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Beaver and trout in the 21st century □ from *The Wildlife Professional*

By Robert C. Willging

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Beloved by some and despised by others, beavers are the subject of a recent management plan in Wisconsin that seeks to balance a wide range of interests. ©Richard Nowitz, USDA

Managing wide-ranging interests in Wisconsin pays off

The decision had been eagerly anticipated and a long time coming. For four years, a Wisconsin group had been crafting a plan to manage beaver, an animal that has long divided people in the state. The plan was finished, but it still needed approval from the seven people appointed by the governor to set policy for the Wisconsin Department of Natural Resources.

The Beaver Task Force had tried to strike a balance between the many differing, and often conflicting, views on how the valued beaver resource should be managed. Chaired by the state's furbearer specialist and moderated by University of Wisconsin Extension, this group of about 40 people represented a wide range of interests and responsibilities, including state and federal wildlife and fisheries managers, tribes and citizen stakeholders. They met regularly, charged with a mission to use peer-reviewed science to develop an updated beaver management plan.

After rounds of public meetings and an online survey, the task force produced a 70-page document meant to replace an outdated 1990 plan and provide statewide direction on beaver management for 10 years.

In October 2015, the Natural Resources Board approved the 2015–2025 Wisconsin Beaver Management Plan, putting into effect its strong emphasis on striking a balance between competing views.

It should not be surprising that it took the task force four years to strike that balance. The North American beaver (*Castor canadensis*) is an iconic species that retains a prominent role in the public's imagination and generates a wide spectrum of perspectives, with passionate beaver advocates at one end and staunch opponents at the other.

Most people, however, occupy a middle ground of fascination and respect for an animal that factored so prominently in the fur trade and European exploration of the continent and still provides a valuable resource for today's fur trappers.

This middle ground is tempered by the problems beaver can cause when their activities conflict with human endeavors. Beavers can flood roads and bridges, damage commercial forests and negatively impact trout fisheries.

Recovering beaver populations

In the centuries since French *coureurs de bois* first traded brass kettles and glass beads with the Ottawa and Huron for beaver pelts, beaver-caused conflicts with humans occupy a fairly short span of time. Beaver experienced significant population reductions due to heavy exploitation during the fur trade era and the unregulated American market hunting that followed. With the development of a national conservation philosophy and strict regulatory protections beginning in the late 1800s— as well as active management to reestablish beaver populations —beaver numbers across the country began to rise.

A Wildlife Services explosives specialist prepares explosives for beaver dam removal. ©Wisconsin Department of Natural Resources

The recovery, however, often came with an increase in beaver-human conflicts. Payne and Peterson (1986) determined that the increase in beaver complaints in north central Wisconsin from 1946 to 1983 was correlated with increases in human and beaver populations. Most complaints involved damage to roads, railroads and timber. Increases in New York state's beaver populations in the 1980s was "accompanied by a rise in nuisance beaver complaints" (Siemer et al. 2004). Most respondents to a 1993 Wyoming survey felt that beaver were stable or increasing. Eighty-nine percent of those with beaver on their property reported damage problems, including blocked water control structures, girdled timber and flooded pasture, timber and crops (McKinstry and Anderson 1999).

Even though perspectives abound regarding best strategies for addressing negative beaver impacts to resources such as roads and timber, such conflicts are relatively clear cut. It's more difficult to understand, as the Wisconsin task force spent many hours debating, the relationship between beaver activities and cold-water stream fisheries resources. Whether positive or negative, the impacts can be quite complex, and they often progress slowly and largely out of sight.

Historically, the discussion has been pretty basic, focused on whether beaver are good or bad, —"saints or sinners" — when it comes to a cold water ecosystem and the aquatic community it supports. Detractors complain of influences on water temperature and chemistry, increased streambed siltation and obstructions to upstream water retention during low flow conditions. Beaver supporters say fisheries may improve due to increased nutrient cycling, higher water quality and salmonids' ability to grow larger (Collen and Gibson 2001).

Early concerns

In Wisconsin where relatively small, low-gradient streams support important brook trout (*Salvelinus fontinalis*) populations, the debate — at times more philosophical than scientific — is decades old and oftentimes has been more of a focal point than the actual impacts themselves. The origin of the idea that beaver activities may negatively influence cold-water ecosystems goes back to the turn of the century in northern Wisconsin. The massive logging of old-growth pine peaked in Wisconsin by 1880. Left in its wake were thousands of acres of "cutover" in northern and central parts of the state — slash-covered ground prone to devastating wildfires. In 1898, half of northern Wisconsin is estimated to have been burned over at least once (Knudsen 1963). With the advent of more effective fire control in the early 1900s, second-growth pioneer birch-aspen forest thrived, providing excellent beaver habitat at a time when beaver numbers were at a low. Also promoting beaver recovery were strict protections on beaver trapping. Between 1903 and 1933, 22 years were completely closed to beaver harvest and open years were greatly regulated (Knudsen 1963).

The concern over negative beaver impacts to trout streams came on the heels of the dramatic increase of beaver populations. By the time WDNR wildlife biologist George Knudsen reported in 1959 that beaver were "very common" across the northern third of the state, an increasing numbers of studies and reports had detailed damage to trout streams caused by burgeoning beaver numbers (Cook 1940, Sprules, 1940, Evans 1948, Patterson 1951, Bailey and Stearns 1951).

From the start is was recognized that "attempts to manage both trout and beaver in the same area and on the same streams invariably results in heated controversies between trout fisherman and the trapper with the game and fish manager caught in the middle." (Evans 1948).

Elusive solutions

A Wildlife Services specialist begins to remove a beaver dam on a low-gradient trout stream in northern Wisconsin. ©Wisconsin Department of Natural Resources

With nearly 50 percent of Wisconsin's 2,989 recognized trout streams — covering over 13,000 miles of stream — located in the northern third of the state (Mike Vogelsang, WDNR, personal communication), the early concern resulted in a succession of "beaver-trout" committees tasked with developing solutions. The first in 1950 recognized that stream-specific management was preferred to region-wide population reduction. It recommended more liberal trapping regulations on "classic" trout streams.

Knudsen recognized that a "general state-wide reduction would have to be severe to eliminate beaver from trout streams." A 1950 proposal that never took flight described a multi-disciplinary approach where wildlife, fisheries and law enforcement staff managed a program of paid trappers focused on designated trout streams.

The stream flows again after a portion of the dam is removed. ©Wisconsin Department of Natural Resources

When early measures failed to attain desired results, recommendations from a 1959 committee resulted in a more integrated and aggressive program that included continued liberal seasons, as well as live trapping and dam removal by state employees. From 1960 to 1989, managers invoked a variety of strategies, including paying private fur trappers up to $25 per beaver to remove beaver and dams from trout streams, issuing nuisance beaver permits to landowners and a continued liberalizing of regulations. In 1980, bag limits were eliminated. In 1989, underwater snares were allowed.

Although the state's wildlife and fisheries departments devoted a great deal of attention and resources to the problem, efforts in stemming beaver-trout conflicts proved inconsistent and ineffective. A WDNR Bureau of Fisheries evaluation of beaver control strategies from 1983 through the summer of 1987 concluded that beaver numbers continued to increase and any future beaver management funding should "be used to target beaver control in specific, high priority watersheds, using permanent personnel or watershed specific contracts (WDNR 1987)." The problem when it came to trout streams was that although liberal fur trapping seasons and cash incentives may have increased general beaver harvest, fur harvest — subject to the vagaries of fur prices and other factors — was not consistent or intense enough to effectively resolve stream level impacts.

By the late 1980s, a new beaver management strategy was needed.

A first in Wisconsin

A seven-member Beaver Project Team, including representatives from WDNR's wildlife, fisheries, forestry and law enforcement departments, as well as the Great Lakes Indian Fish and Wildlife Commission, developed the new strategy. The 14-page 1990 Beaver Management Plan incorporated some of the strategies already in use, such as beaver subsidy payments and liberalization of regulations. But the plan also included some new ideas. It proposed a new harvest season framework based on zones that encouraged greater trapper harvest where beaver-trout stream conflicts were highest, while at the same time suggesting zones where beaver populations were promoted. The concept of "negative habitat management," promoting conifers and hardwoods and discouraging the clearcutting of aspen-birch along trout stream corridors, was another new plan component.

The plan also recognized that "intensive effort" was required on designated streams to meet trout habitat restoration objectives. This idea was certainly not new. It was born from five decades of trial and error that revealed that mitigating beaver impacts on Wisconsin's high-quality brook trout streams required focused and sustained effort.

As one component of this strategy, the U.S. Department of Agriculture's Wildlife Services program was incorporated into the 1990 plan. With initial efforts directed towards high-quality trout streams on the Chequamegon-Nicolet National Forest and funded by the U.S. Forest Service in the late 1980s, Wildlife Services employed a strategy similar to what had been proposed back in 1950 — a work crew organized and managed specifically to address beaver impacts to designated cold-water systems.

A Wildlife Services specialist sets trap to remove beaver in an important cold water tributary to Lake Superior. ©USDA Wildlife Services

The primary objective was to restore and maintain designated systems in free-flowing condition. Significantly, the measurements for success did not depend on numbers of beaver or dams removed, but rather the number of miles of stream restored. This would be accomplished through a well-defined protocol that actually involved more leg work at times than actual trapping or dam removal. A key component was the use of annual surveys of designated stream systems from the air, but perhaps more importantly, also on foot, to ensure that the streams remained free-flowing. This meant long days and many hours in the field slogging through swamps, searching for stream channels and studying maps to find access points.

The program targeted the most impacted streams first — those streams "stair-stepped" with dams, sometimes an incredible 50 to 60 dams per mile (Steve AveLallemant, personal communication). In these systems, dam removal often revealed older dams that had been flooded by newer dams, and the work to clear a stream of dams often took two or three years. After targeted beaver and dam removal, restoration of trout habitat was up to Mother Nature and depended largely on stream gradient.

Once a stream system was opened up, a critical step — the lack of which had stymied restoration efforts in the past — was the ongoing maintenance effort necessary to ensure habitat recovery and stability across an entire stream system. Locating, trapping and removing beaver certainly served as a critical component to the strategy. The program, however, was not a fur harvest or population management effort. Rather, it was a complex and focused wildlife conflict management and habitat restoration project.

Currently, the Wildlife Services program maintains about 1,700 miles of cold-water stream systems, primarily in northern Wisconsin, representing about 13 percent of the trout streams in the state. These streams are recognized to be some of the best trout waters in northern Wisconsin. Most of the streams worked today by Wildlife Services, which only manages the streams between April and October to avoid impeding recreational trapping, have long been in a maintenance phase and exhibit greatly improved habitat and numbers of fish.

The influence of beaver dams on trout stream channels is apparent from the air. ©USDA Wildlife Services

WDNR fisheries biologists based in the north have observed dramatic results from the agency's stream-specific beaver management. Max Wolter, a fisheries biologist based in Hayward, Wis., compared stream survey data from nine streams worked by Wildlife Services to nine similar streams in the same area not targeted. On the managed streams, trout recruitment or average young of the year per mile, was 20 times higher and abundance of adult trout measured per mile was seven times higher compared to beaver-impacted streams (Max Wolter, WDNR, personal communication). In real numbers, this was an average of 649 hatchlings per mile on the managed streams compared to only 30 in unmanaged streams, and 460 adult trout per mile compared to 70 per mile on beaver-impacted streams.

Due to the powerful combination of cost-effectiveness and on-the-ground success in improving trout habitat, many WDNR fisheries biologists have indicated that if funding allowed for only one type of stream habitat improvement work in northern Wisconsin they would choose beaver management (Mike Vogelsang, WDNR, personal communication).

Challenges for the future

While the 1990 beaver management plan broke new ground and successfully addressed many of the beaver management concerns at the time, by the early 2000s it was time for a critical reassessment. Some user groups felt the 1990 plan had accomplished its goals, but at the same time, there was a recognition that the northern Wisconsin landscape had changed significantly over the 10-year period.

The Wisconsin Beaver Task Force formed in 2011 to develop a new plan, but it faced many of the same questions and problems — as well as contentious debate — that had been around for over a half-century. The context of beaver management discussions in the 21st century was much different than in previous eras, though.

The greater diversity of groups at the table — about 40 individuals representing 20 entities — and the amount of time spent — years rather than months — in the development of the 2015 Wisconsin Beaver Management Plan, along with a strong focus on science-based decision making, attests to the idea that beaver management today requires a complex, multifaceted and interdisciplinary approach with strong input from the public.

By taking the time necessary to respect all perspectives and striving to make good science-based decisions, the task force showed that Wisconsin can continue to attain an acceptable balance of objectives in managing this controversial species.

*Note: The **Wisconsin Beaver Management Plan 2015-2025** is appended below*

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Wisconsin Beaver Management Plan

2015–2025

Executive Summary

Beaver management in Wisconsin has been, and will continue to be a mix of societal needs and concerns, habitat and landscape management, science, respectful use, and balanced needs. While the 1990 Management Plan primarily addressed the need to reduce beaver populations and protect critical resources, the 2015–2025 plan continues to emphasize resource protection, but does so with concern and care for various user groups, and takes into consideration the importance of beaver populations and the value they provide.

In an effort to address beaver management in a comprehensive and inclusive manner, the Wisconsin Department of Natural Resources (WDNR) organized a Beaver Task Force (hereafter referred to as the Task Force) representing programs, agencies, organizations and tribes with interest in beaver management. Public input was also gathered and used in developing this plan. News releases encouraged input from citizens via four regional public listening sessions, a live webinar, and an online survey.

Beaver and mankind have co-existed for centuries and will continue to do so through improvements in our knowledge and understanding, as well as through compromise. The Task Force sought to achieve this balance in its planning approach and its recommendations for beaver management over the next decade. With an expected duration of ten years, however, it will be critical to the implementation of this plan that those involved maintain flexibility while taking a collaborative approach, and allow balanced input and considerations of the needs of all species, including humans.

The 2015−2025 Wisconsin Beaver Management Plan identifies the following goals:
1) Stable beaver populations are maintained in suitable habitats throughout Wisconsin while at the same time providing trapping and viewing recreation, and limiting human-beaver conflicts and impacts to resources.
2) Habitat management is used as a tool for managing beaver populations.
3) Beaver damage is mitigated.
4) Education, information and outreach on Wisconsin beaver management is improved.
5) Emerging disease threats to beavers and any related zoonotic implications are monitored, investigated, and managed.
6) Beaver management is improved by obtaining better information on beaver harvest, population status, ecological impacts, and societal views and values.

Linda Pohlod

Table of Contents

WISCONSIN
DEPT. OF NATURAL RESOURCES

Table and Figures

WISCONSIN
DEPT. OF NATURAL RESOURCES

Introduction

In the early 1900s Wisconsin legislators managed beaver primarily through total protection or limited harvest seasons. As beaver populations grew and the Wisconsin Conservation Department was established, beaver management occurred primarily through regulated trapping by citizens and damage control by government agencies. In the late 1980s beaver populations, primarily in the north, were causing serious damage to human infrastructure, forests, certain wildlife habitats, and native trout streams. In response, the WDNR developed a beaver project team and a beaver management plan that primarily focused on population reduction.

The 2015–2025 Beaver Management Plan is in response to changes in beaver populations, beaver management, and beaver habitat since the initial 1990 Beaver Management Plan. Primary concerns regarding beaver management over the next 10 years include the need to:

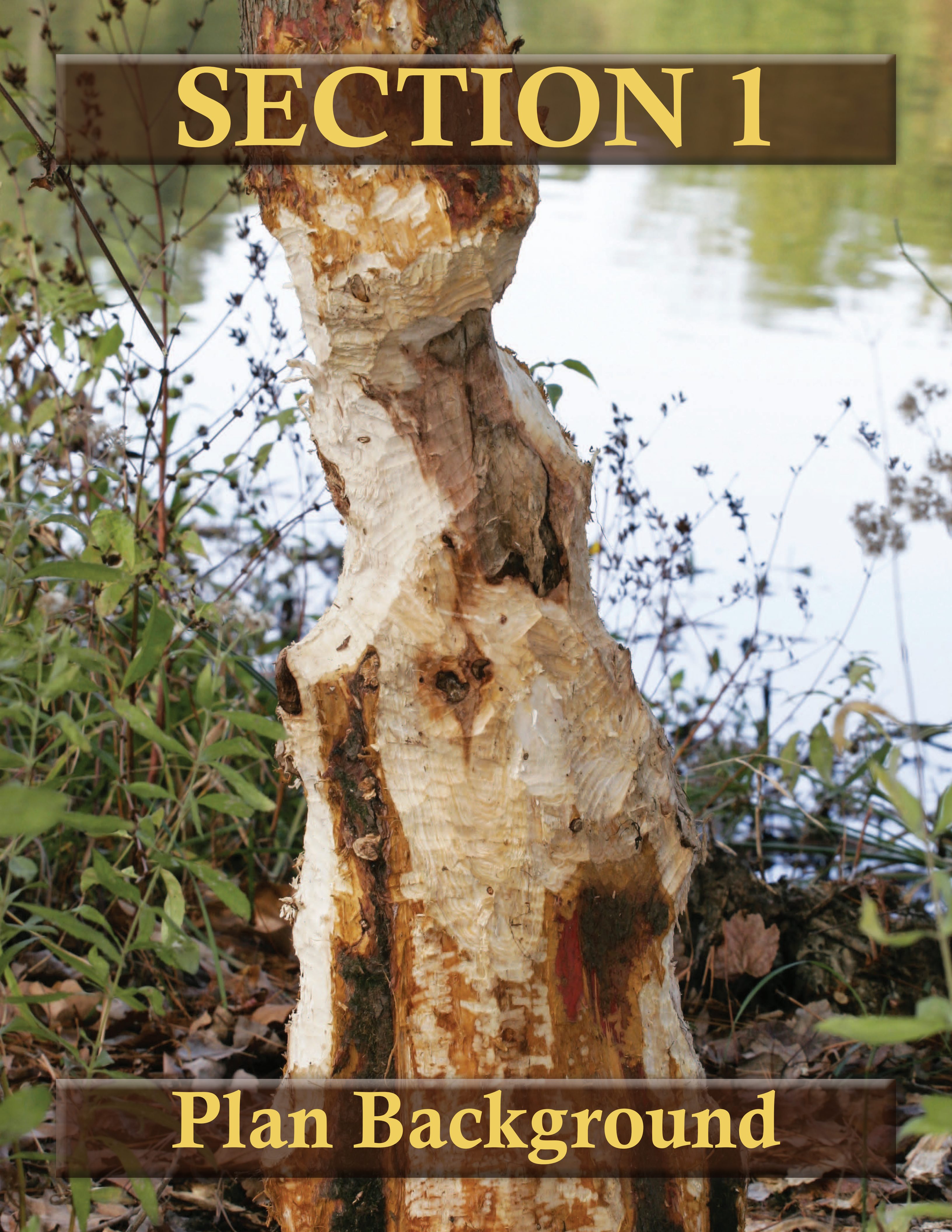
1. Maintain a relatively stable population of beavers across Wisconsin. This may require management flexibility through additional protection in some areas and increased harvest in other areas.
2. Develop partnerships between governments, agencies, organizations and user groups resulting in team decisions and collaborative management. This may include improvements in outreach efforts and fiscal planning.
3. Protect trout populations in designated, cold water streams across Wisconsin. This may require free-flowing streams and continued removal of beavers on select streams or stream segments.
4. Continue to protect human infrastructure and important resources from the impacts of beaver activity. This includes public roads, timber, private property and critical resources such as wild rice and rare plants and animals.
5. Develop a better understanding of the beaver/trout/watershed relationship and the potential impacts of ecological change, predation, disease, forest management, and other management actions.
6. Improve beaver population monitoring in all regions of Wisconsin. This may include changes in current protocols and the development of new techniques that are as accurate, yet more economical.
7. Modify forest management practices to discourage beaver on cold water streams and areas where an increase in beaver populations may not be compatible with other resources and encourage beaver on warm water streams where beaver activity may be compatible with other resources.
8. Improve flexibility in harvest regulations relative to population management goals and societal needs.

Key to Acronyms Used

KEY TO ACRONYMS
BMPs – Best Management Practices
GLIFWC – Great Lakes Indian Fish and Wildlife Commission
USFS – United States Forest Service
USFWS – United States Fish and Wildlife Service
Wildlife Services – U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services
WDNR – Wisconsin Department of Natural Resources

SECTION 1

Plan Background



Beavers (*Castor canadensis*), a native to Wisconsin, can be both beneficial and detrimental to our landscapes, depending on a person's view or the situation. Beaver management includes knowledge, cooperation, compromise, listening, and vision. These qualities existed within the earlier management team that developed the 1990 Beaver Management Plan, and are now present in the current team. Successful highlights of the current, 25 year old plan include a significant reduction in beaver populations and the development of an efficient, effective damage control program. But with accomplishments, new knowledge, and increasing conflicts, our new paradigm requires us to mold and modify this older plan into a vision for the next decade and beyond.

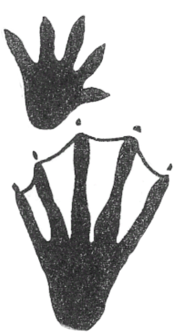
While the 1990 Plan addressed the need to reduce beaver populations and protect critical resources, the new plan continues to emphasize critical resource protection while addressing the concerns of multiple stakeholders and user groups and addressing the need and value of beaver populations.

In an effort to address beaver management in a comprehensive and inclusive manner, the WDNR organized a Beaver Task Force, hereafter referred to as the Task Force. The WDNR Wildlife Policy Team recommended that an offer be made to all parties interested in beaver management to be involved in the development of a new beaver management plan. The Task Force includes representatives from WDNR programs, other agencies, organizations, and tribes (Members of the Task Force are noted in Appendix 4).

