A. Nicks, J.C. Wester, and J.L. Larkin. 2017. Diets of Fishers (Pekania pennanti) and Evidence of Intraspecific Consumption in Pennsylvania. The American Midland Naturalist, 177(2), 200-210.

Mead, J. I., A. E. Spiess, and K. D. Sobolik. 2000. Skeleton of extinct North American sea mink (Mustela macrodon). Quaternary Research 53(2): 247-262.

Mech, D.M., D.M. Barnes, and J.R. Tester. 1968. Seasonal Weight Changes, Mortality, and Population Structure of Raccoons in Minnesota. J. Mammalogy 49(1): 63–73.

Melquist, W. E., and M. G. Hornocker. 1983. Ecology of river otters in west central Idaho. Wildlife Monographs 83: 1-60.

Melquist, W. E., P. J. Polechla Jr., and D. Toweill. 2003. River otters. Pages 708-734 in G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, editors. Wild mammals of North America: biology, management, and conservation. Second Edition. The John Hopkins University Press, Baltimore, Maryland.

Messier, F., Barrette, C. and Huot, J. 1986. Coyote predation on a white-tailed deer population in southern Quebec. Canadian Journal of Zoology, 64(5):1134-1136.

Moll, R. J., J. D. Cepek, P. D. Lorch, P. M. Dennis, T. Robison, J. J. Millspaugh, and R. A. Montgomery. 2018. Humans and urban development mediate the sympatry of competing carnivores. Urban Ecosystems 21(4): 765-778

Morris, K. I. 1986. Bobcat Assessment. Maine Department of Inland Fisheries and Wildlife, Bangor, ME. 43 pp.

Niedzielski, B. and Bowman, J. 2015. Survival and cause-specific mortality of the female eastern wild turkey at its northern range edge. Wildlife Research, 41(7): 545-551.

Northeast Furbearer Resources Technical Committee. 2015. Trapping and furbearer management in North American Wildlife Conservation (2nd edition).

Obbard, M. 1987. Fur grading and pelt identification. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources, Toronto, Canada, 717-826.

Ozoga, J.J. and Harger, E.M. 1966. Winter activities and feeding habits of northern Michigan coyotes. Journal of wildlife management 30(4):809-818.

Palmer, R. S. 1937. Mammals of Maine. Thesis. University of Maine. 181 pp.

Parker, G.R. 1995. Eastern coyote: the story of its success. Nimbus Publishing, Halifax, N.S. 254pp.

Paquet, P.C. 1992. Prey use strategies of sympatric wolves and coyotes in Riding Mountain National Park, Manitoba. Journal of Mammalogy, 73(2): 337-343.

Patterson, B.R., Benjamin, L.K. and Messier, F. 1998. Prey switching and feeding habits of eastern coyotes in relation to snowshoe hare and white-tailed deer densities. Canadian Journal of Zoology, 76(10):1885-1897.

Payer, D.C. 1999. Influences of timber harvesting and trapping on habitat selection and demography of marten. Ph.D. dissertation. University of Maine.

Payer, D.C. and D.J. Harrison. 2003. Influence of forest structure on habitat use by American marten in an industrial forest. Forest Ecology and Management 179:145-156.

Pearman-Gillman, S.B., J.E. Katz, R.M. Mickey, J.D. Murdoch, and T.M. Donovan. 2020. Predicting wildlife distribution patterns in New England, USA with expert elicitation techniques. Global Ecology and Conservation 21:e00853.

Pekins, P.J. and Tarr, M.D. 2008. A critical analysis of the winter ecology of white-tailed deer and management of spruce-fir deer wintering areas with reference to northern Maine. Final report to the Cooperative Forestry Research Unit, University of Maine, Orono, Maine. RR-08-02. 154 pp.

Petraborg, W. H., and V. E. Gunvalson. 1962. Observations on bobcat mortality and predation on deer. Journal of Mammalogy 43: 430–431.

Phillips, D.M. 1994. Social and spatial characteristics, and dispersal of marten in a forest preserve and industrial forest. Thesis. University of Maine.

Powell, R.A. 1977. Hunting behavior, ecological energetics and predator-prey community stability of the fisher (Martes pennanti). Chicago, IL: University of Chicago. Ph.D. thesis. 132 p.

Powell, R. A. 1993. The fisher: life history, ecology, and behavior. Second edition. University of Minnesota Press, Minneapolis, USA.

Powell, Roger A.; Buskirk, Steven W.; Zielinski, William J. 2003. Fisher and marten. Wild Mammals of North America: Biology, Management, and Conservation, p. 635-649.

Powell, S. M., E. C. York, J. J. Scanlon, and T. K. Fuller. 1997. Fisher maternal den sites in central New England. Pp. 265–278 in Martes: taxonomy, ecology, techniques, and management (G. Proulx, H. N. Bryant and P. M. Woodward, eds.). Provincial Museum of Alberta, Edmonton, Alberta, Canada.

Prins, H. E., and B. McBride. 2007. Asticou's Island Domain: Wabanaki Peoples at Mount Desert Island, 1500-2000. Northeast Region Ethnography Program, National Park Service.

Raesly, E. J. 2001. Progress and status of river otter reintroduction projects in the United States. Wildlife Society Bulletin 29: 856-862.

Responsive Management. 2015. Maine residents' and outdoor recreationists' attitudes toward wildlife management and participation in wildlife-related recreation. Responsive Management Report, Harrisonburg, VA. 466 pp.

Responsive Management. 2015. Trap use, furbearers trapped, and trapper characteristics in the United States in 2015. Responsive Management Report, Harrisonburg, VA. 268 pp.

Responsive Management. 2016. The opinions of Maine residents, landowners, and hunters regarding deer, moose, bear, and turkey. Responsive Management Report, Harrisonburg, VA. 543 pp.

Responsive Management. 2020. The human dimensions of furbearer management in Maine. Responsive Management Report, Harrisonburg, VA. 535 pp.

Reynolds, H.C. 1952. Studies on reproduction in the opossum (Didelphis virginiana virginiana). Univ. Calif. Publ. Zool. 52:223-284.

Richens, V.B. and Hugie, R.D. 1974. Distribution, taxonomic status, and characteristics of coyotes in Maine. Journal of Wildlife Management 38(3): 447-454.

Roberts, N. M., and S. M. Crimmins. 2010. Bobcat population status and management in North America: evidence of large-scale population increase. Journal of Fish and Wildlife Management 1(2):169–174.

Robinson, L. 2006. Ecological relationships among partial harvesting, vegetation, snowshoe hares, and Canada lynx in Maine. Thesis, University of Maine, Orono. 184 pp.

Ruggiero, Leonard F.; Aubry, Keith B.; Buskirk, Steven W.; Lyon, L. Jack; Zielinski, William J. 1994. The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. Gen. Tech. Rep. RM-GTR-254. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 184 p.

Sato, J.J., M. Wolsan, F.J. Prevosti, G. D'Elia, C. Begg, K. Begg, T. Hosada, K.L. Campbell, and H.Suzuki. 2012. Evolutionary and biogeographic history of weasel-like carnivorans (Musteloidea). Molecular Phylogenetics and Evolution 63:745–757.

Saunders, D. A. 1988. Adirondack Mammals. State University of New York, College of Environmental Science and Forestry. 216 pp.

Sealfon, R. A. 2007. Dental divergence supports species status of the extinct sea mink (Carnivora: Mustelidae: Neovison macrodon). Journal of Mammalogy 88(2): 371-383.

Seton, E. T. 1913. Wild animals at home. Doubleday, Page & Company. Garden City. 226 pp.

Sheffield, S. R. and H.H. Thomas. 1997. Mustela frenata. Mammalian Species 570:1–9.

Sherburne, J. A., and G. L. Matula, Jr. 1981. Predator habitat utilization studies. Dickey-Lincoln School Lakes Project. Unpubl. Rept. 67pp.

Sherburne, S.S. and J.A. Bissonette. 1994. Marten subnivean access point use: response to subnivean prey levels. Journal of Wildlife Management 62:663-673.