The Task Force, facilitated by a University of Wisconsin – Extension Natural Resources Educator, met first in July 2011 and immediately identified the need to gather input from stakeholders. To that end, four in-person public input meetings were held in September 2011, in La Crosse, Oshkosh, Rhinelander and Hayward. Additionally, a webinar was held in October, 2011. Sixty-two people participated in the in-person meetings and 22 participated in the webinar. These input opportunities were publicized on the WDNR's public meetings calendar and via a press release. In addition, a "Wisconsin Beaver Management: Past Present and Future" website was developed and maintained by UW – Extension Regional Natural Resources Program.

A questionnaire was distributed at the in-person meetings and available on-line, with 571 respondents completing the questionnaire. This information was used by the Task Force to get a general sense of what stakeholders were thinking regarding beaver management. Since it was not distributed to a random sample population, the responses were not intended to be statistically analyzed. The questionnaire was developed collaboratively between the WDNR and the UW–Extension Environmental Resources Center (ERC), with the UW–Extension ERC administering the on-line questionnaire and compiling the results.

The Task Force met again in December 2011 and February 2012 to review public input and identify key issues and potential goals, objectives and strategies. Members of the Task Force worked from March 2012 through October 2013 to draft the Beaver Management Plan, with review of the plan beginning in October. The Task Force continued to meet throughout the early months of 2014 to bring forth a plan that is truly a compromise of the concerns and wishes of user groups, partners, tribal communities, public and private land managers, WDNR biologists, and citizens, and reflects the mission of the Wisconsin Department of Natural Resources (dnr.wi.gov/about/mission).



Wisconsin DNR Mission:

"To protect and enhance our natural resources: our air, land and water; our wildlife, fish and forests and the ecosystems that sustain all life.
To provide a healthy, sustainable environment and a full range of outdoor opportunities.
To ensure the right of all people to use and enjoy these resources in their work and leisure.
To work with people to understand each other's views and to carry out the public will.
And in this partnership consider the future and generations to follow."

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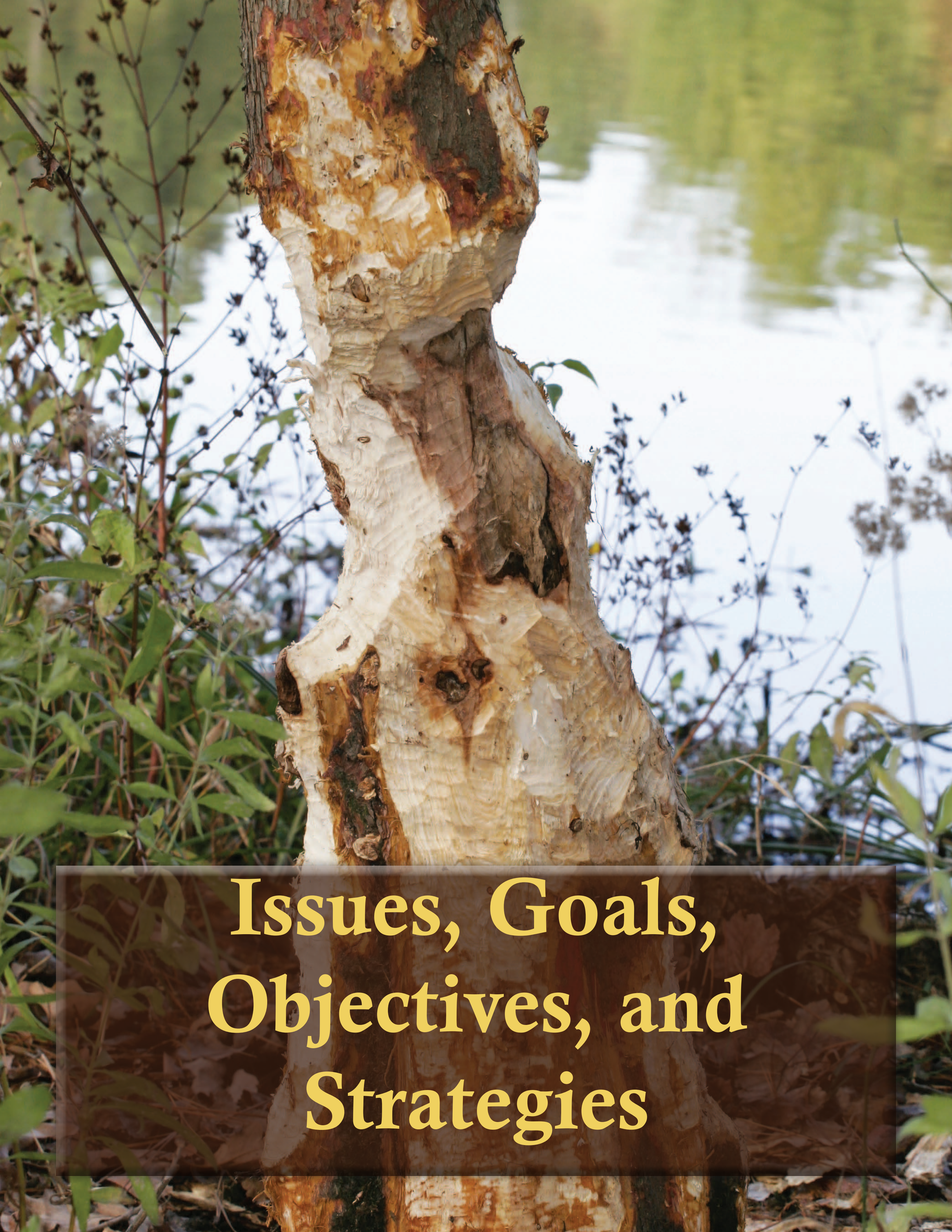


Issues, Goals, Objectives, and Strategies

Following are the issues, goals, objectives and strategies identified by the Task Force with input from the public. The order listed does not imply priority importance.

Issue Statement 1. Population Management

Beavers are vulnerable to overharvest as documented by the near extirpation during a time of unregulated harvest prior to 1900. Currently, regulated trapping includes a long season with no bag limit. The number of beaver harvested correlates to the number of trappers and trap-nights, and the number of active trappers is influenced by pelt price. The rate of decline in beaver populations in northern Wisconsin during the 1990s and 2000s suggested that the level of harvest during that period was too high to maintain a beaver population at levels acceptable to some user groups.

Goal 1. Stable beaver populations are maintained in suitable habitats throughout Wisconsin, providing wetland habitat and trapping and viewing recreation, while limiting human-beaver conflicts, and impacts to resources.

Objective 1.1. Use zone-specific beaver population objectives and review in Year 5.

Public harvest is important in beaver population management.

Beaver Zone A: Maintain the Zone A beaver population at its current level (2014) or allow a slight increase.
Beaver Zone B: Maintain the Zone B beaver population at its current level (2014) or allow a slight increase.
Beaver Zone C: Maintain the Zone C beaver population at its current level (2014).
Beaver Zone D: Maintain the Zone D beaver population at its current level (2014) or allow a slight decrease.

Strategy 1.1.1. Retain current beaver management zones (Figure 1; page 9).

Strategy 1. 1.2. Modify regulated trapping season lengths and/or bag limits as needed to work toward population objectives for each beaver management zone.

Strategy 1. 1.3. Target additional harvest pressure to specific areas within management zones to address local damage issues.

Strategy 1. 1.4. Continue to use the WDNR Furbearer Advisory Committee to develop specific regulation change recommendations needed to achieve zone-specific population trend objectives.

Strategy 1. 1.5. Monitor population trends within management zones using a variety of methods including periodic aerial quadrat surveys of active colonies, annual fixed-wing surveys of managed trout streams, rate of harvest per effort, trappers' opinion of population trends, beaver damage complaints received by Wildlife Services and WDNR staff, periodic surveys of rural landowners' opinions of population trends, and beaver observations during trout stream surveys.

Strategy 1. 1.6. Reconvene the Beaver Task Force mid-way through the duration of this plan (2020) to review beaver population trends and recommend adjustments to population trend objectives as appropriate.

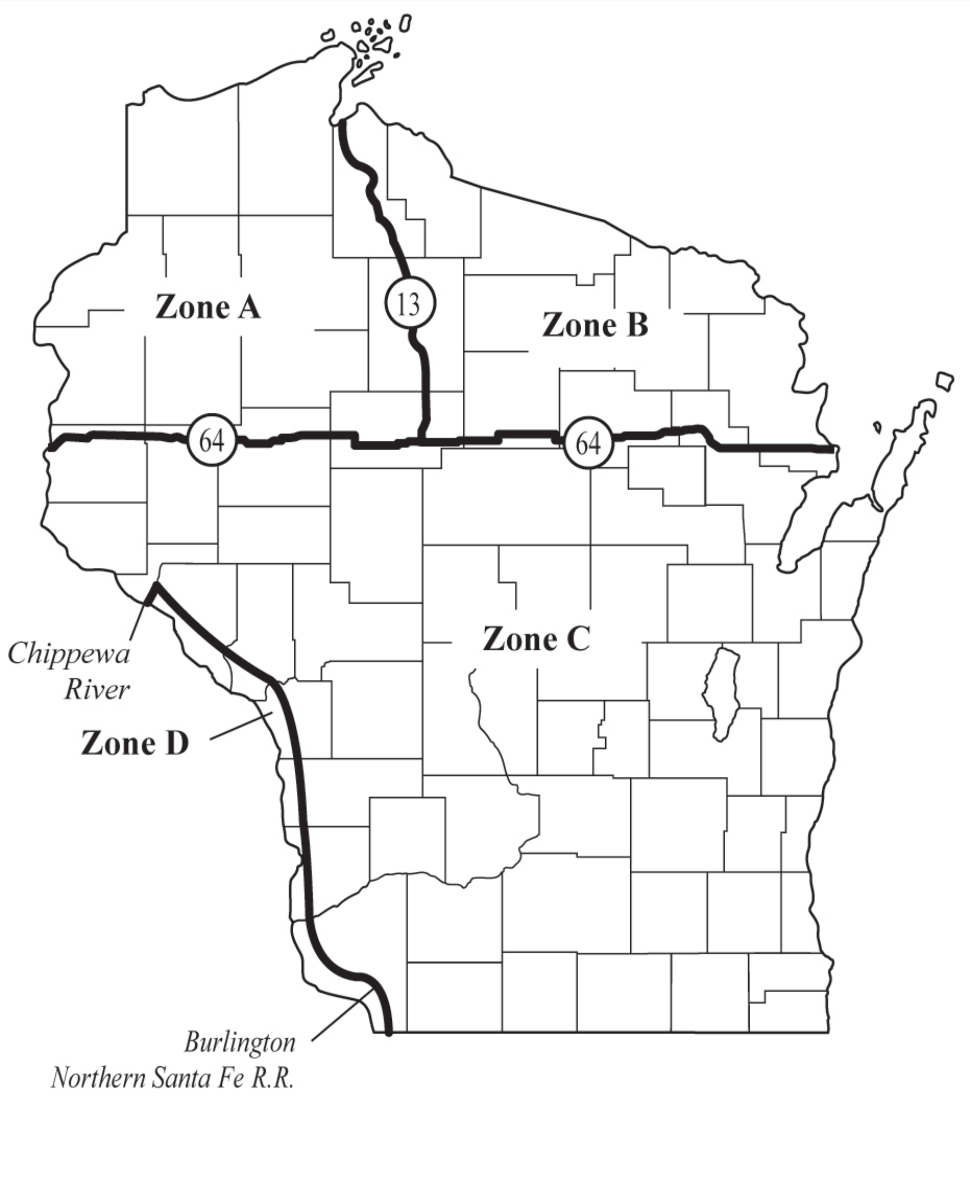


Figure 1. Current Wisconsin beaver management zones adopted in 1991.

Issue Statement 2. Habitat Management

Current forest management practices in riparian zones may affect beaver populations, therefore steps could be taken to encourage or discourage beaver when managing habitat.^

Goal 2. Use habitat management as a tool for managing beaver populations.

Objective 2.1. Encourage beavers through habitat management where beaver activity may be compatible with other resources.

Strategy 2.1.1. Identify opportunities to improve beaver habitat. For example, identify priority areas that could be managed for aspen to meet the goals of the Wisconsin Young Forest Partnership.

Strategy 2.1.2. Work with foresters and the state hydrologist to utilize Forestry BMPs (WDNR 2010; page 95) and other accepted silviculture prescriptions to maintain or increase aspen and other preferred food species available within a beaver-accessible riparian zone while protecting water quality.

Strategy 2.1.3. Work with partners and other agencies to educate private landowners on the benefits of providing quality beaver habitat in preferred locations.

Habitat management decisions affect long term suitability for wildlife, especially beaver.

Strategy 2.1.4. Include beaver habitat management in appropriate management handbooks.

Objective 2.2. Discourage beavers through habitat management where beaver activity may not be compatible with other resources (e.g., trout streams, timber, etc.)

Strategy 2.2.1. Identify watersheds or portions of watersheds where decreased beaver habitat is desired.

Strategy 2.2.2. Utilize Forestry BMPs (WDNR 2010) and other accepted silviculture prescriptions to minimize regeneration of aspen and other preferred food species within a beaver-accessible riparian zone.

Strategy 2.2.3. Utilize Forestry BMPs and other accepted silviculture prescriptions to reduce existing aspen and other preferred food species and allow succession of species less desirable to beaver such as long-lived conifers and northern hardwoods.

Strategy 2.2.4. Work with partners and other agencies to educate private landowners on how to discourage beaver presence through forest habitat management.

^ Footnote: Habitat management on public lands can be complex, variable, and property specific. Public properties, including town, county, state and federal lands that provide fish and wildlife habitat, timber resources, recreational opportunities and other public benefits often have comprehensive plans that identify long term goals and visions as well as specific objectives, strategies and actions needed to achieve meet those goals. Habitat management to achieve Objectives 2.1 or 2.2 (above) must be compatible with these approved plans. Examples of such plans utilized by the DNR include the Fish, Wildlife and Habitat Management Plan, the Wildlife Action

Plan, property Master Plans and species plans. Other agencies have their own plans , such as the USFS Forest Plan (USDA Forest Service 2004), the U.S. Department of Agriculture Natural Resources Conservation Service's Driftless Area Landscape Conservation Initiative (USDA NRCS 2013) and the U.S. Army Corps of Engineers Upper Mississippi River Systematic Forest Stewardship Plan.

Statewide or regional comprehensive plans are broad in scope and provide the foundation for more specific property or species plans. They may identify in which context certain habitat or species goals are priority. Long-term property or master plans consider the capability of the property, both in terms of natural resource management and recreational opportunities, and what specific role it can play within a broader geographic context. They evolve thorough public review and official approval, and are specific to a property for a specific period of time. Species plans are much the same, but provide guidance and direction in overall statewide management of a species across boundaries and jurisdictions. Comparatively, short-term, local work plans follow guidance of these more formal visions but highlighting specific actions to be taken during a shorter specified period of time. These local actions may vary on an annual or biannual basis due to several factors, yet still strive to accomplish long term goals.

Several state-level resources are available to aid in addressing habitat management including but not limited to: Public Forest Lands Handbook (MC 2460.5), Forestry Operations Handbook (MC 2420.5), Private Forestry Handbook (MC 2470.5), Forestry Training Handbook (MC 9155.1), Wildlife Management Operations Handbook (MC 2310.5), Public Access of Navigable Waters Handbook (MC 3710.5), Natural Heritage Inventory, Property Managers Guidance (Version 1.1 September, 2012), and Property Planning Handbook (MC 2210.1).

Issue Statement 3. Damage Control and Coordination

Beaver activity at any population level can negatively impact resources. Decisions to control damage involve various department programs, other agencies, interested user groups, and the public. Clear and open communications is critical in understanding damage control decisions. For example, dam building, flooding and the felling of trees can result in environmental and economic damage, as well as safety issues. Beaver dams on cold water stream systems can negatively impact cold water fish communities by creating barriers to fish movements and water flow, and could degrade trout habitat and spawning areas by siltation of the stream bed. Divergent interests in beavers make it difficult to decide where to conduct beaver control and which parties to engage in the decision.

Goal 3. Beaver damage is mitigated.

Objective 3.1. Afford opportunities to manage and mitigate site-specific beaver impacts.

Beaver damage is a reality and requires management.

Strategy 3.1.1. Continue the existing Cooperative Service Agreements for the Beaver Damage Management Program with Wildlife Services, addressing the wide range of impacts caused by beavers to public and private resources, including roads, bridges, forests and agricultural resources, landscape plants, sensitive species and habitats, wild rice waters, flowages and infrastructure. Annual review of agreements a Memorandum of Understanding and Cooperative Service Agreement between WDNR and Wildlife Services on cold water fish management will include input and substantial effective agreement from various department programs including Fisheries, Wildlife, Natural Heritage Conservation, Forestry and Law Enforcement. Final WDNR Cooperative Service Agreements must be consistent with the approved Beaver Management Plan.

Strategy 3.1.2. Continue to provide accessible and updated beaver damage management information to the public, tribes, other agencies and organizations, including Cooperative Service Agreements, state laws and statutes.

Strategy 3.1.3. Continue to allow beaver removal and beaver dam removal by government agencies, private trappers, nuisance control operators, or landowners to protect specific resources, while developing a system of reporting this activity (Strategy 4.2.3, page 15).

Strategy 3.1.4. Limit beaver control work on warm water streams to actions protecting resources such as roads, highways, rail corridors, timber, agriculture, other human infrastructure, wild rice waters, and unique natural communities.

Objective 3.2. Maintain free-flowing conditions on select cold water stream systems and connected spring ponds as recommended by WDNR Fish Management through removal of beaver and beaver dams. Specific cold water systems where beaver removal will be conducted will be determined through a substantial effective agreement with the various department functions, other agencies and the public.

Strategy 3.2.1. Convene a WDNR Fisheries area-level resource team with the first meeting held in Year 1 (2015) of the Beaver Management Plan. This team, chaired by Fish Management, should meet every two years and will include WDNR Fisheries, Wildlife, Forestry, Natural Heritage Conservation, and Law Enforcement. Invitations would also be extended to representatives of the Beaver Task force in addition to others with an expressed interest.

Strategy 3.2.2. With input from other federal and tribal agency fisheries staff, WDNR Fisheries Management will develop and make available to the area-level resource team and other interested stakeholders, a list of priority Class 1^ and Class 2^ trout waters (up to 50% of total perennial stream mileage in a county) where beaver and beaver dam removal will occur.

Strategy 3.2.3. If the provided list of Class 1 and 2 trout waters exceeds 50% of the total perennial stream miles in a given county it will then be reviewed by the area-level resource team, other federal and tribal agency staff and other interested stakeholders, and by substantial effective agreement, the resource team will agree on a recommended course of action.

Regulated trapping provides habitat management benefits.

Strategy 3.2.4. If the provided list includes beaver and beaver dam removal on designated Class 3^ streams (e.g., anadromous fish use of Lake Superior streams), it will require the same level of review and substantial effective agreement as identified in Strategy 3.2.3.

Strategy 3.2.5. Initial recommendations of these teams will be reviewed by the Beaver Task Force in relation to the 5-year population management objectives (Objective 1.1; page 8) of the Beaver Management Plan. Recommendations from the area teams will then be sent to department policy teams for consideration and action, both in Year 1 (2015) and Year 5 (2020) of the Beaver Management Plan.

Strategy 3.2.6. Make reports and decisions from WDNR area-level resource team meetings available to stakeholders.

Strategy 3.2.7. Allow increased public trapping opportunity on trout waters listed as per 3.2.2, 3.2.3 and 3.2.4.

Strategy 3.2.8. Conduct beaver and beaver dam removal on selected cold water stream systems and connected spring ponds through a combination of WDNR Cooperative Service Agreements with Wildlife Services, direct action by WDNR and other agency fisheries management teams and action by other entities under written authorization with WDNR Fisheries Management. Annual WDNR Cooperative Service Agreements with Wildlife Services will include input and substantial effective agreement from various department programs including Fisheries, Wildlife, Natural Heritage Conservation, Forestry and Law Enforcement. Final agreement must be consistent with the approved Beaver Management Plan.

^ "Class 1 Trout Stream" is a stream or portion thereof with a self-sustaining population of trout. Such streams contain trout spawning habitat and naturally produced fry, fingerling, and yearling in sufficient numbers to utilize the trout habitat; or contains trout with 2 or more age groups, above the age of one year, and natural reproduction and survival of wild fish in sufficient numbers to utilize the available trout habitat and to sustain the fishery without stocking.

"Class 2 Trout Stream" is a stream or portion thereof that contains a population of trout made up of one or more age groups, above the age one year, in sufficient numbers to indicate substantial survival from one year to the next, and may or may not have natural reproduction of trout occurring; however, stocking is necessary to fully utilize the available trout habitat or sustain the fishery.

"Class 3 Trout Stream" is a stream or portion thereof that requires the annual stocking of trout to provide a significant harvest; and does not provide habitat suitable for the survival of trout throughout the year, or for natural reproduction of trout.

Issue Statement 4. Education

The public's awareness and understanding of beaver biology and management, and acceptance of regulated trapping as a legitimate outdoor activity has diminished, and may continue to diminish as society becomes less connected to wildlife resources.

Goal 4. Education, information and outreach on Wisconsin beaver management are improved.

Public understanding and support for beaver management is important.

Objective 4.1. Continue to provide opportunities to increase knowledge about beavers and increase public support for beaver management.

Strategy 4.1.1. Work with WDNR Office of Communication and other partners to develop and implement a beaver management communication plan. Components could include:

- Making beaver information available in print and via the WDNR website.
- Partner with WDNR educators and external partners to feature or link to WDNR beaver information for personal programming and print media.
- Use WDNR social media tools to get the word out on Wisconsin beaver natural history and management (YouTube, chats, etc.).
- Summarize information in the Wisconsin Beaver Management Plan so that pertinent information is inviting for youth and adults to read.
- Investigate the benefit of developing Wisconsin beaver education kits and exhibits to increase the capacity of educators to conduct beaver management education.
- Cooperatively work with external partners throughout the state to procure financial resources, build, and display permanent "Wisconsin Beaver" exhibits to reach a potential of at least 1 million people annually. For example:
    - Milwaukee Public Museum: 700,000 visitors per year
    - Milwaukee Public Zoo: 1.3 million visitors per year
    - Neville Museum (Green Bay): 57,000 visitors per year

Strategy 4.1.2. Continue to promote regulated trapping and the use of Best Management Practices for trapping to increase knowledge of and support for humane and selective beaver trapping activities (found under the "furbearer management" tab at fishwildlife.org).

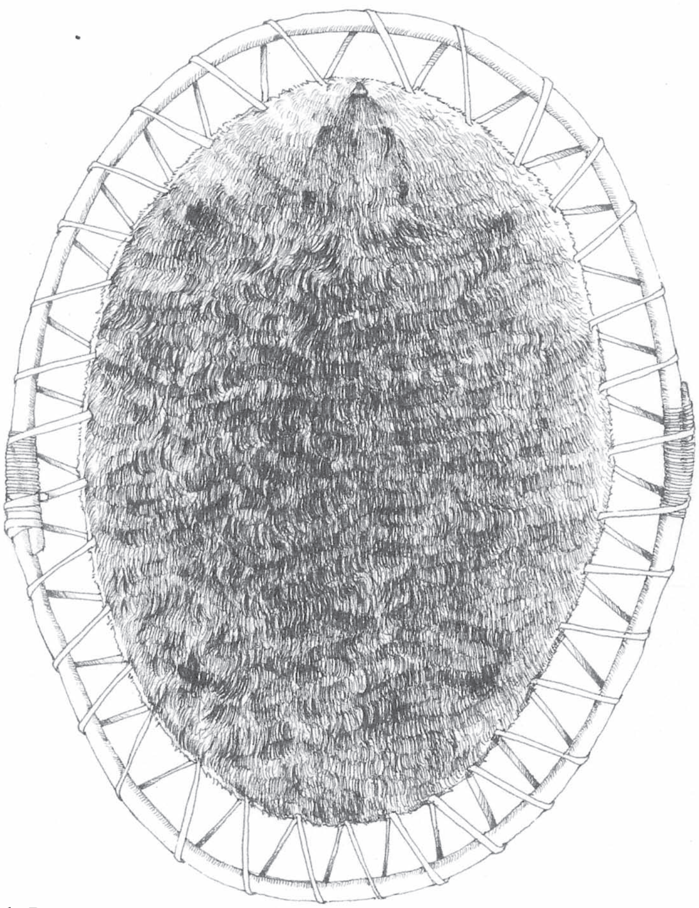
Strategy 4.1.3. Through the Wisconsin Cooperative Trapper Education Program, encourage agricultural teachers and media sources to increase the emphasis on BMPs relative to aquatic furbearers—especially beaver—encouraging participants to use the latest and best available harvest tools.

Objective 4.2. Provide information on options regarding beaver damage management to agencies and the public.

Strategy 4.2.1. Work with partners to provide local officials and highway departments responsible with highway and culvert construction and replacement with information on the importance of culvert placement, potentially reducing beaver activity and damage costs.

Strategy 4.2.2. Continue to provide non-lethal abatement technique information and advice to highway departments, landowners, lake associations and others with interest.

Strategy 4.2.3. WDNR will develop a consistent reporting system for participating agencies that documents known beaver damage take and associated information.



Marly Beyer

Beaver health will be monitored.

Issue Statement 5. Beaver Health

Tularemia has significantly affected beaver populations in the past and a number of beaver-associated diseases have human health implications. Changing environmental landscapes, global travel, and increased contact between wildlife and domestic species has resulted in a number of emerging diseases as well as the translocation of diseases worldwide. Therefore it is difficult to predict what diseases may emerge and impact our beaver population.

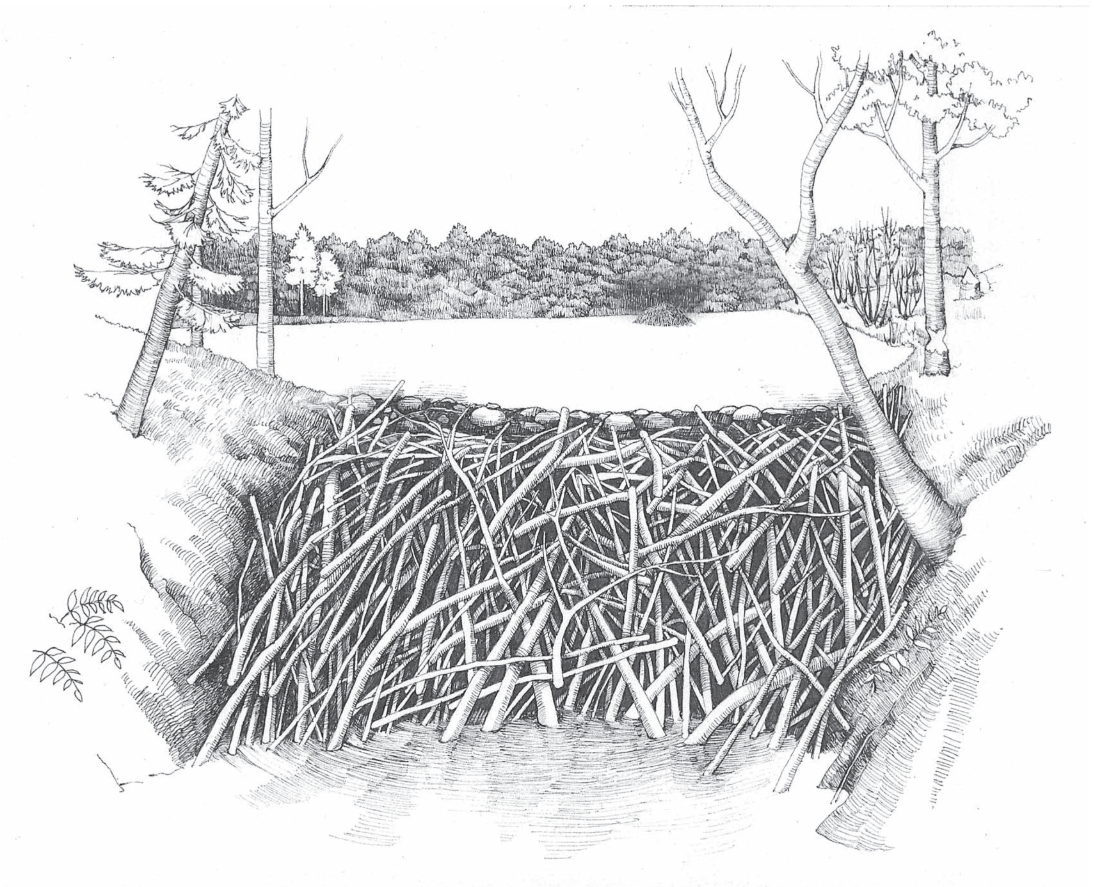
Goal 5. Emerging disease threats to beavers and any related zoonotic implications are monitored, investigated and managed.

Objective 5.1. Investigate unusual mortalities of beavers in a timely manner.

Strategy 5.1.1. Continue to inform trappers, wildlife damage control staff, and the general public about common diseases of beavers and other furbearer species, especially zoonotic diseases and their prevention.

Strategy 5.1.2. Work with the trapping community and citizens interested in beaver management to cooperate in the prompt identification and notification of unusual lesions or mortality events.

Strategy 5.1.3. WDNR will conduct necropsies to determine cause of death of reported mortality events and share information as appropriate.



Marly Beyer

Issue Statement 6. Research

Beaver management may be enhanced by having accurate and broad-range information. Accurate information about beaver population status and harvest is needed to inform harvest management decisions. Additionally, studies of beaver impacts on Midwestern stream systems are limited, quantitative measures of attitudes and behaviors of Wisconsin's public toward beavers, beaver damage and beaver management are lacking.

Goal 6. Beaver management is improved by obtaining better information on beaver harvest, population status, ecological impacts, and societal views and values.

Understanding beaver and aquatic systems are key to sound management actions.

Objective 6.1. Maintain and improve data needed for sound beaver population management.

Strategy 6.1.1. Continue to conduct an annual beaver trapper survey to estimate beaver harvest trends, number of active beaver trappers, and beaver trapping effort.

Strategy 6.1.2. Conduct research to better understand biases associated with mailed survey-based estimates of beaver harvest and develop correction factors to yield more accurate harvest estimates.

Strategy 6.1.3. Continue to conduct existing beaver helicopter surveys in northern Wisconsin to monitor population abundance while developing an alternative, more cost-effective survey.

Strategy 6.1.4. Assess alternative population survey methods suitable for beaver population monitoring in the southern two-thirds of Wisconsin.

Objective 6.2. Conduct research utilizing an interdisciplinary approach to understand impacts, both positive and negative, of beavers, beaver dams, and beaver dam removal on wildlife, groundwater, trout, etc.

With knowledge we make informed decisions.

Strategy 6.2.1. Conduct research to better understand how beavers and their impoundments affect the diversity and abundance of aquatic invertebrates, reptiles, amphibians, birds, and mammals including large carnivores.

Strategy 6.2.2. Conduct research to better understand the effects of beaver dams on stream flow, water volume, water temperature, water quality and flood damage under low and high flow conditions and how these may change under different climatic warming and precipitation scenarios.

Strategy 6.2.3. Conduct research in multiple ecoregions of Wisconsin to quantify the impacts of beaver dams compared to free-flowing conditions on stream habitat and trout population abundance, size structure, seasonal movements and production.

Strategy 6.2.3.1. Utilize paired studies of trout streams currently maintained under free-flowing conditions. Maintain free-flowing conditions in a subsample of streams and allow beavers to recolonize another subsample of similar streams.

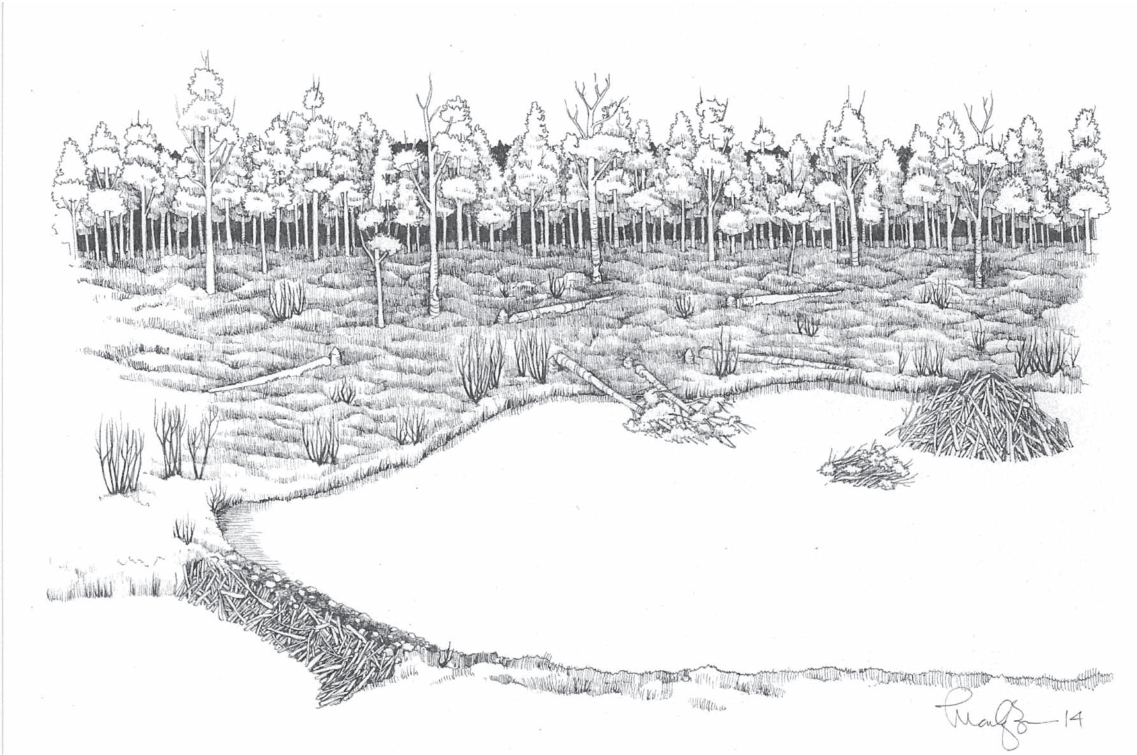
Strategy 6.2.3.2. Utilize paired studies of trout streams that are currently colonized by beavers. Remove beavers and create free-flowing conditions in a subsample of streams and allow beaver colonization to continue in another subsample of similar streams.

Strategy 6.2.4. Conduct research to quantify the impacts of beaver dams on gill lice dynamics in Wisconsin trout streams, including impacts on community dynamics in streams with sympatric populations of brook trout and brown trout.

Objective 6.3. Conduct research to better understand the attitudes of the people of Wisconsin toward beavers and beaver management.

Strategy 6.3.1. Conduct human dimensions research to establish a baseline of attitudes of Wisconsin's residents toward beavers and beaver damage and their acceptance of the beaver management program.

Strategy 6.3.2. Periodically (every 5 years) resurvey Wisconsin's residents to assess how their attitudes toward beavers and beaver management have changed.



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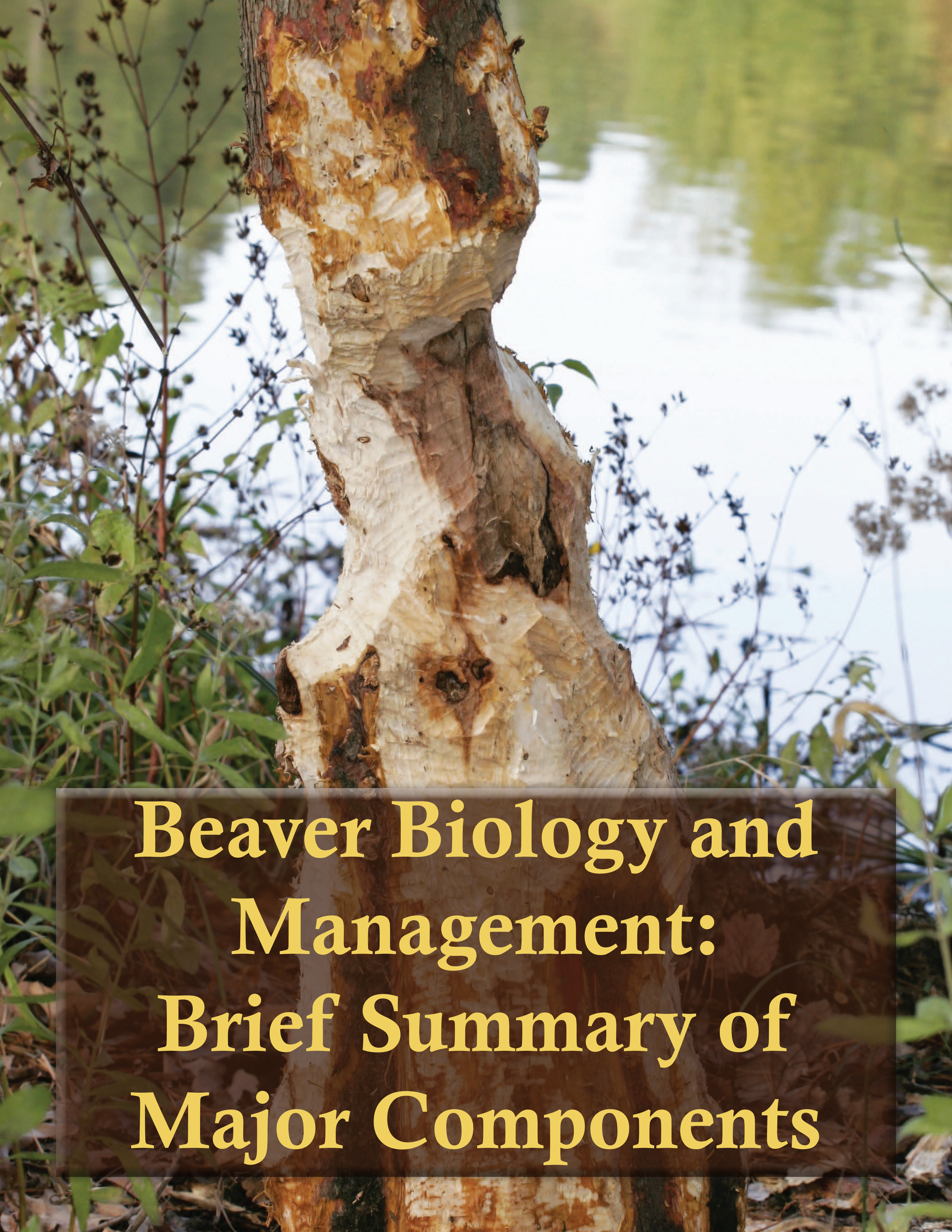


Beaver Biology and Management: Brief Summary of Major Components

The following is a brief summary of the significant components of beaver biology and management in Wisconsin. Each topic is covered in more detail on pages 23–53 under ***Beaver Biology and Management – Review of Major Components***.

Biology. Beavers, the largest rodent in North America, are widespread in North America and one of few species that alters natural landscapes to their benefit. Human take through regulated trapping is a significant mortality factor. Changes in beaver populations affect other wildlife species as beaver ponds serve as habitat for nesting, foraging, and denning for some species. In addition, beavers are an important seasonal food item for some species of large mammals. Beaver colony density is dependent on habitat quality and foraging ability. Aspen, an early successional species is highly utilized for beaver habitat and food but has declined across northern Wisconsin. Tularemia (bacterium), Giardia (parasite) and blastomycosis (fungal), associated with beaver and/or beaver ponds, are important health risks to humans.

Ecological Impacts. Significant changes in climate may alter forest composition and alter populations of species, including beaver. The presence of beavers and beaver ponds benefit some species, affect groundwater recharge and flood prevention, yet can be a detriment to other species in need of cold, free-flowing water, especially trout.

Economic Impacts. The development of beaver wetlands and regulated trapping have value to society, but at the same time, the loss of free-flowing cold water streams can negatively impact communities and regions. Additionally, flooding resulting from beaver dams causes damage to property and infrastructure and is a serious concern for agencies and individuals.

Cultural Considerations. As a clan animal to several native tribes, beavers are an essential fabric to their culture and spirituality. European descendants historically viewed beavers as an extractive, economic resource, but many now share views of mutualism. A better understanding of the values and attitudes of Wisconsin's citizens toward beavers will be important for effective management of human-beaver relationships.

Beaver Management History. Beaver populations, once widespread across the state, dramatically declined due to unregulated take and habitat alteration. Following protection and significant changes in young forest habitat, populations rebounded statewide. During dramatic shifts in beaver populations, government programs first protected beavers, but eventually evolved into levels of harvest management, and more recently an intensive harvest and damage control program.

Continued concerns resulted in the 1990 Beaver Management Plan that generated priorities and funds to conduct habitat protection and beaver management. The management recommendations included: subsidies, harvest zones, Wildlife Services damage mitigation, and removal efforts on trout streams. It also considered human issues combined with various user and population surveys in an overall effort of beaver reduction in a regulated, controlled manner.

Population Status. Currently, various population and harvest surveys assist in monitoring beaver numbers by management zone, especially in the northern 1/3 of the state. A long term population decline in northern Wisconsin began in 1995 and continued through the most current survey in 2014. Beavers occur in all counties of the state, and population size is somewhat stable in central and southern Wisconsin, and has stabilized or increased on the Mississippi River. Although utilized as a source of food by other wildlife, the majority of beaver mortality is by regulated take via trapper harvest.

Population Management. Regulated trapping is the primary tool in managing beavers. Trapper harvest is regulated through season length, harvest limits and trapping techniques. The WDNR and the Wisconsin Trappers Association administer a mandatory Trapper Education program that includes beaver harvest methods and regulations, as well as ethical standards and responsibilities.

Forest Management. Forest management, through Best Management Practices for Water Quality, has silvicultural prescriptions that affect beaver habitat in the critical riparian zone. The use of selective harvest in riparian zones discourages regeneration of aspen that is highly preferred by beavers. Management for young forests to promote some species of game and nongame birds has the potential to benefit beavers.