Siepielski, A.M. 2006. A Possible Role for Red Squirrels in Structuring Breeding Bird Communities in Lodgepole Pine Forests. The Condor 108(1), 232-238.

Simons, E.M. 2009. Influences of past and future forest management on spatiotemporal dynamics of habitat supply for Canada lynx and American martens in Northern Maine. Ph.D. dissertation. University of Maine.

Simons-Legaard, E., D. Harrison, J. Hepinstall-Cymerman, and D. Payer. 2022. Sex-biased habitat selection by American marten in the Acadian Forest. Landscape Ecology 37: 2803-2817.

Siracusa, E., Morandini, M., Boutin, S., Humphries, M.M., Dantzer, B., Lane, J.E. and McAdam, A.G., 2017. Red squirrel territorial vocalizations deter intrusions by conspecific rivals. Behaviour 154(13-15):1259-1273.

Sirén, A.P.K., C.S. Sutherland, C.A. Bernier, K.J. Royar, J.R. Kilborn, C.B. Callahan, R.M. Cliché, L.S. Prout, and T.L. Morelli. 2021. Abiotic stress and biotic factors mediate range dynamics on opposing edges. J Biogeogr. 48: 1758-1772.

Smith, M.C. 1968. Red squirrel responses to spruce cone failure in interior Alaska. Journal of Wildlife Management 32(2): 305-317.

Smithers, B.L., Boal, C.W. and Andersen, D.A. 2005. Northern Goshawk diet in Minnesota: an analysis using video recording systems. Journal of Raptor Research 39(3): 264-273.

Soutiere, E.C. 1979. Effects of timber harvesting on marten in Maine. Journal of Wildlife Management 43:850-860.

Squires, J.R. and Ruggiero, L.F. 2007. Winter prey selection of Canada lynx in northwestern Montana. Journal of wildlife management 71(2):310-315.

Stearns, C. R., and T. L. Serfass. 2011. Food habits and fish prey size selection of a newly colonizing population of river otters (Lontra canadensis) in eastern North Dakota. 2011. American Midland Naturalist 165: 169-184.

Stevens, S. S., E. H. Just, R. C. Cordes, R. P. Brooks, and T. L. Serfass. 2011. The influence of habitat quality on the detection of river otter (Lontra canadensis) latrines near bridges. The American Midland Naturalist 166(2): 435-445.

Steventon, J.D. and J.T Major. 1982. Marten use of habitat in commercially clear-cut forest. Journal of Wildlife Management 46(1): 175-182.

Southwick Associates. 2014. Hunting in Maine in 2013: a statewide and regional analysis of participation and economic contributions. Report Maine Office of Tourism and Maine Department of Inland Fisheries and Wildlife. 53pp.

Theberge, J.B. and Wedeles, C.H. 1989. Prey selection and habitat partitioning in sympatric coyote and red fox populations, southwest Yukon. Canadian Journal of Zoology, 67(5):1285-1290.

U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

U.S. Department of Transportation Federal Highway Administration (USDOT). Office of Highway Policy Information. Highway Statistics Series. Functional System Lane-Length – 2017. Released August 23, 2018.

Vashon, J. H., A. L. Meehan, J. F. Organ, W. J. Jakubas, C. R. McLaughlin, A. Vashon, and S. M. Crowley. 2008. Diurnal habitat relationships of Canada lynx in an intensively managed private forest landscape in northern Maine. Journal of Wildlife Management 72(7): 1488–1496.

Verts, B.J. 1967. The biology of the striped skunk. University of Illinois Press, Urbana, 218 pp.

Viljugrein, H., O. Lingjaerde, N. Stenseth, and M. S. Boyce. 2001. Spatio-temporal patterns of mink and muskrat in Canada during a quarter century. Journal of Animal Ecology 70: 671-682.

Voigt, D.R. and Earle, B.D. 1983. Avoidance of coyotes by red fox families. Journal of Wildlife Management, 47(3): 852-857.

Voipio, P. 1990. The samson fox episode in Finland in the 1930s and 1940s, and the hypothetico-deductive method. Ann. Zool. Fennici 27: 21-27.