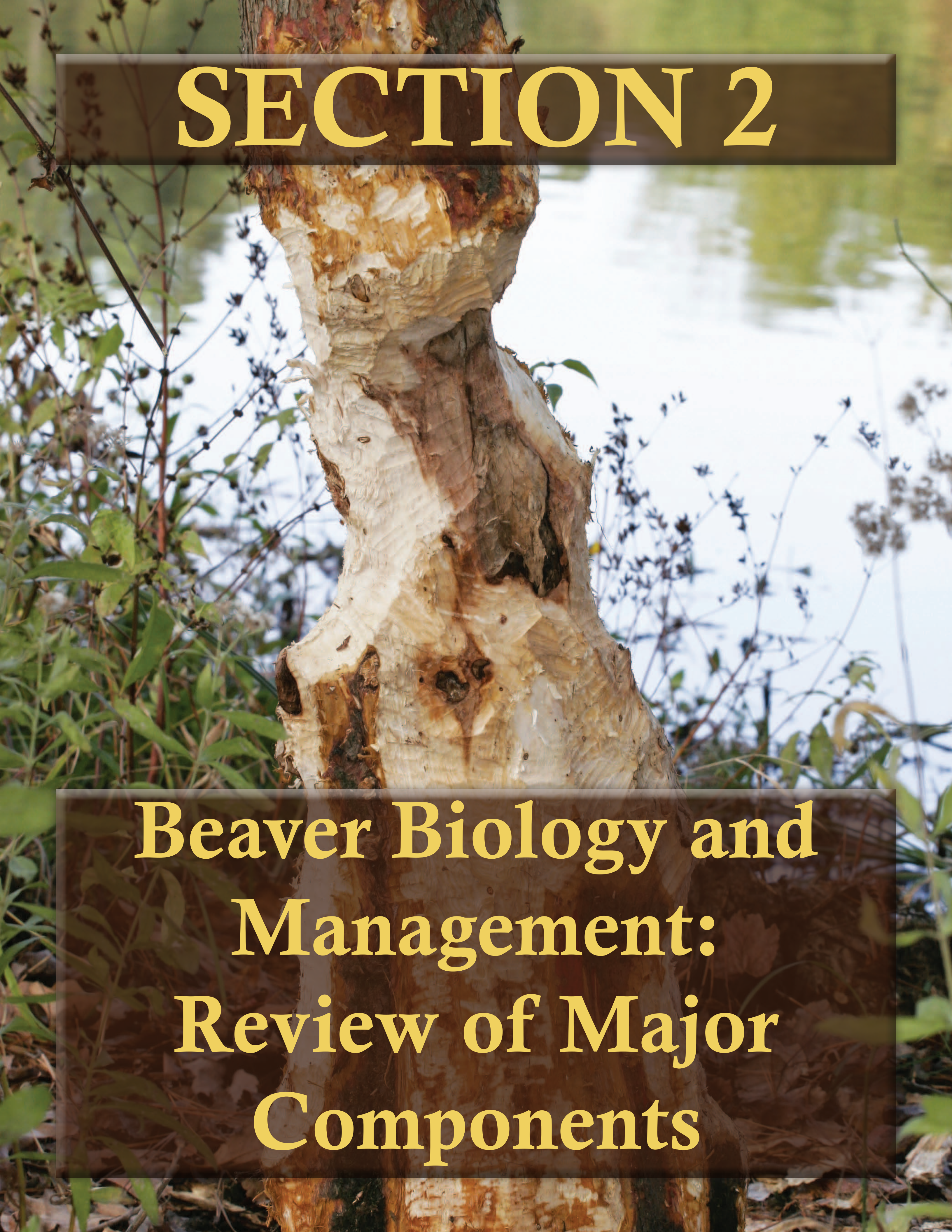
Fisheries Management. Fisheries management has developed programs that rehabilitate and protect free flowing stream conditions critical to the health and productivity of cold water organisms, especially brook trout. These programs are targeted at a limited number of high-quality trout streams. Maintaining these streams free flowing requires the removal of all beavers and beaver dams.

Damage Management. In Wisconsin, the private landowner and Wildlife Services are the primary entities addressing beaver damage. Landowners on their own property need no permits to deal with nuisance or beaver damage issues. Wildlife Services, under cooperative service agreement, follow strict protocols in handling a wide-range of damage situations.

Beaver management is a collaboration of many interests.

SECTION 2

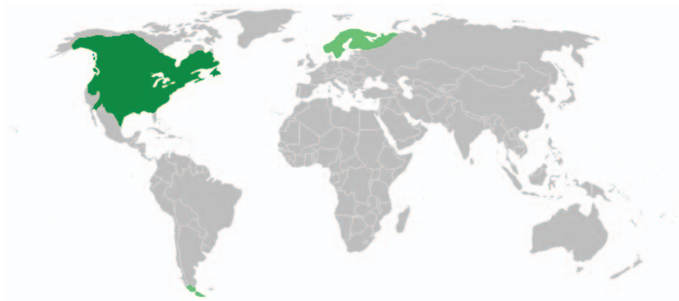
Beaver Biology and Management: Review of Major Components



BIOLOGY

Taxonomy and Physical Description

The American beaver (*Castor canadensis*) is one of two present-day beaver species. The European beaver (*Castor fiber*) is a closely related species native to Europe and Asia. Prehistoric relatives include the giant beaver, *Castoroides sp*., an extinct genus native to North America. The family Castoridae dates back to the Oligocene; the genus *Castor* first emerged in the Pleistocene or late Tertiary (Hill 1982).



Range of the American beaver (Castor canadensis) in North America where it is native and Europe and South America where it was introduced.

Beavers are the largest rodent in North America with most adults weighing 35–70 lbs. (Baker and Hill 2003), although some in southwestern Wisconsin reportedly weighed in excess of 80 lbs. (Schorger 1953). Beavers powerful hind legs and webbed hind feet propel them in the water. The large dorsoventrally flattened, scale-covered tail is used for maneuvering in water and for balance on land. The forefeet are smaller than the hind feet, heavily clawed, and are used for digging, carrying building material and handling food.

Beaver fur consists of two types of hair—underfur and guard hairs. The underfur is thin, soft, wavy and very dense. For adult beaver during winter underfur is ~1 inch long. Air trapped in the fine underfur provides excellent insulation underwater (Hildebrand 1974). Guard hairs are longer (~2–2.5 inches) and much larger in diameter than underfur hairs. Pelt coloration varies among individuals from reddish, chestnut, and yellow-brown, to nearly black.

The skull and mandibles of beavers are massive, providing a strong foundation for powerful jaw muscles and large, continually growing incisors. The outer surface of the incisors is covered by hard, orange enamel, while the inner surface is composed of softer dentin that wears faster than enamel (Novak 1987), resulting in a chisel-shaped cutting edge. The skull and incisors are well adapted to withstand the stresses associated with cutting hardwoods such as oaks and maples. The four cheek teeth are adapted for grinding plant food, with high crowns (hypsodont) and deep roots. As the cheek teeth wear, the root slowly rises higher in the jaw with bone being deposited under the roots, thereby exposing more of the crown (Hildebrand 1974). Continually exposing more of the root of the tooth helps to maintain the ability of the teeth to grind coarse food for multiple years.

Unlike a sawyer's saw, beaver incisors self-sharpen with use.

Reproduction and Mortality

Beavers in middle latitudes of North America are capable of reaching sexual maturity by 21 months, but the age of first breeding appears to be affected by population density and habitat quality (Hill 1982). Estimates of the percentage of yearlings that breed have varied from 11 to 44% (Novak 1987), with breeding by young adults tending to be lower in fully occupied habitats where dispersal is reduced (Baker and Hill 2003). Breeding by yearlings and in some situations older adults, may be inhibited by older dominant females (Novak 1987). Beavers are monogamous and each colony (extended family group) produces a single litter per year. Breeding typically occurs during January–March at middle latitudes and gestation lasts 100–110 days (Hill

1982). Litters range in size from 1 to 9 and typically average 3–4 young (Hill 1982; Baker and Hill 2003). Variation in litter size appears to be affected by habitat quality, and the age and weight of the mother (Baker and Hill 2003).

Beaver are an important summer food for wolves and black bears.

Based on examination of beaver carcasses provided by northern Wisconsin trappers from 1990–93, Kohn and Ashbrenner (1995) estimated pregnancy rates of 15% for 1.5-year old females, 62% for 2.5-year old females, and 81% for females $\geq$ 3.5 years of age. Pregnant females averaged 4.2 fetuses per litter. Peterson and Payne (1986) estimated pregnancy rates of 13% in 2-year old females and 87% for females $\geq$3 years of age in Forest and Oneida counties in 1976–77. Their estimate of mean litter size was 3.4. Zeckmeister and Payne (1998) noted that no females younger than 3 years of age bred on the Sandhill Wildlife Area in central Wisconsin in 1981 when it was opened for trapping for the first time since it was purchased by the state in 1962. Pregnancy rate and litter size increased after 1 year of regulated trapping.

Human exploitation is often the most significant mortality factor in beaver populations. Estimates of trapping mortality in studies reviewed by Novak (1987) ranged from 13% to 70%. Causes of natural mortality include severe winter weather, under-ice starvation, flooding, falling trees, intraspecific fighting, predation and disease (Novak 1987; Baker and Hill 2003). Beavers are vulnerable to predation by coyotes and wolves when they forage away from water. Wolves can prey heavily on beavers during summer months under some circumstances, but the frequency of wolf predation on beavers appears to be a function of wolf density, the abundance of beavers, and the availability of alternate prey. Voigt et al. (1976) found that the percentage of summer wolf scats containing beavers on three areas in central Ontario increased substantially during 1963–72 as deer populations in these areas declined due to severe winters. Other mammalian species that occur in Wisconsin known to prey on beavers include domestic dogs, red foxes, mink, river otters, and black bears (reviews by Novak 1987; Baker and Hill 2003). Generally, predation by these species is not considered to be significant. However, Smith et al. (1994) documented a substantial reduction of beavers on Stockton Island following the colonization of the island by black bears in the 1970s.

Diseases, Parasites and Toxins

Tularemia, a highly infectious disease caused by the bacterium *Francisella tularensis,* has caused mass mortalities of a number of wildlife species including beavers (Friend 2006). A major tularemia outbreak that was associated with significant local mortality started in Manitoba and northwestern Ontario in the late 1940s and spread throughout northern Minnesota, Wisconsin, and the Upper Peninsula of Michigan during the early to mid-1950s (Knudsen 1953; Stenlund 1953; Lawrence et al. 1956). Wisconsin trappers reported 290 dead beavers from 83 colonies with multiple mortalities throughout northern and central parts of the state in 1953 (Knudsen 1953). Substantial tularemia outbreaks were also noted in Montana and Wyoming in 1939–40, Isle Royale after 1950, and Alberta in 1952–53 (Novak 1987). Zeckmeister and Payne (1998) indicated that tularemia was documented on the Sandhill Wildlife Area in 1981. The most recent occurrence of tularemia mortality in beavers occurred in the Voyageur National Park in Minnesota in 2007. Beavers are usually infected through ingestion of contaminated water but transmission can also occur through the bite of an arthropod that has fed on an infected animal (Friend 2006). In Wisconsin, the American dog tick (*Dermacentor variablilis*), also known as the wood tick, and deer flies can act as vectors of tularemia. Beavers are highly susceptible to tularemia and death occurs rapidly, consequently clinical signs are not often observed. Humans are highly

susceptible to tularemia and severity of disease can range from mild to severe. Symptoms vary depending on how the disease was contracted. Clinical signs may include ulcers or abscesses at the site of inoculation. Non-specific signs of the disease include swollen lymph nodes, sore throat, abdominal pain, diarrhea, vomiting and pneumonia-like symptoms (Feldman 2003). Beavers are a significant source for transmission of tularemia to humans through contaminated water (Friend 2006). Hunters and trappers may be exposed to the disease through handling of infected carcasses and should take precautions, including wearing gloves and washing hands and contaminated surfaces when skinning or gutting animals.

Giardia spp. are protozoan parasites that reproduce in the small intestine of their host. In North America, *G. lamblia* infects humans and other mammals, including beavers (Gaydos 1998), who are reservoirs for the parasite and in turn contaminate the water systems they occupy (Dunlap and Thies 2002). Humans may become infected through ingestion of cysts in contaminated water, or material contaminated with infected fecal matter. *Giardia* do not appear to affect beavers or cause obvious mortalities (Dunlap and Thies 2002), however, *Giardia* infection in humans may cause diarrhea, dehydration, abdominal pain, flatulence, anorexia, weight loss and in extreme cases, malabsorption syndrome (Adam 2001). The best way to prevent human infection with *Giardia* is through good hygiene, frequent hand washing, and using a filter or iodine to treat water when traveling and hiking. Hunters, trappers and those who have contact with beavers and other wildlife should take preventative measures including wearing gloves, washing hands, and decontaminating surfaces.

Blasto is a serious, wet-soil fungal disease.

Blastomycosis is an uncommon fungal disease contracted by breathing in spores of the fungus *Blastomyces dermatitidis*. It is found in moist soil, especially where there is rotting vegetation. In North America, it is most common in the central and southeastern United States. Blastomycosis is not known to affect beavers; however, the fungus has been associated with beaver dams. Humans and canines are most commonly affected, but other animals may also develop the disease (Hagan and Bruner 1973). In humans, infection starts in the lungs and then spreads to other areas of the body including the skin, bones and joints (Gray and Baddour 2002). Symptoms are often seen once the infection has spread from the lungs and include bone and chest pain, cough, fatigue, fever, joint pain, shortness of breath and weight loss (Kauffman 2007). In humans, blastomycosis is rare and typically affects people with weakened immune systems. It should be a consideration in individuals who have been working in association with beaver dams or live in areas where the disease is endemic.

A survey of mercury in Wisconsin furbearers indicated beavers had the lowest levels in tissues of all the species analyzed (Sheffy and St. Amant 1982), therefore, consumption of beaver is unlikely

to be associated with mercury-related public health implications. In certain environments, beaver impoundments can contribute to the amount of methyl mercury in downstream water bodies due to enhanced microbial activity and oxygen depletion (Roy et al. 2009). This may result in higher mercury levels in other species associated with beaver flowages.

Population Density and Dynamics

Beaver population density is a function of habitat quality (food and water), mortality (human exploitation, disease, predation, drought), and behavior (territorial defense and intrafamily aggression) (Novak 1987; Baker and Hill 2003). Over trapping was believed to be responsible for the severe decline in beaver populations in Ontario during the 1920s (Novak 1987). An outbreak of tularemia was associated with the decline in beaver colony counts in an 11,600 mi^2 area of Ontario from 2,300 in 1949 to 900 in 1953 (Novak 1987). Novak (1987) reported beaver colony densities ranging from 0.4 colonies/mi^2 to 12 colonies/mi^2. The number of colonies on the Sandhill Wildlife Area decreased from 3.4 colonies/mi^2 to 1.3 colonies/mi^2 after the area was opened to trapping (Zeckmeister and Payne 1998). Colony density on an area adjacent to Sandhill that was open to trapping was 1.2/mi^2. Estimates of beaver colony density in northern Wisconsin, based on aerial quadrat surveys conducted at approximately 3 year intervals since 1992, have varied from a high of 0.9 colonies/mi^2 in 1995 to a low of 0.4 colonies/mi^2 in 2008 (Rolley et al. 2012).

Behavior

Beavers live in extended family groups (colonies) that usually consist of the adult pair, the current year's offspring (kits), and young from the previous year (yearlings). Occasionally, nonbreeding individuals more than 24 months of age may remain with the family group. Dispersal by 2-year-old beavers is typical and generally occurs in spring, during high water conditions, prior to the birth of kits. Beavers maintain territories by active scent marking. During ice-free periods of the year, beavers are crepuscular (active at dawn and dusk) and nocturnal.

Beavers are unique in their ability to modify aquatic habitats for their benefit by constructing dams to impede the flow of moving water (Hill and Baker 2003). Animal behavior studies reviewed by Novak (1987) suggest that dam building is an innate behavior that involves little learning. Dam building behavior appears to be triggered by the sound of moving water. Beavers also dig canals to facilitate movement of food and building materials within and between ponds. Beavers construct lodges in ponds or shallow lakes, either surrounded by water or along the shoreline. Lodges provide protection from predators and weather. Lodge construction is similar to dam building utilizing piles of peeled sticks covered with mud. The top of the lodge is not covered by mud to provide air exchange. Beavers will also dig bank dens, usually along rivers or deep lakes. Bank dens typically have an underwater entrance and an above water nest chamber.

Food Habits and Habitat

Beavers are herbivores and have been described as choosy generalists (Novak 1987). Beavers eat mainly herbaceous vegetation during spring and summer but depend on woody vegetation stored under the ice for winter feeding. Studies in the Northeast and Midwest reviewed by Novak (1987) found that during the ice-free period of the year beavers ate grasses, ferns, sedge, waterweed, pondweed, filamentous algae, horsetail, water lily, pond lily, as well as cultivated row crops. Knudsen (1962) documented that the woody tree species cut by beavers in Wisconsin included aspen, cottonwood, maple, birch, ash, and oak, along with the shrubs of willow, alder, and red-osier dogwood.

Aspen, alder, birch and willow are preferred foods for beaver.

Beavers are able to utilize a wide range of habitats from the marshes of the Deep South, to the edge of the tundra in the Arctic, to permanent flowages of the arid Southwest and from sea level to elevations up to 11,000 feet (Novak 1987; Hill and Baker 2003). Beavers will readily use artificial ponds, flowages, and drainage ditches, however natural ponds, small lakes with muddy bottoms and meandering streams are highly preferred. Rocky streams, lakes with rocky shorelines, large lakes with excessive wave action, and flood-prone areas with extreme fluctuations in water level are not preferred habitats.

Changes in Habitat Suitability

Beaver populations in Wisconsin have historically been affected by changes in habitat suitability associated with changes in forest distribution, composition, and structure. Beaver habitat suitability in the future will be influenced by these same things, as well as changes in climate, soils, natural disturbance regimes, past and current logging, habitat fragmentation, and shifts in human population density and land use (Scheller and Mladenoff 2008).

Beavers prefer early successional species like aspen or poplar when they are available. Prior to European contact, Native Americans likely increased the availability of these species in Wisconsin through their use of fire (Gartner 1997). With the decline in Native American populations and their traditional practices following European colonization, the availability of early successional species declined as forests matured. The decline in habitat suitability during 1600–1850 likely contributed to the decline in beaver populations following European settlement. Land surveys of northern Wisconsin during the mid-1800s showed that aspen was widely scattered across the north but was not abundant (Mladenoff et al. 2008).

The logging of the northern forest during the late 1800s and early 1900s together with subsequent slash fires created large areas of bare mineral soils, allowing pioneer species such as quaking aspen and paper birch to become widely established. Improved fire suppression during the 1930s increased tree seedling survival (Mladenoff et al. 2008). A forest inventory of Wisconsin, conducted in 1936, revealed a very young forest, with aspen-birch being the most prevalent forest type (WDNR 2000), favoring beaver population growth.

Aspen was and still is a fairly dominant tree growing along many streams and lake shores, but has declined in the past half century. Factors that have had an impact include natural succession and use or removal of aspen by beaver themselves. Other critically important management efforts that benefit overall watershed health, such as Best Management Practices for Water Quality and county zoning regulations, typically result in growing conditions that are unfavorable for aspen.

In addition, beaver feeding on aspen may kill acres of aspen which allow the growth of other tree species that beaver do not prefer to eat.

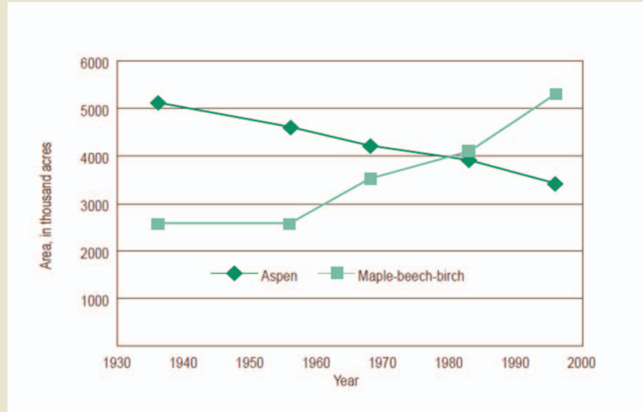


Figure 2. Area in thousands of acres of aspen and maple-beech-birch timber types, 1930–2000 in Wisconsin.

The acreage of aspen in Wisconsin has decreased since the mid-1930s and has been on a steady decline since 1983, partly as a result of natural forest succession (Figure 2; WDNR 2000). About 75% of all aspen volume is located in northern Wisconsin with another 13% in the central part of the state. The ratio of aspen removals to growth has been greater than 100% since 1996. This is much higher than the average ratio of 56% for all species. The number of saplings, poles and saw timber trees for quaking and bigtooth aspen and the number of bigtooth aspen seedlings have decreased, suggesting a decreasing presence of aspen in future forests of Wisconsin. This decline in aspen will likely result in decreased habitat suitability for beavers.

Changes in climate may affect forests, beaver and trout.

Human housing density in northern Wisconsin increased substantially during 1940–1990, especially in areas near lakes and streams, and further increases are predicted over the next 20 years (Radeloff et al. 2001). Higher housing density is expected to result in less intensive timber management and further declines in early successional tree species (Scheller and Mladenoff 2008).

Analysis of air temperature and precipitation data from across Wisconsin during 1950–2006 revealed significant warming especially during winter and spring (Kucharik et al. 2010). The northwestern and central regions of the state experienced the greatest warming. During the same period of time southern and western Wisconsin experienced an increase in precipitation while northern Wisconsin had reduced precipitation. Climate change models predict significant warming in all months with higher low temperatures, and more extreme heat (>90°F) and less extreme cold (<0°F) over the next several decades (Wisconsin Initiative on Climate Change Impacts 2011). Models also predict greater total precipitation, primarily in the winter and spring, and more heavy precipitation events (>2 inches) and fewer lighter events; however, predictions for changes in precipitation are less certain than those for air temperature.

Rising groundwater tables may cause increases in groundwater flooding. Stream base flow may increase or decrease depending on whether precipitation increases or decreases. If precipitation increases in winter and spring as predicted, we may see greater soil erosion, channel erosion, and sediment transport in streams following large runoff events. Large runoff events may also lead to stream channel widening and down-cutting. These hydrologic changes may impact beaver use of streams, and beaver dams and impoundments may impact how these hydrologic changes impact stream habitat. The degree of change may be site-specific depending on how precipitation varies across the state. Site-specific changes to groundwater availability may also be affected by differences in soil and land characteristics, topography, depth to bedrock and groundwater, and land use (Betz et al. 2011).

Climate change may affect forest communities across Wisconsin. Beaver depend on the availability of various tree species near streams for food and the construction of lodges and dams. Current models of the effects of climate change on northern forest communities predict declines in abundance of quaking aspen, paper birch, and yellow birch by 2100 (Swanston et al. 2011), which could be of future management concern.

ECOLOGICAL IMPACTS OF BEAVER

Because of their instinctive need to impound water, beavers can cause significant change to natural systems. Such change affects entire communities, benefiting some species and negatively impacting others. Beaver dams can alter stream morphology and flow, which may change nearby groundwater dynamics. Beaver dams may elevate the water table adjacent to waters impounded by dams (Wilde et al. 1950), the extent of which depends on existing stream morphology and the height of the dam.

Groundwater recharge is critical to maintaining base flow in streams that are predominantly fed by groundwater as opposed to surface water runoff. Pollock et al. (2003) reviewed a number of studies, primarily in western U.S. streams, that showed beaver dams recharged groundwater, and even established perennial flows in formerly intermittent streams. Ehrman and Lamberti (1992) found that streams with beaver dams retained water at least 50% longer than streams without beaver dams in a study of third order steams in Indiana. The extent to which beaver dams helped recharge groundwater and augment flows depended on the size, shape and hydraulic properties of the aquifer (Pollock et al. 2003), but any increase in the duration of time water is present in a watershed may increase the recharge of groundwater.

Beaver dams have positive and negative impacts.

Beavers are considered "ecological engineers" because of their ability to "directly or indirectly control the availability of resources to other organisms by causing physical state changes in biotic and abiotic materials" (Jones et al. 1997). Baker and Hill (2003) and Novak (1987) reviewed the numerous effects that beavers have on their environment. Those studies are summarized below:

- The construction of dams and canals by beavers greatly affects the structure and function of ecosystems. Dams slow current velocity, increase deposition and retention of sediment and organic matter, and reduce turbidity downstream. They increase the area of soil-water interface and elevate water tables. Dams change annual stream discharge rate by retaining precipitation runoff during high flows and slowly releasing it during low flows. Beaver dams alter stream gradients by creating a stair-step profile. Beaver canals spread impounded water over a larger surface area, thus magnifying the effects of single dams. Beaver dams generally decrease channel and stream bank erosion and increase sediment deposition.
- Beaver activity alters the biogeochemical characteristics of watersheds through the

accumulation, availability and translocation of nutrients and ions. Beaver ponds have higher carbon inputs, higher carbon standing stock and higher carbon outputs than riffles. Beaver ponds have much longer carbon turnover time and higher accumulation of nitrogen than riffles. Beaver transported organic materials from forested uplands to ponds, later become available for vegetative growth when ponds become meadows. Transport of water through beaver ponds can neutralize acids, increase pH, and increase dissolved oxygen concentrations in acidic systems.

- Higher water tables caused by beaver dams generally kill upland vegetation and promote establishment and growth of wetland vegetation. Beaver activities can improve conditions for seedling establishment of willow, cottonwood, and other riparian species. Beaver cutting can stimulate vigorous resprouting, increasing biomass production in many woody riparian species. In Minnesota, beaver decreased tree density and basal area near ponds. Selective foraging by beaver decreased aspen and increased alder and conifer with long-term effects on forest succession. Beaver meadows dominated by grasses and sedges often develop on the rich sediments left in drained beaver ponds. Meadows may resist invasion of conifers for decades due to lack of ectomycorrhizal fungi.

Beaver ponds have positive and negative impacts.

- Beaver ponds affect species composition and abundance of stream invertebrates. Species that prefer running water are replaced by pond species. Community function changes with shifts in foraging strategies of species. The importance of collectors and predators increases while the importance of shredders and scrapers decreases. In Quebec, the density and biomass of invertebrates was 2–5 times higher in ponds than in riffles in spring and summer. Leaf beetles that fed on cottonwoods grew faster and were heavier at maturity due to more total nitrogen in beaver-cut regrowth. A study in New York found that mosquito populations were lower after beaver impounded an area of poorly drained forest; mosquitoes were unable to breed in permanent water of ponds.

- Beaver impoundments may alter density, distribution and species composition of fish. In areas where low flows or extremely cold water temperatures are limiting, especially in higher altitude areas in western states, trout habitat may be improved by beavers. In contrast, in many lowland areas in eastern and midwestern states where trout are limited by high water temperatures, beaver ponds may increase water temperatures (see Ecological Impacts on Cold water Fish Communities, page 32). Dams may restrict fish passage but fish may be able to pass over dams during high water or passage may be possible if dams are fully or partially washed out. In Minnesota, beaver ponds served as a reproductive "source" population for fish. A study in Georgia found that warm water fish species richness increased with pond age up to 9–17 years. The effects of beaver ponds on fish species richness varied based on size and age of ponds and how ponds are distributed within the landscape.

- Relatively few studies have quantified the effects of beaver ponds on reptiles and amphibians. A study in South Carolina did not find differences in species richness and abundance of amphibians between beaver ponds and unimpounded streams. However, species diversity of reptiles was highest at old beaver ponds, intermediate at new ponds, and lowest on unimpounded streams. Several species of turtles expanded their range with beaver range expansion.

- Beaver ponds provide important nesting, brood-rearing and migration habitat for numerous species of waterfowl. Ponds provide dense nesting cover and dead trees provide nest sites for cavity nesters such as wood ducks and hooded mergansers. The increased production of invertebrates provide food important for brood rearing. In Maine, an increased beaver population was associated with increased density of Canada geese, hooded mergansers, and mallards. Beaver ponds have been found to benefit woodcock, ruffed grouse and wild turkeys. A New York study found that 92% of 106 wetland bird species were associated with beaver ponds.

- Beaver ponds supply habitat for large mammals such as deer, moose, elk, and black bears, with increased abundance or palatability of woody and herbaceous forage. Ponds are widely used by other species of semiaquatic furbearers (river otter, mink and muskrat). A study in Idaho documented that the biomass of voles and shrews was 2–3 times higher in beaver pond habitat than in adjacent riparian habitat.

In addition to the studies summarized by Baker and Hill (2003) and Novak (1987), McMaster and McMaster (2000) found the hydrological gradient created by beaver dams, along with beaver activity and beaver artifacts (dams, lodges, canals, food caches, etc.) contributed to high vascular plant diversity in a Massachusetts study. However, increased densities of beaver may pose a threat to later successional wetland species (McMaster and McMaster 2000). In regards to wild rice waters, the Minnesota Department of Natural Resources (1993) found beaver can dam up outlets, causing lake levels to rise and preventing wild rice from producing at its earlier abundance.

Beaver ponds benefit many species and can be aesthetic.

Cunningham et al. (2007) documented the best predictors of wetland sites with high amphibian species richness were connectivity of wetlands through stream corridors and wetland modification by beaver. Beaver recolonization increased number and diversity of available breeding habitat types for pond-breeding amphibians (Cunningham et al. 2007).

The North American beaver was introduced into Scandanavia in the 1930s and is now the most commonly found beaver in Finland. In a long-term study (1988–2001) of beaver flooding effects on Eurasian teal in boreal areas of Finland, Nummi and Hahtola (2008) found pond use by teal broods systematically increased upon beaver flooding. Beaver ponds contained more resources such as aquatic invertebrates and had shallower shores than other waters, which is a more favorable structure for ducklings. As a result, teal brood mortality was lower in beaver ponds than in waters unaffected by beaver (Nummi and Hahtola 2008). Nummi and Holopainen (2014) researched beaver recolonization in Europe and found the number of waterbird species per pond per year and waterbird abundance per survey increased during beaver inundation. Of the seven species studied (including Mallards and Common Goldeneyes), all seven increased in abundance, though only three increased significantly and the most substantial increases were during the first two years of flooding (Nummi and Holopainen 2014).

Wisconsin waterfowl breeding surveys from 2002–2011 indicate that the northern 1/3 of Wisconsin supports 48% of Wisconsin's breeding wood duck population and 38% of the mallard population (Van Horn 2011). These waterfowl survey regions overlap closely with Beaver Management Zones A and B. Beaver-related wetlands provide necessary habitat for wood ducks, mallards, and other waterfowl in Wisconsin.

Ecological impacts on cold water fish communities

The scientific literature is ambiguous about the impacts of beaver dam construction or removal on cold water streams and trout populations therein. Beaver dams may create ephemeral pool habitat that benefit trout in high gradient streams in mountainous areas (Pollock et al. 2015), but in lower gradient streams in the Midwest, beaver dams may be lasting structures causing long-term detrimental impacts to streams. Such impacts may include siltation of the streambed and disruption to stream habitat connectivity (Novak 1987; Baker and Hill 2003).

McRae and Edwards (1994) found no consistent relationship between the size or number of beaver dams and their impacts on downstream water temperatures in four northeastern Wisconsin streams, and according to Pollock et al. (2003), detrimental population-level effects of beaver dams on trout have not been demonstrated in the scientific literature. In contrast, Avery's study on the Pemonee River and seven of its tributaries from 1982 to 2000 (Avery 2002) showed that the removal of 546 beaver dams by 1986 and the maintenance of free-flowing conditions through 2000 resulted in decreases in stream temperatures and increases in brook trout abundance and size structure in 2000 as compared to 1982. While the data suggest the removal of beaver dams has improved the trout fishery in the Pemonee River system, questions have been raised on the lack of control streams in the study and the extent to which the study results can be generalized to cold water streams throughout the state. However, additional baseline stream monitoring surveys and habitat project evaluations throughout Wisconsin have also identified beaver dam removal as a positive factor related to improvements in brook trout abundance, size structure, and biomass, as noted, below.

Beaver ponds can put some species at risk.

Intensive beaver and beaver dam removal in Forest and Florence Counties has been ongoing since 1988. Brook trout abundance on eight streams has increased significantly, in many cases over 10 fold, since beaver and dams have been removed. Beaver control was the only habitat manipulation conducted on these streams (Nelson 2012, unpublished WDNR Fish Management data/report).

Intensive beaver and beaver dam removal was initiated on the South Fork of the Kinnickinnic River, Pierce County, in 1991. Abundance of brook trout (number per mile) monitored over time at three stations documented very low brook trout abundance prior to beaver removal (1974–1991) and a steady increase at all stations from 1996 to 2012. Current abundance places the stream in the upper 90th percentile of similar trout streams in the area. Cold water IBI (Index of Biotic Integrity; a measure of cold water stream habitat quality) increased from "very poor" to "good" over the same time period (Engel 2012, unpublished WDNR Fish Management Report).

Brook trout abundance was compared on eight trout streams with significant beaver damming (no beaver control) and six trout streams with active beaver control efforts to maintain free-flowing conditions in Sawyer County. No trout were found in seven of the eight streams without beaver control. Surveys in 2007–2011 on streams with active beaver control documented from 25 to 1,940 trout per mile including significant numbers of young-of-year fish in some stations (Wolter 2012, unpublished WDNR Fish Management data/report).

An additional trout management concern is the increased incidence of gill lice (*Salmincola edwardsii*) infections as anglers are currently reporting more infected brook trout in more streams. Beaver dams, as they interrupt stream flow and reduce stream velocity, are hypothesized to play a role in gill lice-brook trout dynamics. Gill lice are ectoparasites that infect brook trout but not brown trout. Recent data suggests that species interactions between brook trout, brown trout, and gill lice in the context of changing environmental conditions can lead to declines in brook trout recruitment and possibly extirpation (Mitro et al. 2014). Gill lice have a free-swimming larval stage, and low stream flow and stream velocity conditions may facilitate the detection of a brook trout host by the larval parasite. Research is needed to understand to what extent the interruption of free-flowing conditions by beaver dams may be contributing to gill lice dynamics in Wisconsin trout streams.

Gill lice threaten brook trout.

ECONOMIC IMPACTS

The economic value of beaver trapping has many components. These include the market value of the fur, the value of the meat for human or animal consumption, the value of the lifestyle associated with trapping, the recreational value of outdoor activities, the value to people employed in the fur industry, and the consumer value of fur products (Shieff and Baker 1987). In addition to their value for consumptive recreation, beavers have value for non-consumptive wildlife watching and general aesthetic value.

Recreational trappers benefit local economies throughout the state, but especially in northern Wisconsin, through their expenditures on transportation, fuel, food, supplies, and lodging, as well as, local processing and sale of beaver fur and pelts. Trappers also provide revenue to the DNR through license fees.

Limited information on economic impacts of beaver pelts can be garnered from the Wisconsin Fur Buyers Report and the Wisconsin Beaver Trapper Questionnaire which provide average pelt prices paid by licensed fur buyers in Wisconsin (not including those sold by auction houses) and an estimate of beaver numbers harvested by trappers (Table 1). During 2000–2011, the total value from reported sales of pelts averaged more than $800,000/year (Dhuey 2000–2012; Dhuey and Olson 2000–2012).

While estimated expenses are not specific to beaver trappers, fur trappers collectively reported expenses of approximately $1 million dollars/year for traps, lures, gas, licenses, etc. This expense

Table 1. Take of beaver in Wisconsin by licensed trappers, 1990–2013.

Year	Beaver Harvested*	Average Pelt Price^	Estimated Total Pelt Value
1990	21,253	$10.04	$213,380.12
1991	20,253	$4.36	$88,303.08
1992	21,648	$8.43	$182,492.64
1993	49,099	$15.23	$747,777.77
1994	60,545	$14.45	$874,875.25
1995	35,821	$16.46	$589,613.66
1996	24,835	$20.44	$507,627.40
1997	36,320	$17.76	$645,043.20
1998	19,160	$11.21	$214,783.60
1999	39,416	$12.83	$505,707.28
2000	62,628	$15.38	$963,218.64
2001	71,985	$13.57	$976,836.45
2002	66,410	$12.67	$841,414.70
2003	62,126	$14.86	$923,192.36
2004	71,985	$14.86	$1,069,697.10
2005	63,849	$21.15	$1,350,406.35
2006	48,716	$20.30	$988,934.80
2007	29,924	$18.73	$560,476.52
2008	37,425	$12.94	$484,279.50
2009	31,049	$14.51	$450,520.99
2010	25,540	$14.65	$374,161.00
2011	46,413	$21.15	$981,634.95
2012	29,374	$22.17	$651,221.58
2013	25,544	$18.59	$474,862.96

* Estimate based on annual Beaver Trapper Questionnaire
^ Based on annual Fur Buyer Report

estimate does not include any economic multiplier. In addition, beaver trapping by citizens may provide a service to local communities by reducing beaver populations and their potential damage thereby reducing local tax payer expenses. Beaver harvest also generates a valuable product in the form of furs and lures, and provides food for humans and pets.

Beaver colonies often develop and maintain wetlands of significant size. While the relationship between beaver abundance and wetland acreage has not been quantified in Wisconsin, Hood and Bayley (2008) found a strong relationship between the number of active beaver lodges and the area of open water in Elk Island National Park, Alberta, Canada. Additionally, the area of wetland habitats on the Kabetogama Peninsula in Voyageurs National Park increased more than 10 fold between 1940 and 1986 as the beaver population increased from near extirpation to a density of 2.6 colonies/mi^2 (Johnston and Naiman 1990).

Wetlands provide economic benefits to Wisconsin.

Although the positive ecosystem services associated with wetland development and maintenance by beavers have not been directly quantified, a recent economic study of Wisconsin wetlands provides a preliminary view of the economic value of the state's wetlands (Batker et al. 2012). This study used benefit transfer methods to approximate the value of 10 of 22 ecosystem services associated with the 5.3 million acres of wetlands in Wisconsin and estimated a range of $3.3 billion to $152 billion per year in economic benefit to the state. Because only a subset of ecosystem services was assessed, the authors felt this was a significant underestimate of the true value. The valued services included: protecting against flooding, assuring water supply, buffering climate instability, maintaining critical habitat, providing waste treatment, maintaining biodiversity, and providing aesthetic and recreation opportunities. Therefore it is logical to conclude that wetland habitats created and maintained by beavers provide substantial beneficial ecosystem services to Wisconsin.

An example of economic benefits associated with managed, high quality cold water streams is provided in a report commissioned by Trout Unlimited on the economic impact of recreational trout angling in the Driftless Area (NorthStar Economics 2008). The Driftless Area comprises parts of southwest Wisconsin, southeast Minnesota, northeast Iowa, and northwest Illinois. NorthStar Economics estimated that recreational trout fishing in the Driftless Area generated an economic impact of about $1.1 billion to the local economy of these four states.

The WDNR's sale of Inland Trout Stamps generates over $1.5 million dollars annually which are apportioned to WDNR Fisheries Management teams across the state and used to restore and enhance cold water stream habitat to benefit trout. Additional funding is provided by general fishing license fees and trout angler groups. Beaver dams damage these restoration efforts by inundating re-established riparian vegetation and in-stream habitat structures. Most of this damage is in the northern part of Wisconsin where approximately $250,000 of the total annual statewide appropriation is invested annually in trout stream habitat restoration, much of it to restore beaver-damaged stream channels.

Beavers also can cause damage to private property and public infrastructure such as trees, roads, culverts, and bridges. The economic impacts of nuisance behavior by beaver may include loss of property, maintenance costs for repairing damaged infrastructure, and labor and supply costs for animal control specialists. The cost of beaver damage in Wisconsin reported to Wildlife Services during 2009–2011 averaged $1.3 million/year (USDA APHIS Wildlife Services 2013), not including damage that was not reported because landowners or managers dealt with the beaver problems themselves. Wildlife Services estimated that the value of resources protected in Wisconsin during 2009–2011 averaged approximately $8 million/year, including $4 million worth of timber, $2.5 million for cold water ecosystems/trout habitat, and $1.1 million for roads and bridges. Changes in regulated, licensed trapping may increase potential damages if harvest is reduced or may reduce potential damages through increased harvest.

Beaver, the Spirit Keeper.

CULTURAL CONSIDERATIONS

To many Native American cultures, the beaver is an innovative builder and an inspiration of wisdom and resourcefulness. Many indigenous cultures pass wisdom, spirituality, and traditional ecological knowledge between generations through stories of wild creatures and the passage of the seasons. Family groups and kinship are often arranged in clans based on symbolic animals. Wildlife species are therefore seen as kin to humans and are treated with reverence and respect. The beaver is a respected clan animal in several tribes in the Great Lakes Region and present in their creation stories.

In Algonquin society, the beaver is the spirit keeper of the east whose wisdom helps man master his relationship with the environment. In the Aanishinaabe culture of the Great Lakes, the beaver taught man many things, from lessons in parenting to showing man how to work together for the greater good of the community (Dunn 1995). Historically, the beaver also represented a great source of trade revenue for the Potawatomi, who often traded furs to the French for luxuries such as kettles, clothing, guns, and gunpowder (Mitchell 1995; Forest County Potawatomi Community 2008).

The beaver is tightly woven into the culture, spirituality, governance, and survival of tribes currently in the Great Lakes region. A clan animal, teacher, spiritual guide, and a source of food and clothing for tribal peoples, both historically and today, the beaver needs to be managed with care and respect and with an understanding of a different way of knowing this animal.

Beavers and other wild animals were also of tremendous importance for both practical and cultural reasons for Americans of European descent who brought with them the Judeo-Christian concept of stewardship and domination over nature (Decker et al. 2001). Wildlife exploitation was essential for the survival of early settlers, and although conditions have changed, the values held by many citizens are still deeply shaped by past relationships with wildlife. However, as the United States is evolving from an industrial to a post-industrial society, wildlife values appear to be shifting from domination to a mutualism orientation (Manfredo 2008). While the selling of beaver and other furbearer pelts remains an important source of income for many trappers (Decker et al. 2001), other citizens value the opportunity to watch or photograph beavers or enjoy the quiet solitude of canoeing on a beaver pond (Jackson and Decker 2004).

Attitudes are a direct precursor to behavior.

To effectively manage human-beaver conflicts, it is important for managers to understand people's attitudes and why they hold those attitudes (Jonker et al. 2006). Attitudes are a direct precursor to behavior. Therefore, negative attitudes toward beaver could imply public support for reducing beaver numbers while positive attitudes could suggest support for species protection. A better understanding of how values and attitudes toward beavers differ among rural and urban regions of Wisconsin and among cultures will be important for effective management of human-beaver relationships.

HISTORY OF BEAVER POPULATIONS AND BEAVER MANAGEMENT IN WISCONSIN

Historical View – Pre 1990 Plan

Presence and populations. There is limited information available on beaver population densities prior to European settlement. Alcoze (1981) estimated the beaver population in the Great Lakes drainage area at 2 million ca. 1600, or approximately 10/mi^2. Approximately 1/3 of Wisconsin is within the Great Lakes basin, so if this density was representative of the larger region, it would suggest Wisconsin's 65,503 mi^2 was home to hundreds of thousands of beavers prior to European settlement. Although beavers were widely distributed throughout Wisconsin during the period of European settlement (1600–1850), Knudsen (1963) believed they were less abundant during this period (than in the early to mid-1900s) because much of the forests in Wisconsin were in mid- to late-successional stages and were not preferred beaver habitat.

The history of beaver is the history of the region called Wisconsin.

The history of beaver populations in Wisconsin followed a pattern common to many states of the Great Lakes region. European demand for beaver fur led to the exploration and early settlement of the Great Lakes region, and by the late 1800s the intense fur trapping pressure, coupled with extensive logging followed by widespread slash fires, led to low beaver populations. Beaver populations likely reached their lowest level around 1900 (Knudsen 1963). At the turn of the century beavers could be found only in far northwestern Wisconsin (Knudsen 1963), and Jackson (1961) estimated that fewer than 500 beavers remained in Wisconsin.

A questionnaire sent to trappers in 1950 asked about beaver occurrence in the areas they were familiar with (Knudsen 1963). Beavers were reported to be present during the 1900s in Burnett, Chippewa, Douglas, Iron, and Price counties. Beavers were first reported to be present in Washburn County in 1911, Marinette and Oneida counties in 1912, Vilas in 1915, Rusk and Langlade in 1916, and Forest in 1917. First reports of beavers did not occur until the 1920s in Barron, Florence, Marathon, Polk, Sawyer, and Taylor counties.