Wade-Smith, J., B. Verts. 1982. Mephitis. Mammalian Species, 173: 1-7.

Ward, E. M., and S. M. Gorelick. 2018. Drying drives decline in muskrat population in the Peace-Athabasca Delta, Canada. Environmental Research Letters 13(12): 124026.

Warsen, S.A. 2012. Evolving niche of coyotes in the Adirondack Mountains of New York: Long-term dietary trends and interspecific competition. State University of New York College of Environmental Science and Forestry.

White, H. B., G. R. Batcheller, E. K. Boggess, C. L. Brown, J. W. Butfiloski, T. A. Decker, J. D. Erb, M. W. Fall, D. A. Hamilton, T. I. Hiller, G. F. Hubert Jr., M. J. Lovallo, J. F. Olson, and N. M. Roberts. 2020. Best management practices for trapping furbearers in the United States. Wildlife Monographs 207: 3-59.

White, L.A. and Gehrt, S.D. 2009. Coyote attacks on humans in the United States and Canada. Human Dimensions of Wildlife, 14(6): 419-432.

Wilson, D.E. and Reeder, D.M., eds. 2005. Mammal Species of the World: A Taxonomic and Geographic Reference (3rd ed.). Johns Hopkins University Press.

Wilson, P. J., W. J. Jakubas, and S. Mullen. 2004. Genetic status and morphological characteristics of Maine coyotes as related to neighboring coyote and wolf populations. Final report to the Maine Outdoor Heritage Fund Board, Grant #011-3-7. Maine Department of Inland Fisheries and Wildlife, Bangor, 58pp.

Woolard, T. 2021. Cumulative effects of habitat change: American marten habitat selection and 30 years of forest harvesting in Maine. Thesis. University of Maine.

Wynn, K.M. and J.A. Sherburne. 1984. Summer home range use by adult marten in northwestern Maine. Can. J. Zoology 62(5):941-943.

Yates, D. E., D. T. Mayack, K. Munney, D. C. Evers, A. Major, T. Kaur, and R. J. Taylor. 2005. Mercury levels in mink (Mustela vison) and river otter (Lontra canadensis) from northeastern North America. Ecotoxicology 14(1-2): 263-274.

Zielinski, W.J., R.L. Truex, G.A. Schmidt, F.V. Schlexer, K.N. Schmidt, and R.H. Barrett. 2004. Home Range Characteristics of Fishers in California. Journal of Mammalogy. 85: 649–657.

APPENDIX I

Furbearer Plan Steering Committee

STEERING COMMITTEE	
ORGANIZATION	REPRESENTATIVE
Sportsman's Alliance of Maine	Gerry Lavigne & Bob Noonan
Maine Forest Products Council	Nathan Kay & Henning Stabins
Humane Society of the U.S.	Katie Hansberry
Maine Farm Bureau	Julie Ann Smith
Maine Professional Guides	Don Kleiner
USDA Wildlife Services	Robin Dyer
Maine Trappers Association	James Cote
The Nature Conservancy	Nancy Sferra
Maine Chapter of The Wildlife Society	Adam Gravel
MDIFW Legislative Committee Rep	Rep. Scott Landry
Past MDIFW Advisory Council Rep	Don Dudley
MDIFW	Bob Cordes & Shevenell Webb
Warden Service	Chris Cloutier
Wildlife Division Director	Nate Webb

Furbearer Subcommittee Co-chairs:
Shevenell Webb and Bob Cordes

BEAVER/OTTER SUBCOMMITTEE

- Ben Nugent
- Dan McAllister
- Randy Canarr
- Frank Short
- Jerry LeBeau
- Justin Sweitzer
- Don Dudley
- Karen Coker
- Eric Ham
- Nathan Kay
- Jeremiah Wood
- Cory Stearns
- Chuck Hulsey
- Charles Brown
- Tony Gray

MINK/MUSKRAT SUBCOMMITTEE

- Tom Berube
- Dave Miller
- Linda Welch
- John Sewell
- Ben Simpson
- Kendall Marden
- Adam Vashon
- John Slack
- Josh Matijas
- Ethan Buuck
- Brad Richard