Beavers were present in Buffalo County in the 1920s and were moving into other Mississippi River counties by the early to mid-1930s (Knudsen 1963). Beginning in 1932 (Knudsen 1963), the Wisconsin Department of Conservation (now WDNR), managed a beaver live-trapping and restocking program. Nuisance beavers in northern Wisconsin were live-trapped and transported and released in Adams, Jackson, Juneau, and Wood counties. During 1946–53, approximately 1,800 beavers were live-trapped and relocated (Smith and Knudsen 1955). These areas contained large blocks of aspen and numerous artificial wetlands created by the cranberry industry. Prior to these releases, beavers were absent or very rare in central Wisconsin. Restocking along with strict protection and changes in forest management practices which favored beavers, led to a steady increase in beaver abundance and distribution.

Beavers were believed to be absent from east-central Wisconsin for several decades prior to 1930 (Knudsen 1963). By the late 1930s, beavers were reported to occur in Portage, Sheboygan, and Waushara counties with isolated colonies in Door, Fond du Lac, Washington, and Waukesha counties. Beavers were first reported along the lower Wisconsin and Mississippi rivers in southwestern Wisconsin in the late 1930s and early 1940s. A colony in central Rock County was reported in 1961.

With our help, beaver re-colonized Wisconsin.

Pre-1990 Wisconsin Beaver Management

Trapping. Knudsen (1963) summarized beaver trapping seasons during 1850–1960 (Appendix 1). During the latter half of the 1800s, beaver trapping was allowed year round except during the late 1860s and 1870s when there was a 6 month season.

Beaver trapping seasons were closed during 1903–16 and beaver populations in northern Wisconsin began to recover. In 1917, legislation was passed that authorized the Wisconsin Conservation Department to investigate complaints of beavers causing damage, trap the beavers, and remove dams and lodges if necessary (Smith and Knudsen 1955). One or two month trapping seasons were opened in a limited number of counties during 1917–23. The trapping season was again closed during 1924–33 (Appendix 2).

During the mid to late 1930s, trapping seasons were opened in 13–18 counties during late winter-early spring for 13–60 days. Trapping seasons were closed in 1940, 1945, and 1947. During 1933–60, the number of counties opened to beaver trapping gradually increased from 17 to 58 reflecting the expansion of beaver populations from the northern part of the state into central and southwestern Wisconsin. The population growth and expansion was believed to be due to better control of forest fires in the 1930s and the subsequent regeneration of early successional stands of aspen, birch, and pin cherry (Knudsen 1963).

The 1960s and 1970s was a period of expanding beaver populations and generally increased harvest opportunities. Portions of east central and southeastern Wisconsin were still closed to beaver trapping in the 1960s. Trapping seasons were limited to 1½ to 2 months in northern Wisconsin during the early 1960s, but had been extended to 4 months by the mid-1980s. Possession limits increased from 35 beavers in northern Wisconsin in the 1960s, to 50 in the early to mid-1970s, to unlimited by the late 1970s. Beginning in the mid-1970s, trapping season extensions were enacted for targeted watersheds with high priority trout streams.

Beaver harvest was determined by mandatory pelt registration starting in 1934 (Kunelius 1990). In 1983 the requirement to register beaver pelts was removed and harvests were estimated from fur buyer surveys and trapper questionnaires (Kohn and Ashbrenner 1995). Statewide beaver harvests averaged about 10,000 during the 1950s and 1960s (Figure 3). During the 1970s and 1980s, beaver harvests generally increased to an estimated 40,000 by the late 1980s.

Regulated trapping is an important management tool.

Beaver damage complaints/conflicts. As beaver populations grew and expanded, the number of complaints about beaver damage submitted to the Conservation Department increased (Knudsen 1963). During the late 1930s, a minimum of 40 complaints were received annually primarily from far northern counties. From the mid-1940s through the 1950s the number of complaints received grew to where 400–600 complaints/year were made from all counties except for those in the southeastern part of the state.

During 1946–53, beaver complaints were received from 56 of 71 counties in the state and concerns about the effects of high beaver populations were growing (Smith and Knudsen 1955). Expanded harvests in the agricultural regions of the state in the late 1940s and early 1950s were believed to have reduced beaver populations and damage complaints in those regions (Smith and Knudsen 1955). In 1946, beaver harvest density and trapper success was highest in Buffalo County (Barger 1947).

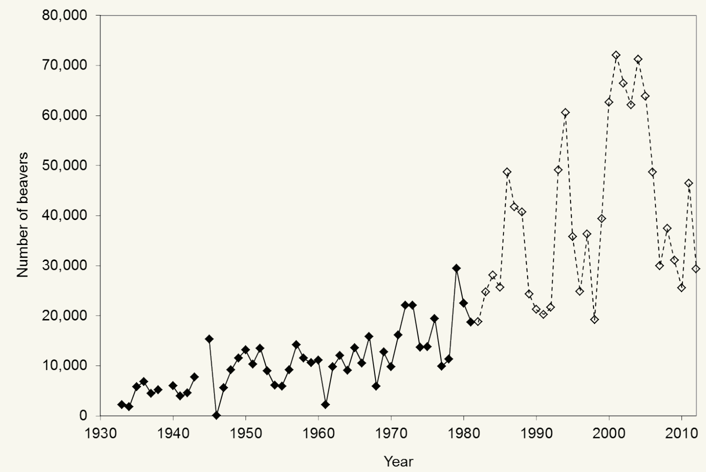


Figure 3. Estimated beaver harvest in Wisconsin, 1933–2012. Harvest based on mandatory registration (solid diamonds) or mail questionnaires to beaver trappers (open diamonds).

In Oneida and Forest counties, the number of complaints about beaver damage to roads, timber, and other resources increased steadily from the mid-1960s to the early 1980s (Payne and Peterson 1986). The increase in complaints was correlated with increases in the number of active beaver dams observed on aerial surveys and with human population growth in Oneida County.

Beaver damage can be serious and widespread.

In the early 1980s, a sharp decline in the commercial demand for beaver fur led to greatly reduced efforts by private fur trappers. By the mid-1980s, beaver populations in north central and northeastern Wisconsin had reached high levels creating numerous conflicts with people. During 1987 and 1988 more than 2,000 complaints of beaver damage were received annually (WDNR 1990) and in 1988, approximately $900,000 to $1 million was spent by federal, state, and county agencies to reduce damage to roads, trout streams, timber, crops and other resources (Kohn and Ashbrenner 1995).

Legislation was enacted in 1987 granting landowners the ability to hunt or trap beavers causing damage on their land year round without a license or permit and to remove beaver dams. The same legislation also authorized spending $100,000 annually from the Segregated Fish and Wildlife Account to pay a subsidy of $7.50/beaver for animals shot or trapped by contract holders in beaver damage control areas after the close of the beaver trapping season (WDNR 1990). In 1988, at the request of the state, Congress authorized funding for the federal Animal Damage Control (ADC) agency (now Wildlife Services) to assist with beaver damage management in Wisconsin (USDA APHIS Wildlife Services 1996). ADC entered into cooperative agreements with the WDNR (Wildlife Management and Fisheries Management) and the USFS to control beavers on priority trout streams and to protect forest resources, roads and bridges. On five trout streams, totaling 39 miles in length, that were completed in the first year of operations, ADC specialists identified 38 colonies and removed 213 beavers and 426 dams at a cost of approximately $470/mile (Dickerson 1989).

Beaver damage to trout streams. Concerns were being expressed as early as the 1930s about the effect that beavers were having on trout streams in Wisconsin, Michigan, and Minnesota (Hine 1961). The Department of Conservation sponsored cooperative projects with depression-era Works Progress Administration and Civilian Conservation Corps programs to remove beaver dams on selected waters throughout northern Wisconsin. In 1936, 740 dams were removed. Special trapping seasons were held in 1953–56 in Forest, Langlade, and Oconto counties to reduce beaver populations in several trout watersheds with trapping seasons extended 10–20 days in these areas. In 1959 the Wisconsin Conservation Department formed an interdivisional committee to address the problems of beaver management. The committee made recommendations regarding general beaver trapping, focused control activities in special problem sites, development of stream classifications, surveys to assess beaver abundance, the issuance of permits to landowners experiencing damage, and research needed to improve beaver management (Hine 1961). In 1960 a Conservation Congress study committee recommended beaver control in cases where “fishing values outweigh wetland game values”.

The U.S. Congress became involved in Wisconsin beaver management.

Starting in 1979, an annual appropriation from the fisheries account was used to attempt to increase beaver and beaver dam removal from high quality trout streams in the Antigo, Marinette and Park Falls areas. The program included contracts with trappers for beaver removal from specified trout streams during the closed season, special trapping areas bounded by roads, and subsidies paid to trappers during the open season, as well as removal of beaver dams from trout streams by WDNR Fisheries Management staff. Despite these combined efforts, numbers of beaver dams continued to increase on trout streams. A total of 25,558 beaver were removed under the subsidy program during 1983–87. While beaver harvest did increase, individual streams were not maintained as free-flowing (WDNR 1990).

Beaver research. The late 1940s and 1950s was a period of increased research interest in beavers and their effects on the environment. Donald Patterson with the Wisconsin Conservation Department (now WDNR) conducted some initial studies on the relationships of beaver and trout in northeastern Wisconsin in 1949 and 1950 (Patterson 1951). During the 1950s, George Knudsen of the WDNR coordinated a multifaceted study that addressed the types of damage caused by beavers, an assessment of the movements of relocated nuisance beavers, methods to monitor changes in beaver populations, and an investigation of the impacts of an outbreak of tularemia (Knudsen 1953, 1954, 1955a, and 1955b). Starting in the 1950s, wildlife managers flew fixed-wing aerial surveys to assess beaver abundance in their areas (Knudsen 1955b). These surveys provided an index of population trends along selected water courses but did not provide estimates of population size.

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Beaver Management – 1990 Plan

In 1989 the WDNR assembled a beaver project team (Appendix 3) to develop a beaver management plan (Pils and Addis 1992). The project team brought insights and knowledge from various WDNR programs including wildlife management, wildlife research, fisheries management, law enforcement, and forest management, in addition to financial and tribal interests. With additional input from the public and WDNR field and administrative personnel, the team built a plan that was described as a "balanced approach addressing solutions to immediate problems and the long-term plan for management of beaver" (Wisconsin Beaver Management Plan 1990).

1990 Beaver Management Plan Recommendations

- revised trapping zones and seasons
- research to better quantify beaver abundance and population dynamics
- subsidy payments to trappers to increase beaver harvests in specific areas
- a public education program on beaver management and damage control
- negative habitat management to favor long-lived hardwoods and conifers near priority trout streams
- stream specific control activities using Wildlife Services, WDNR fisheries staff, and contract trappers
- cost-sharing with counties for beaver control activities
- a beaver water bank program to pay landowners to provide habitat for beavers in central and southern Wisconsin
- broad based funding for beaver management and control

The 1990 Plan set management direction in Wisconsin.

1990 Plan Accomplishments:

The plan's recommended beaver management zones and seasons were approved by the Natural Resources Board in 1990 and implemented in 1991, to include zone A in the northwest, zone B in the northeast, zone D along the Mississippi River, and zone C in the remainder of the state (Figure 1). Initial trapping season lengths varied from 3½ months in Zone D to 6½ months in Zone B (5 months in Zone A and 4½ months in Zone C.) In 1995, trapping season length in Zone A was extended to 6½ months to equal that in Zone B. Currently, the season runs from mid-October through March in Zones C and D, and to the end of April in Zones A and B.

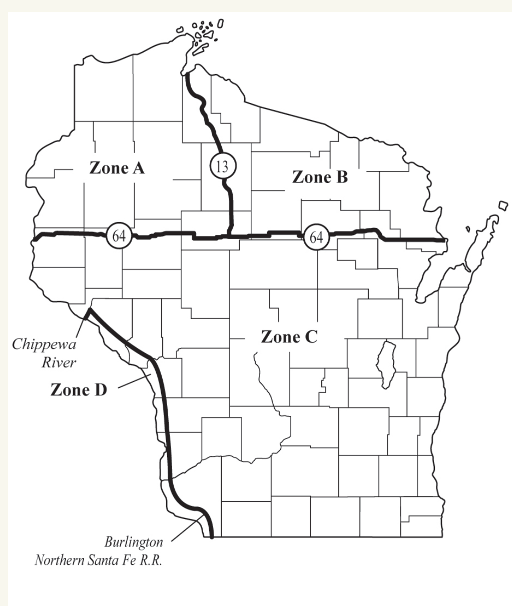


Figure 1. Current Wisconsin beaver management zones adopted in 1991.

Beaver subsidy payments were made from 1989 to 1995. The program's primary focus was northeastern Wisconsin, but in the first year several counties in central Wisconsin were included, and in 1992 the targeted area expanded to include Ashland, Iron, Price, and Taylor counties (Dantion and Brown 1994). Initially, the subsidy season

extended through the end of September, but after the first year the season was shortened to the end of April. Participation in the subsidy program ranged from 250 to 615, with an average of 327 participants per year (Peterson and Solin 1996). During this seven year effort an average of 6,445 beavers (range 5,474–7,740) were harvested annually.

Detailed records of beaver removal by Wildlife Services and Fish Management, combined with estimates of citizen harvest, show an annual beaver harvest that varied from 21,719 in 1991 to 73,445 in 2001. During 2000–2011, targeted removal by Wildlife Services averaged 2.5 % of the estimated statewide harvest (Table 2).

1990 Plan Recommendations Implemented:

- Zone management and season management was acceptable to citizens, implemented, and has been a pivotal aspect of today's beaver management program. Over time the successful control efforts in Zone B were extended into Zone A with long, liberal seasons.
- Beaver population management and research efforts were highlighted by the accurate, but expensive, beaver helicopter survey of Zones A and B. Due to costs, fall flights have occurred on average every three years since 1992, providing a reasonable assessment of population trends.
- Stream-specific control has been a major focus by Fisheries Management with annual written agreements with Wildlife Services to maintain free-flowing, high quality trout waters primarily in Zones A and B and to a lesser extent in Zone C.
- Aerial monitoring of beaver activity on select streams within the Chequamegon/Nicolet National Forest continues annually, providing citizen trappers with information and maps on the location of active beaver colonies.
- Beaver Damage Guidelines (WDNR Publication #WM-007) has provided countless landowners, lake associations, town boards, industrial and public forest managers, and citizens with up-to-date information on beaver—living with them or legal and

Table 2. Take of Beaver in Wisconsin by Wildlife Services and WDNR Fisheries, and license trappers, 1990–2014.

Year	Wildlife Services†	WDNR† (Fisheries)	Licensed Trappers
1990	1,257	48	21,253
1991	1,442	24	20,253
1992	1,282	14	21,648
1993	1,589	19	49,099
1994	1,726	22	60,545
1995	1,642	28	35,821
1996	1,976	40	24,835
1997	1,663	44	36,320
1998	1,322	44	19,160
1999	1,569	45	39,416
2000	1,304	14	62,628
2001	1,433	27	71,985
2002	1,418	14	66,410
2003	1,340	30	62,126
2004	1,499	18	71,985
2005	1,289	9	63,849
2006	1,122	41	48,716
2007	896	44	29,924
2008	1,137	35	37,425
2009	1,137	51	31,049
2010	897	73	25,540
2011	1,258	15	46,413
2012	964	8	29,374
2013	1,268	61	25,544
2014	1,455	62	^

* Estimate based on annual Beaver Trapper Questionnaire
† Based on annual reports
^ Not available until fall, 2015

No records available for public damage or nuisance take of beaver.

Beaver zones allow for regional management

The 1990 plan accomplished a great deal.

reasonable methods of controlling their damage or nuisance activities.

- Trapper subsidies were somewhat effective in increasing harvest but due to cost and an increase in average pelt prices this effort was short-lived, ending in the mid-1990s. Subsidies were not effective in complete removal of beaver on problem waters.
- Contract trappers were also somewhat effective but for the same reasons stated above, not used to any large extent today.
- Private and local government cooperation continues as needed with a number of counties entering into contracts with Wildlife Services or directly with citizen trappers. County cost share with Wildlife Services has worked well for a number of counties.
- A considerable education effort has occurred through the efforts of the WDNR (Fish Management and Wildlife Management), Wildlife Services, UW-Extension, and nature centers.
- Negative habitat management is extremely costly, but direct plantings have occurred in limited locations. The most significant change in riparian habitat has been through recent forestry practices and zoning laws. Under the current guidelines many riparian corridors are becoming less suitable for beaver, thus reducing overall long term populations.

1990 Plan Recommendations Not Implemented:

- Beaver water bank (paying landowners to provide habitat for beaver) in portions of Zone C was never attempted due to other priorities and lack of funding. However, portions of Zone C where beaver populations were low in the early 1990s, especially in the southeast now have well established populations.
- Altering the St. Croix Scenic Waterway trapping closure was not accomplished due to enabling legislation for the property. Federal legislation is required to modify the existing law, however it's important to note that private lands within the corridor are still open to trapping (with permission) and under treaty, tribal members have access as well.
- Funding options have largely been static, with the exception of a few Wildlife Services cooperative agreements with a variety of resource owners and cooperators.

BEAVER POPULATION STATUS

The 1990 beaver management plan stated: "Accurate estimates of regional beaver population levels and dynamics are an absolute necessity for the development of a long-range beaver management plan". In the early 1990s, Kohn and Ashbrenner (1995) developed a helicopter quadrat survey to estimate beaver population density in northern Wisconsin. This

survey has been the primary means for assessing changes in beaver abundance in northern Wisconsin during the past 25 years. Fall quadrat surveys were conducted approximately every 3 years from 1992 through 2014 to estimate beaver population levels (see beaver population analyses for recent reports). The estimated number of colonies in the northern 1/3 of the state in 1995 was approximately 17,270 ± 2,980 (95% confidence interval). In 2014, the estimated number of colonies was approximately 9,890 ± 2,120, 43% lower than in 1995 (Figure 4). The estimated density of beaver colonies in northwestern Wisconsin (Zone A) was 0.46 colonies/mi^2 in 2014. Estimated colony density in northeastern Wisconsin (Zone B) in 2014 was 0.53 colonies/mi^2

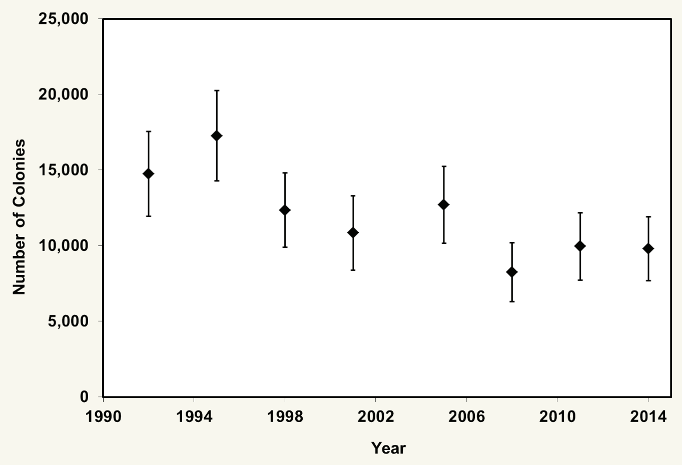


Figure 4. Estimated number of beaver colonies in northern Wisconsin, 1992–2014.

The helicopter quadrat survey performs well in Zones A and B, but no additional population monitoring is conducted in Beaver Zones C or D. Currently population estimates are extrapolated to Zones C and D based on the proportion of statewide harvest from those zones (Rolley et. al. 2009). Development of direct empirically based population estimates for Zones C and D will be critical in monitoring beaver populations in those zones. The rising cost of helicopter flight time, coupled with the large spatial extent of Zones C and D, make it unlikely that the current survey will be easily managed in those zones. Additionally, differences in the proportion of beavers that build visible evidence of their presence (dams and lodges) versus bank-denning beavers that are more cryptic could alter the detection probability on aerial surveys amongst management zones. Rising costs may also necessitate development of new tools in Zones A and B.

Helicopter use results in more accurate beaver estimates.

Since 2002, the beaver trapper questionnaire has included a question asking trappers their opinion about beaver population trends in the zone where they trapped. Between 2002 and 2012, there was a substantial increase in the percentage of trappers in Zones A and B who responded that they believed beaver populations were declining (Figure 5, page 44). Trappers in Zone C have fairly consistently reported stable populations over the last 11 years (Figure 6, page 45). In Zone D, the percentage of trappers reporting stable or increasing populations during 2002–12 has increased while the percentage reporting declining population trends in the zone where they trapped has decreased (Figure 6).

BEAVER AND BEAVER HABITAT MANAGEMENT

Wildlife Management

A primary tool in management of furbearers has been regulated trapping, conducted by licensed trappers during established harvest seasons. Also contributing to population management are government agencies primarily focused on specific nuisance or damage issues, and landowners who, on their own, control beavers causing nuisance or damage on their property. Although landowners may legally dispatch beavers by shooting, the time-proven tool for effective management has been the trap and the licensed trapper. Therefore, controlling trapper harvest

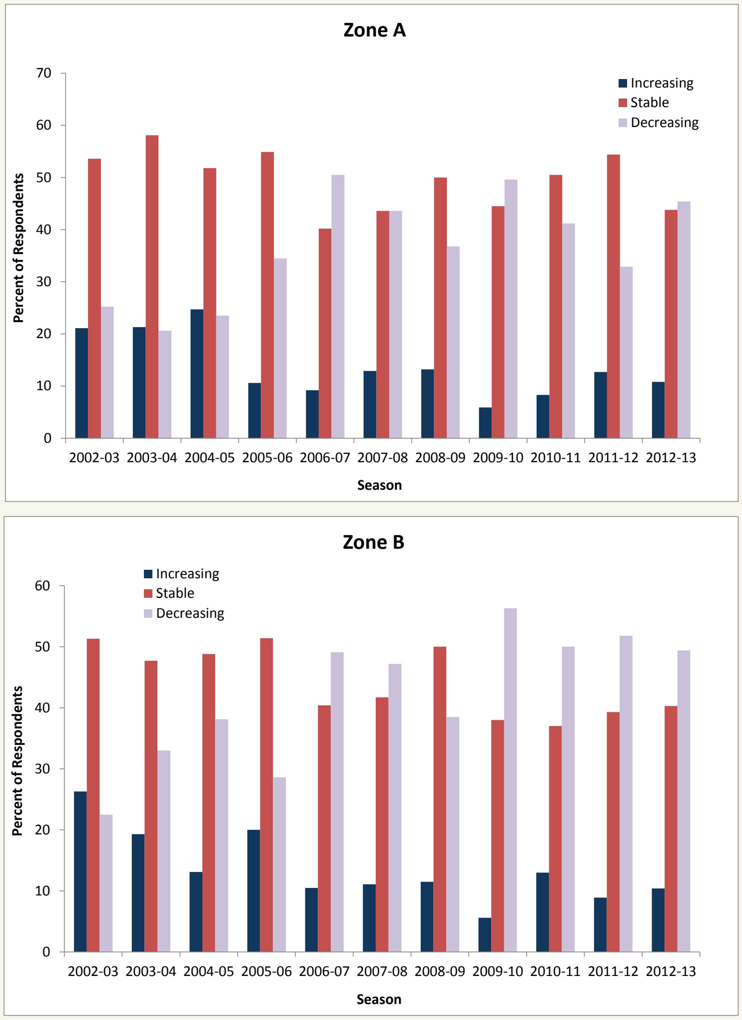


Figure 5. Trapper opinions about beaver population trends 2002–2013 in Zones A and B.

through season lengths, trapping techniques, and limits on take are critically important in beaver management. Short seasons tend to allow population growth, whereas long seasons reduce populations, primarily due to extended trapper activity. Under the current beaver management plan, Wisconsin has the longest regulated harvest season in history and it has been highly successful in population reduction.

Evaluation of these trapping variables is difficult without accurate estimates of harvest. Beaver registration was required and accurately estimated harvest until 1982. Current harvest estimation methods rely upon returns from beaver trapper questionnaires (Dhuey and Olson 2012). Estimates of statewide trapper harvest of beavers, based on questionnaires mailed to those who bought a trapping license, fluctuated widely during the 1990s from about 20,000 in 1991–92 to over 60,000 in 1994–95 (Figure 3; page 38). Estimated harvest was consistently high during the early to mid-2000s, averaging over 65,000 during 2000–2005. However, since the 2005–06 season, with little to no change in season length, estimated statewide harvest has declined 60%. During 2000–04, approximately 75% of the statewide beaver harvest was from the northern 1/3 of the state (Zones A and B). However, the percentage of the statewide harvest from northern Wisconsin declined to an average of about 66% during 2007–10, and to 54% in 2011–12 (Figure 7).

Beaver have relatively slow population growth rates which leaves them vulnerable to overharvest. Sustained yields vary by habitat type. Estimates of sustainable annual harvest from beaver populations range from 20–36% (Hill 1982; Novak 1987). The accuracy of Wisconsin's beaver harvest estimates has been questioned; however, those estimates are still useful in exploring relative sources of human-caused mortality. According to state harvest estimates licensed trappers annually took from 19,160 to 71,985 beavers (mean = 42,392) between 1990 and 2012. Beaver control efforts by state and federal agency personnel annually ranged from 940–2,016 beavers/year (mean = 1,411) over the same time period (Table 2, page 42). The number of beavers that are legally killed by landowners because they are causing damage on their land is unknown, but it is not believed to be a significant source of mortality. Trapping is the vast majority of human-caused mortality in the population and is the primary tool by which populations have been reduced during this time period. Any effort to increase or decrease beaver populations will require a respective change in state licensed harvest to be effective.

Through a cooperative program the Wisconsin Trappers Association has combined with the WDNR to provide mandatory trapper education for residents and non-residents. This program identifies the responsibilities of a trapper, humane tools and methods of harvest, rules and regulations, and ethical standards, as well as other important topics.

Management of furbearers is a primary responsibility of the Mammal Ecology Section of the Bureau of Wildlife Management of the Land Division of the WDNR. A Furbearer Advisory Committee was established that includes various department personnel, county, tribal, and federal agencies, and key cooperators. Through this effort citizens and citizen organizations have become direct partners in furbearer management. This committee structure is designed to allow flexible management with direct input while using the best available research in developing recommendations for consideration by the Wildlife Policy Team and ultimately the Natural Resources Board.

The Bureau of Wildlife Management issues licenses for wildlife rehabilitation and the temporary care of wild

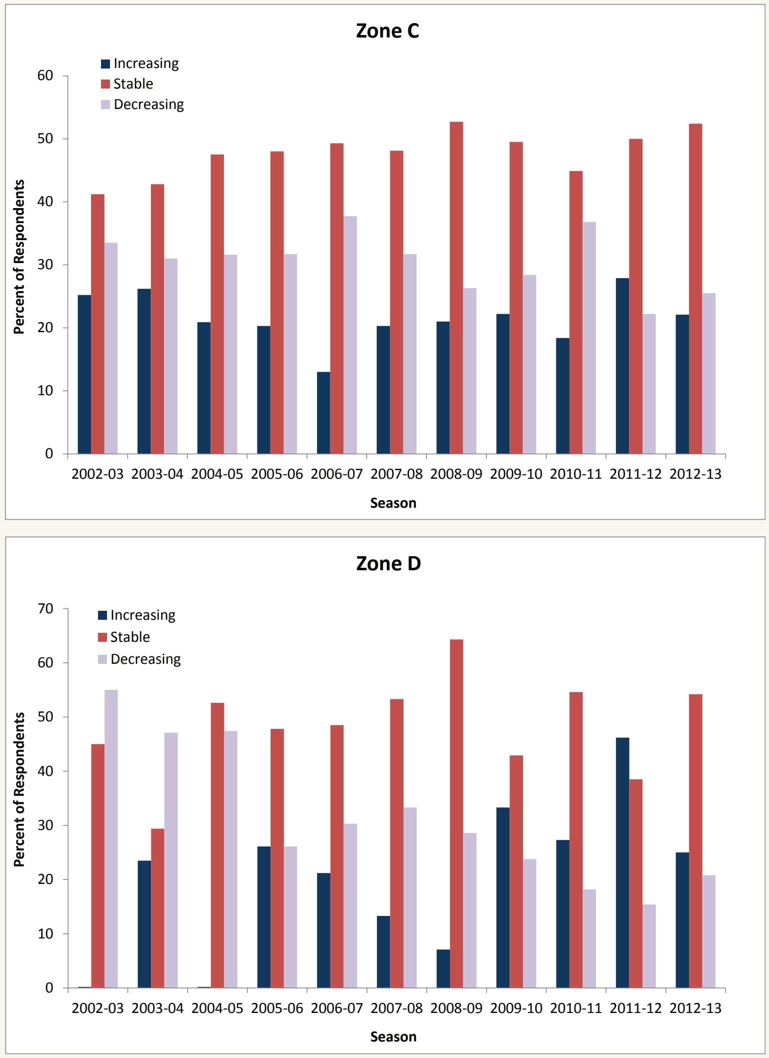


Figure 6. Trapper opinions about beaver population trends 2002–2013 in Zones C and D.

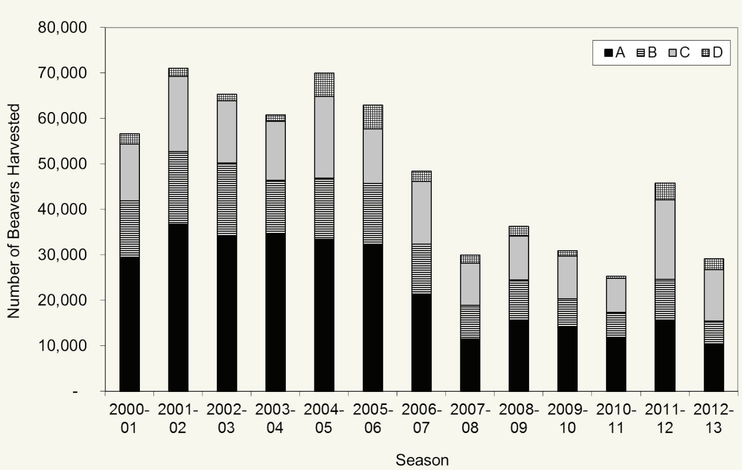


Figure 7. Estimated beaver harvest by management zone (A, B, C, D), 2000–2013.

Commercial forestry is central to beaver habitat management.

animals, and also separate licenses for the captive possession of wild animals native to Wisconsin. To date, wildlife management does not support the placement of beaver into captivity, whether for temporary rehabilitative care or for permanent captivity. Some Wisconsin rehabilitation centers may have facilities to rehabilitate beavers, but this is not a common activity because of the specific requirements in beaver rehabilitation and because beavers are rarely brought to rehabilitation centers. In the past 6 years, less than 10 beavers have been admitted to rehabilitation centers.

Forest Management

Beavers are dependent on trees for food and shelter; therefore they are affected by forest management practices by public and private landowners. Beavers prefer early successional species such as aspen and birch and land management decisions that affect the availability of these species, especially near streams and lakes, affect beaver habitat suitability.

Forestry BMPs for Water Quality are intended to protect water quality, water temperature, nutrient balances, habitat diversity, and hydrologic processes in lakes, streams, and wetlands, before, during, and after forest management activities. One aspect of Forestry BMPs involves riparian management zones (RMZs) next to lakes and streams. These areas are complex ecosystems that provide food, habitat, and movement corridors for aquatic and terrestrial species including the beaver.

Forestry BMPs generally prescribe the use of selection harvests within a RMZ to promote long-lived tree species (such as maple, ash, elm, pine, oak) to the site. This helps to ensure that there are enough trees to shade streams, stabilize shore lands, and provide food and habitat for aquatic organisms. However, managing for long-lived species may discourage beavers and decrease populations.

Aspen is a short-lived tree species with a rotational age of generally 40 to 65 years in Wisconsin. The most common way to regenerate aspen is with a coppice (clear-cut) method, where most of the trees are cut. When aspen is the dominant cover type within a RMZ, a conflict may result in terms of managing for regeneration of aspen and managing for riparian functions. On cold water streams in areas with high beaver populations, it is often recommended to increase the RMZ width and manage tree harvest within the RMZ to encourage species such as white pine, sugar maple, oak or spruce and discourage regeneration of aspen or white birch.

Another type of forest management that influences beaver populations is young forest management. Young forests provide critical habitat for numerous upland game species including ruffed grouse and American woodcock, and birds such as the golden-winged warbler, a Species of Greatest Conservation Need. While there are many different young forest communities present in the state, one of the most important components of young forest management in Wisconsin is regenerating aspen stands. Although there is more than 2.5 million acres of aspen in Wisconsin (unpublished WDNR Forestry data, 2012; Figure 8), a majority is in private ownership, which is less likely to be maintained through clear-cutting or regeneration cutting practices resulting in a long-term decline. Several strategic conservation initiatives are being developed to address young forest habitat needs for a number of species including Woodcock and Golden-winged Warblers (Kelley et al. 2008). These initiatives have the potential to benefit beaver populations, as well.

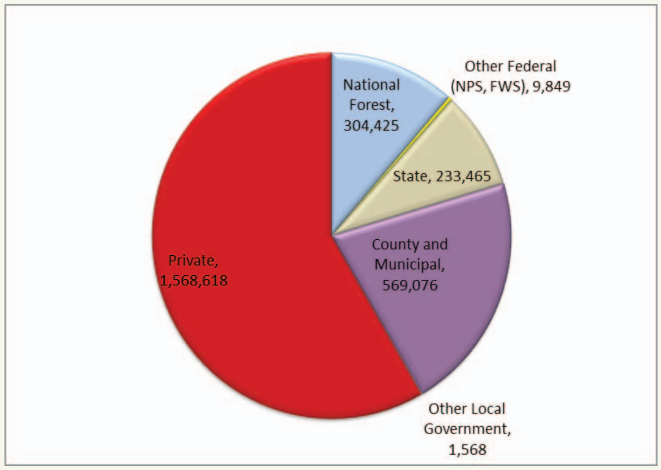


Figure 8. Aspen acreage by ownership in Wisconsin, 2012.

Young forests benefit beaver and many other wildlife.

Fisheries Management

Wisconsin has a total of 37,951 perennial stream miles. Approximately a third, 13,090 miles, are classified as trout streams (Surface Water GIS layer, WDNR). The distribution of trout streams is clustered around the state. Several counties have no trout streams, and in Pierce County all of the perennial streams are trout water (Figure 9).

Most of these trout streams contain native brook trout populations, naturalized brown trout populations, or both. A naturalized trout species is defined as non-native species that has been stocked or introduced into the wild, reproduces successfully to sustain its population, and is now considered part of the environment. A number of tributary streams to the Great Lakes, particularly Lake Superior, also support anadromous naturalized salmonids including brown and rainbow trout, coho and Chinook salmon in addition to native brook trout. The best of these trout streams, identified as Class 1, make up 40% of all trout waters and support abundant wild populations of trout year round. Class 1 trout streams represent less than 50% of total perennial stream miles in all counties except Menominee and Shawano where they comprise 60% and 51% respectively of the perennial stream miles (Figure 9). The majority of trout streams are Class 2, making up 45% of all such waters. They support year-to-year survival and carryover of adult trout and support some natural reproduction, but trout population densities vary considerably based on habitat. Class 2 trout streams typically receive supplemental stocking. Class 3 trout waters make up the remaining 15% which hold trout seasonally or require stocking to maintain a trout fishery due to poor year-to-year survival (WDNR 2002).

Beavers are a challenge to trout management in most trout streams in Wisconsin. This is primarily due to the relatively low gradient of Wisconsin streams and wide spatial distribution of key trout habitat types. This situation is particularly acute in Northern Wisconsin. Issues affecting trout include warmer summer water temperatures that may cause direct mortality, colder winter water temperatures which may affect egg incubation, blocked migrations, especially important when spawning areas are limited, siltation of feeding and nursery habitat, stream channel degradation, and loss of riparian vegetation, particularly tree species such as white cedar (Avery 1983).
While the 18 year study of beaver/trout relationships by Avery (2002) is the most comprehensive work, Fisheries Management conducts baseline monitoring and special project evaluations

of stream trout populations statewide. Data from these surveys provide additional case histories indicating a negative interaction between beaver and brook trout in Wisconsin. (See Ecological Impacts on Cold water Fish Communities, page 23).

Beaver can be a challenge to trout management.

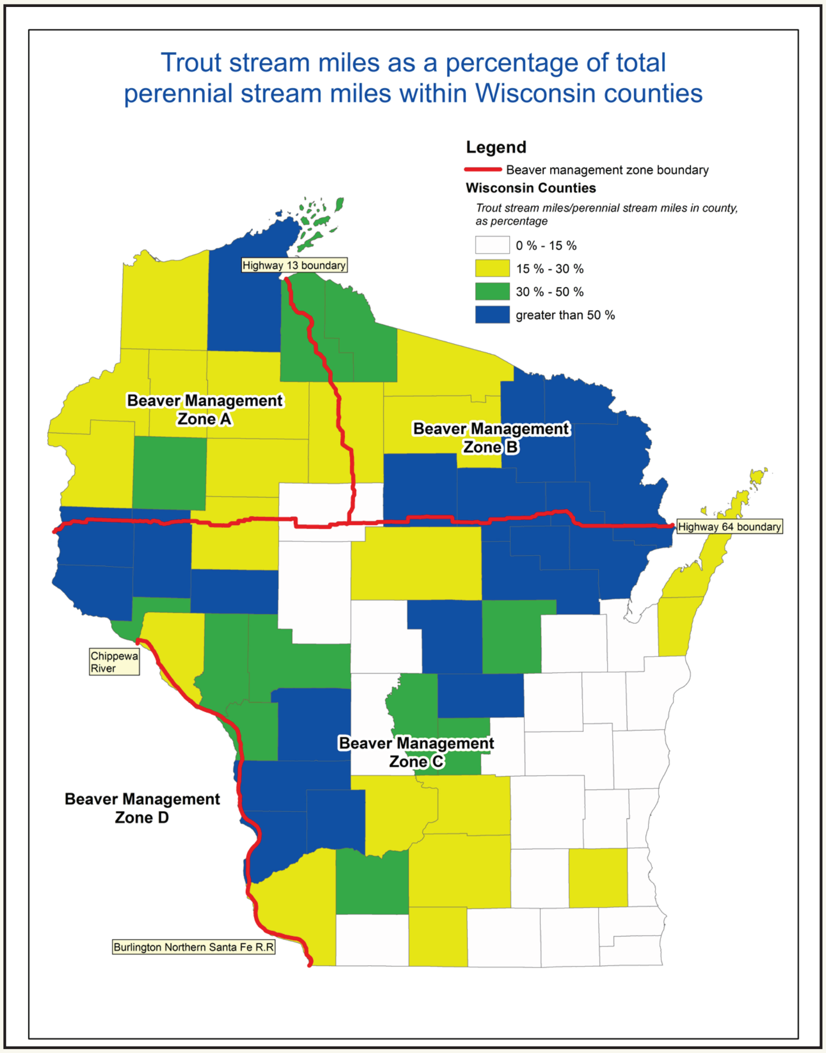


Figure 9. Trout stream miles as a percentage of total perennial stream miles within Wisconsin counties.

The cooperative agreement between WDNR Fisheries Management, USFS, and Wildlife Services is the principle means of beaver control for cold water stream habitat protection and rehabilitation. Some Fisheries Management teams also conduct stream specific beaver control efforts on a smaller scale. These efforts protect high quality existing stream habitats as well as the considerable investment in stream habitat restoration conducted by WDNR and cooperating agencies and organizations across Wisconsin. The combined efforts of these agencies to remove all beaver and beaver dams is focused on less than 30% of the total perennial stream miles in all counties of Wisconsin with the exception of Oconto County (33%) and Langlade County (63%; see the Damage Management section of this plan below for a more complete description of the program).

Cold, free-flowing streams are important to brook trout.

In 2013, WDNR completed a survey of trout anglers (Petchenik 2014) in Wisconsin. An 18 page survey was mailed to a random sample of 1000 buyers of the Inland Trout Stamp during 2011. The response rate was 56%. Anglers were asked several questions pertaining to beaver dams on trout streams. Slightly more than a third (37%) reported that they would never fish (9%) or would prefer not to fish (28%) a stream where beaver dams were present. A much smaller percentage (13%) reported that they would prefer to fish a stream where beaver dams were present. No anglers said they would only fish such streams. However about half of the anglers said that the presence (47%) or absence (55%) of dams had little influence on their decision to fish a stream. Further, only one in ten stream anglers (32 respondents) was very familiar with Wisconsin's Beaver Damage Management Program and those few anglers were about evenly split on their satisfaction with the program. The question did not ask the reason for satisfaction or dissatisfaction though the author speculated that dissatisfaction may have been related to not enough control effort being exercised. The relative unfamiliarity with beaver damage control and the general ambivalence over the

presence of beaver dams as a factor in deciding to fish a stream may be at least partially due to the fact that this was a statewide survey of trout anglers and most of the beaver presence and control efforts on streams is in the northern third of the state.

The impacts to trout and other cold water stream species and habitat by beaver damming is not instantaneous but rather cumulative and long-term. Short term benefits to angling from the creation of pools behind beaver dams allowing for more space to support larger fish are rapidly diminished as other cold water stream habitat elements decline. Once damaged, recovery of these habitats is very difficult. Maintenance of a viable trout fishery is very difficult with beaver present. Given the differing and often competing interests in beaver presence a challenging task is deciding which streams to maintain free-flowing.

DAMAGE MANAGEMENT

The WDNR's Beaver Damage Guidelines provides information about beaver damage management, including non-lethal options, habitat modification, and the rules and regulations surrounding lethal removal. Non-lethal options are varied and generally involve discouraging or excluding beaver or utilizing devices to continue to allow water flow. Lethal options for beaver removal from a landowner's property year-round without a permit include shooting or trapping. Traps may be set by landowners on a beaver dam as part of the removal of those beaver causing damage. People may assist the landowner or lessee providing they have a valid trapping license if they are trapping or small game license if they are shooting beaver, and they must possess written approval from the landowner or lessee when carrying out removal activities. Explosives and poisons may not be used to remove beaver or active beaver lodges. Explosives may be used by licensed Wisconsin blasters to remove beaver dams only. Dams and lodges may also be removed by using hand tools or motorized equipment like a backhoe, however, written authorization from the WDNR is required to remove a beaver lodge. Landowners do not need a permit to remove a dam on their property or neighboring property that is affecting their land. Landowners are liable for damages a beaver dam on their property causes to the property of another. Landowners and lessees may hire someone or have someone assist them to remove dams, as long as they provide written authorization to the person assisting.

Damage management is a huge task and involves many.