CANID SUBCOMMITTEE

- Adam Vashon
- Geri Vistein
- Scott Lindsay
- Craig McLaughlin
- Tim Farrar
- Dave Miller
- Gerry Lavigne
- Dave Ross
- Kara Hodgin
- Claire Perry
- Scott McLellan
- Kristin Peet
- Brandon Sperrey
- Dave Person

BOBCAT SUBCOMMITTEE

- Jennifer Vashon
- Jerry Whitcomb
- Don Kleiner
- Pam Wells
- Paul Laney
- Brad Richard
- Katie Hansberry
- John Litvaitis
- Al Starr
- Brock Clukey
- Craig McLaughlin

MARTEN/FISHER SUBCOMMITTEE

- Ron Picard
- Jerry Whitcomb
- Dan Harrison
- Amanda DeMusz
- Mark Hutcheson
- Bryn Evans
- Bob Noonan
- David Irving
- Steve Dunham
- Henning Stabins
- Joe Dembeck
- Sandy Walczyk
- Kim Bates

OTHER SPECIES SUBCOMMITTEE

- Jesse Morris
- Shelley Spanswick
- Keel Kemper
- Chip McKnight
- Nelson Frost
- Katie Hansberry
- Sean Campbell
- Evan Franklin

APPENDIX II
PROJECT CHARTER

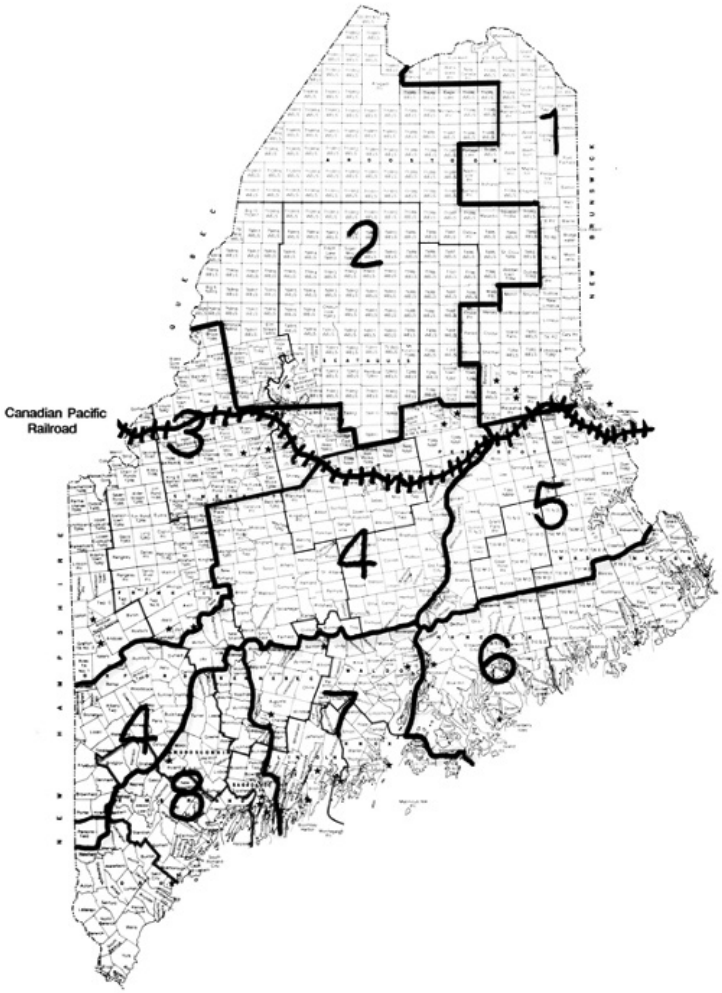
Available Online

2020-2030 FURBEARER MANAGEMENT PLAN

APPENDIX III

WMU / WMD MAPS

WILDLIFE MANAGEMENT UNITS (1973-1997)



WILDLIFE MANAGEMENT DISTRICTS (1998-PRESENT)