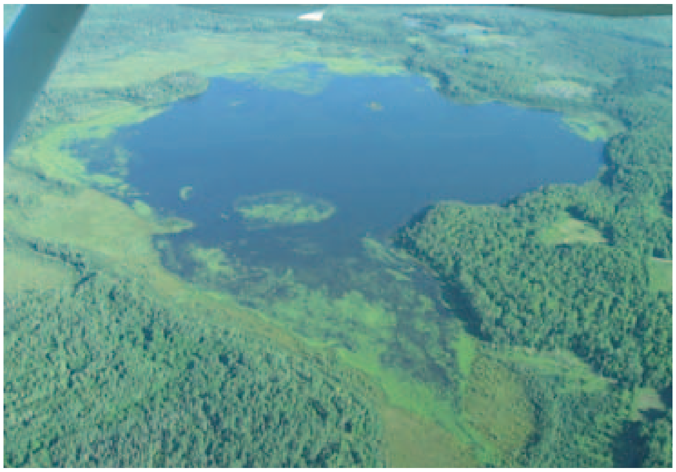
Wildlife Services Cooperative Beaver Damage Management Program

The Wildlife Services's beaver damage management efforts currently focus on protecting cold water ecosystems, in-stream trout habitat improvement projects, road, bridge and culvert protection, and forest resource protection. Wildlife Services also works with the USFS and northern county highway and forestry departments in addition to 12 counties and 50 townships that participate in the Cooperative Beaver Damage Management Program annually. The township program is only offered to address beaver conflicts at town road sites. Road and timber complaints received by Wildlife Services through a toll-free number at the District Office are dispatched to appropriate staff. Additionally, their programs include protection of unique habitats/plants, trail and trail bridges, and dams and impoundments on state and federal wildlife areas. They also provide advice and recommendations to county and township personnel and private individuals regarding beaver damage management and prevention, including information on non-lethal methods to reduce beaver damage.

Since 1999, Wildlife Services's work represents 2-4% of documented beaver take each year.

Wildlife Service's beaver damage management efforts have primarily been conducted in Beaver Zones A and B (Figure 1, page 41), consistent with the 1990 management plan. Although there is a need for beaver damage management in Zone C for the protection of cold water and warm water fisheries, extensive work has not been possible due to budget constraints, though very limited work has been done on select cold water streams in Zone C on an as-needed basis. Wildlife Services has cooperative agreements with various agencies and groups to develop and implement habitat preservation or enhancement plans, including these habitats:

Wildlife Services assists in beaver management for several concerns.



Restoration efforts on Chippewa Lake in Bayfield County would not have been successful without concurrent beaver management.

Wild Rice. Beaver and wild rice have shared the Wisconsin landscape for centuries, and while beaver, or more specifically their dams, can affect wild rice, those impacts can be positive or negative, and can vary from site to site, and even year to year depending on environmental conditions. The addition of a beaver dam to a productive rice bed may have negative impacts, especially during germination and early growth stages. At the same time beaver dams may have positive impacts by creating or enlarging suitable habitat where little or none previously existed. Beaver dams can also help maintain suitable water levels on existing rice beds subject to drought conditions. Overall, wild rice abundance is important to many, making it important for managers to consider beaver effects on wild rice.

This beaver dam caused a decline in the rice on an upstream lake.

While beaver management should not be considered to be synonymous with beaver control, beaver control and dam removal has a place in the management of wild rice. Beaver control should generally be reserved for sites with well-established stands that are showing negative abundance trends, or can be expected to do so. At these sites, ongoing control may be called for, but the focus should be on specific locations and specific animals and their dams.

Wildlife Services assists in monitoring and protecting more than 20 wild rice beds annually, and cooperates with WDNR, GLIFWC, USFS and individual tribes to protect wild rice lakes from negative impacts caused by beaver. Wild rice has major significance to native peoples of Wisconsin, both in a cultural and subsistence aspect, and is important to a variety of migratory birds including rails and numerous waterfowl species.

Wildlife Impoundments. As a part of another cooperative agreement, Wildlife Services provides assistance to WDNR and USFS land managers to reduce conflicts associated with beaver plugging water control devices at impoundments maintained for wildlife. Aside from impeding the ability to manage water levels for waterfowl, the plugging of water control structures causes flooding of roads, timber, and adjacent private lands. The required actions vary from year to year depending on beaver activity and associated damage, but numbered 18–57 projects annually from 2005–11.

Trout Streams. Wildlife Services has treated and continues to protect approximately 200 cold water streams, totaling ~1,500 miles (Figure 10). These streams, located mostly in northern or west central Wisconsin, comprise the highest quality cold water streams in each county.

Trout stream management is hard work and expensive.

The cooperative program between Wildlife Services and WDNR, USFS, and various Wisconsin tribes for removal of beavers and beaver dams, utilizes a systematic and comprehensive approach consisting of an active treatment phase and a less intensive maintenance phase. The initial treatment phase involves the removal of all beaver and dams from designated stream sections. This phase, during which the stream is returned to free-flowing condition, may take from two to four years or longer, depending on the size of the system, density of beaver and dams, and stream gradient. Cost for the initial phase is approximately $1,500–$2,000 per mile of stream.

Once the initial phase is complete, a stream is in the maintenance phase. The goal of the maintenance phase is to maintain the free-flowing condition established in the initial phase, so the cold water ecosystem can recover. Streams in maintenance phase require less effort; however beaver dispersal, primarily in April and early May in northern Wisconsin, requires the need to trap and remove dispersing beavers as they appear. A combination of ground and aerial surveys are used to locate active beaver colonies so they can be investigated, beaver trapped and dams removed. The maintenance phase is site selective, and requires fewer

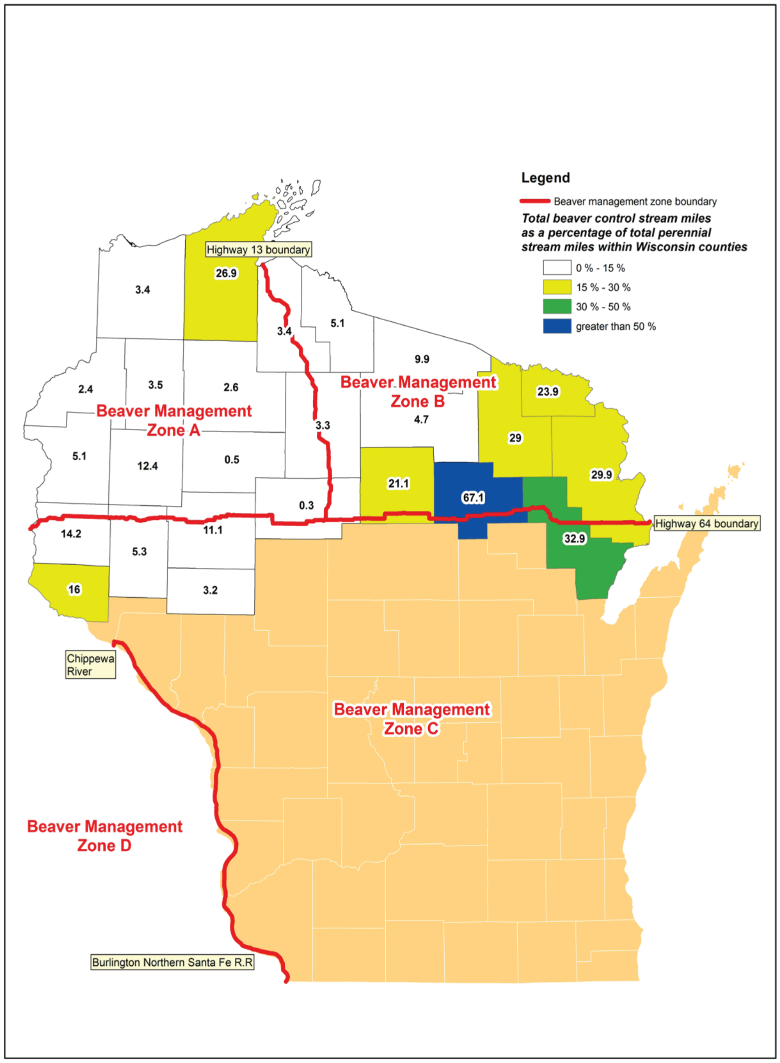


Figure 10. Percentage of total perennial stream miles on which beaver control activities occurred in Wisconsin counties, 2013.

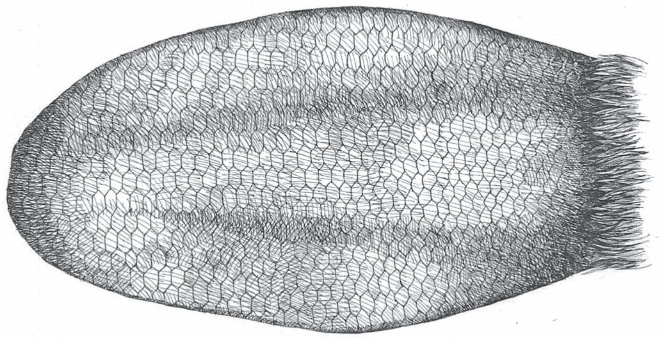
resources than the initial treatment phase. A single specialist can efficiently maintain many miles of stream annually. Cost for maintenance is approximately $300 per mile of stream per year.

Beaver damage management efforts generally run from April through October due to the seasonal nature of beaver activity and the deliberate attempt to avoid conflict with private trappers and to avoid taking beaver during the majority of the Wisconsin beaver trapping season. An average of 754 (range 383–1,063) dams and 736 (range 399–1,108) beaver have been removed from 1993–2014 through this program (Table 3).

Aside from these large scale projects, many smaller projects are also conducted by Wildlife Services each year to address specific beaver damage complaints at the request of other cooperators including Trout Unlimited, lake associations, snowmobile clubs, local WDNR property managers, and private landowners. Combining all of these service agreements, Wildlife Services resolves an average of 200 individual beaver conflicts each year, saving a potential loss estimated at over one million dollars annually as reported by the cooperators.

Table 3. USDA APHIS Wildlife Services beaver damage management activities on trout streams, calendar year totals 1993–2014.

Year	Beaver Removed	Dams Removed Manually	Dams Removed with Explosives	Total Dams Removed	Stream Miles Protected
1993	1,108	696	205	901	630
1994	885	730	116	846	630
1995	1,099	504	291	795	640
1996	1,009	739	261	1,000	640
1997	874	648	77	725	740
1998	564	753	310	1,063	850
1999	865	490	92	582	850
2000	632	711	96	807	900
2001	606	549	44	593	900
2002	650	628	61	689	900
2003	662	565	61	626	1,200
2004	828	821	76	897	1,250
2005	758	809	103	912	1,500
2006	692	649	131	780	1,500
2007	581	704	94	798	1,500
2008	723	765	109	874	1,500
2009	700	517	99	616	1,500
2010	399	526	50	576	1,540
2011	630	349	34	383	1,540
2012	414	551	82	633	1,540
2013	730	600	86	686	1,540
2014	774	696	116	812	1,540
TOTAL	16,183	14,091	2,594	16,594	1,540



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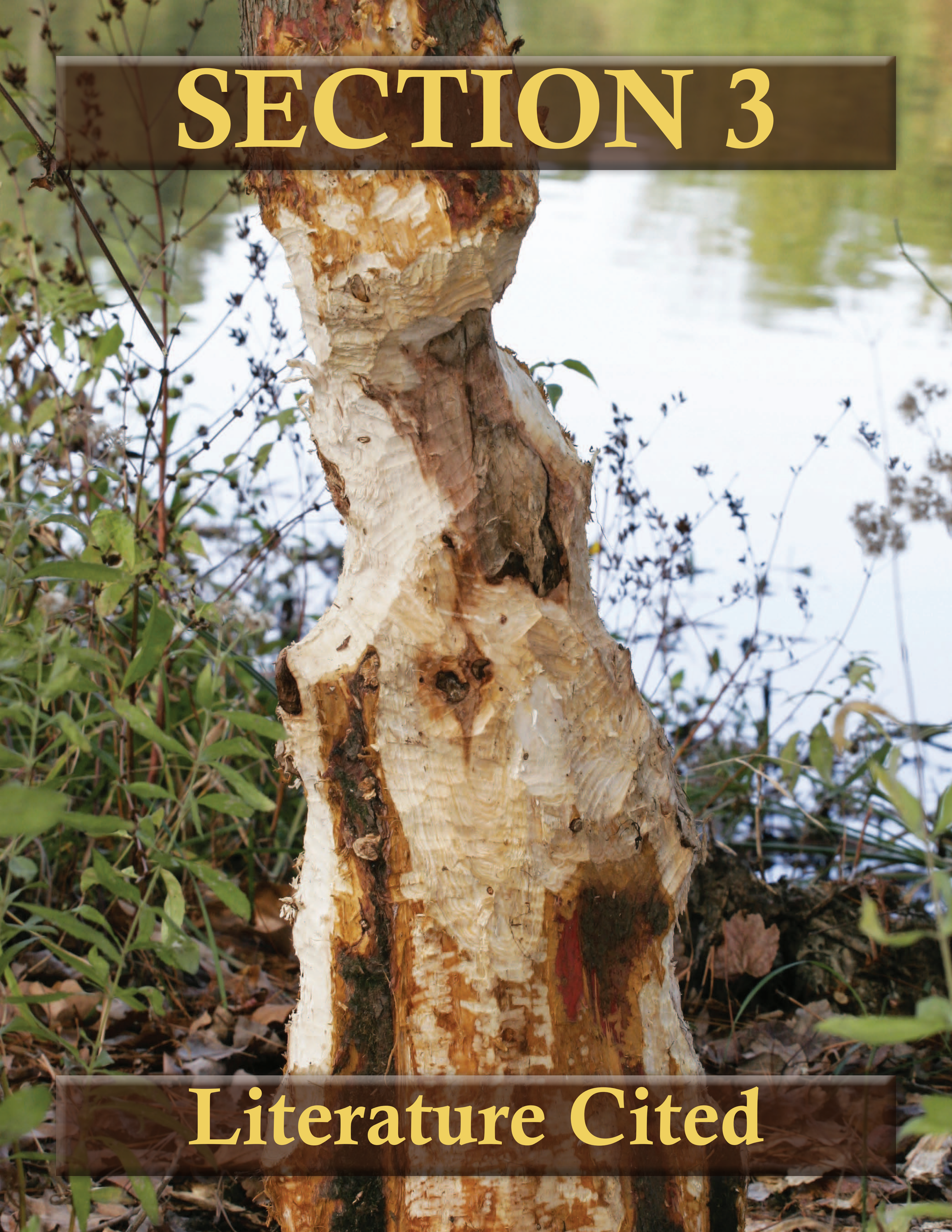
SECTION 3



Literature Cited

Adam, R. 2001. Biology of *Giardia lamblia*. Clinical Microbiology Reviews 14: 447–475.

Alcoze, T. M. 1981. Pre-settlement beaver population density in the Upper Great Lakes Region. Thesis, Michigan State University Department of Zoology, East Lansing, Michigan, USA.

Avery, E. L. 1983. A bibliography of beaver, trout, wildlife, and forest relationships: with special references to beaver and trout. Wisconsin Department of Natural Resources, Technical Bulletin No. 137. Madison, Wisconsin, USA.

Avery, E. L. 1991a. Impact of beaver dam removal on summer water temperatures in a northeastern Wisconsin trout stream. Wisconsin Department of Natural Resources, Research and Management Findings No. 30. Madison, Wisconsin, USA.

Avery, E. L. 1991b. Impact of beaver dam removal on brook trout populations and the sport fishery in a northeastern Wisconsin trout stream. Wisconsin Department of Natural Resources, Research and Management Findings No. 31. Madison, Wisconsin, USA.

Avery, E. L. 2002. Fish community and habitat responses in a northern Wisconsin brook trout stream 18 years after beaver dam removal. Statewide Fisheries and Habitat Research Project F-95-P. Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Avery, E. L. 2004. A compendium of 58 trout stream habitat development evaluations in Wisconsin—1985–2000. Research Report No. 187. Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Baker, B. W., and E. P. Hill. 2003. Beaver (*Castor canadensis*). Pages 288–310 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, editors. Wild mammals of North America: biology, management, and conservation. 2nd edition. John Hopkins University Press, Baltimore, Maryland, USA.

Barger, N. R. 1947. A peak in Wisconsin's beaver harvest. Wisconsin Conservation Bulletin 12:11–15.

Batker, D., J. Harrison-Cox, N. Kirschner, J. Kochmer, R. Schmidt, Y. Snyder, T. Dickinson, Z. Christin, and M. Kocian. 2012. Rapid assessment of the economic value of Wisconsin's wetlands. Earth Economics, Tacoma, Washington, USA.

Beard, E. B. 1953. The importance of beaver in waterfowl management at the Seney National Wildlife Refuge. The Journal of Wildlife Management 17: 398–436.

Betz, C. R., T. Asplund, and J. Hurley. 2011. Wisconsin Initiative on Climate Change Impacts: Water Resources Working Group Report. http://www.wicci.wisc.edu/publications.php accessed 4 May 2012.

Cunningham, J. M., A. J. K. Calhoun, and W. E. Glanz. 2007. Pond-breeding amphibian species richness and habitat selection in a beaver-modified landscape. Journal of Wildlife Management 71: 2517–2526.

Dantion, V., and C. Brown. 1994. Beaver subsidy program: 1989–93. Pages 60–64 *in* B. Dhuey (editor). Wisconsin Wildlife Surveys: April 1994. Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Decker, D. J., T. L. Brown, and W. F. Siemer. 2001. Human dimensions of wildlife management in North America. The Wildlife Society, Bethesda, Maryland, USA.

Dhuey, B. 2000−2012. Wisconsin Fur Buyers Report. Wisconsin Wildlife Surveys. Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Dhuey, B., and J. Olson. 2000−2012. Beaver Trapping Questionnaire. Wisconsin Wildlife Surveys. Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Dhuey, B., and J. Olson. 2001. Beaver Trapping Questionnaire. Wisconsin Wildlife Surveys. Wisconsin Department of Natural

Dickerson, L. 1989. Beaver and beaver dam removal in Wisconsin trout streams. Proceedings of the Eastern Wildlife Damage Control Conference 4:135–141.

Dunlap, B.G., and M.L. Thies. 2002. Giardia in beaver (*Castor canadensis*) and nutria (*Myocaster coypus*) from east Texas. Journal of Parasitology 88:1254–1258.

Dunn, A. M. 1995. When beaver was very great: stories to live by. Midwest Traditions, Inc., Mount Horeb, Wisconsin, USA.

Ehrman, T. P., and G. A. Lamberti. 1992. Hydraulic and particulate matter retention in a 3rd-order Indiana stream. Journal of the North American Benthological Society 11:341–349.

Feldman, K.A. 2003. Zoonosis update: Tularemia. Journal American Veterinary Medical Association 222:725–730.

Friend, M. 2006. Tularemia. United States Geological Survey, Circular 1297, Washington, D.C., USA.

Gartner, W. G. 1997. Four worlds without an Eden. Pages 331–350 *in* R. C. Ostergren and T. R. Vale, editors. Wisconsin Land and Life. University of Wisconsin Press, Madison, Wisconsin, USA.

Gaydos, J. 1998. *Giardia* and wildlife. Southeastern Wildlife Cooperative Wildlife Disease Study Briefs, 14.2, Athens, Georgia, USA.

Gray, N. A., and L. M. Baddour. 2002. Cutaneous inoculation blastomycosis. Clinical Infectious Diseases 34: 44–49.

Gurnell, A. M. 1998. The hydrogeomorphological effects of beaver dam-building activity. Progress in Physical Geography 22:167–189.

Hagan, W.A. and D.W. Bruner. 1973. Hagan and Bruner's Microbiology and infectious diseases of domestic animals. 8th edition. Cornell University Press, New York, New York, USA

Hildebrand, M. 1974. Analysis of vertebrate structure. John Wiley & Sons, New York, New York, USA.

Hill, E. P. 1982. Beaver (*Castor canadensis*). Pages 256–281 *in* J. A. Chapman and G. A. Feldhamer, editors. Wild mammals of North America: biology, management, and economics. John Hopkins University Press, Baltimore, Maryland, USA.

Hine, R. L. (editor). 1961. Beaver-trout-forest relationships. Wisconsin Conservation Department, Madison, Wisconsin, USA.

Hood, G.A. and S.E Bayley. 2008. Beaver (*Castor canadensis*) mitigate the effects of climate on the area of open water in boreal wetlands in western Canada. Biological Conservation 141:556–567.

Jackson, H. T. 1961. Mammals of Wisconsin. University of Wisconsin Press, Madison, Wisconsin, USA.

Jackson, S. and T. Decker. 2004. Beavers in Massachusetts: natural history, benefits, and ways to resolve conflicts between people and beavers. University of Massachusetts Extension and Massachusetts Division of Fishers and Wildlife.

Johnston, C.A. and R. J. Naiman. 1990. Aquatic patch creation in relation to beaver population trends. Ecology 71:1617–1621.

Jones, C. G., J. H. Lawton, and M. Shachak. 1997. Positive and negative effects of organisms as physical ecosystem engineers. Ecology 78:1946–1957.

Jonker, S. A., R. M. Muth, J. F. Organ, R. R. Zwick, W. F. Siemer. 2006. Experiences with beaver damage and attitudes of Massachusetts residents toward beaver. Wildlife Society Bulletin 34:1009–1021.

Kauffman, C. A. 2007. Blastomycosis. Page 355 *in* L. Goldman, D. Ausiello, editors. Cecil Medicine. 23rd edition. Saunders Elsevier, Philadelphia, Pennsylvania, USA.

Kellert, S. R. 1976. Perceptions of animals in American society. Transactions of the North American Wildlife and Natural Resources Conference 41:533–546.

Kelley, J.R., S. Williamson, and T.R. Cooper, editors. 2008. American woodcock conservation plan; a summary of recommendations for woodcock conservation in North America. Washington, D.C. Association of Fish and Wildlife Agencies. 162pp.

Knudsen, G. J. 1953. Job completion report: beaver disease investigations. Wisconsin Wildlife Research 12(3):75–85.

Knudsen, G. J. 1954. Job completion report: general beaver damage. Wisconsin Wildlife Research 13(1):117–130.

Knudsen, G. J. 1955a. Job completion report: beaver movement studies. Wisconsin Wildlife Research 14(1):161–175.

Knudsen, G. J. 1955b. Job completion report: annual beaver census, 1954. Wisconsin Wildlife Research 14(2):75–84.

Knudsen, G. J. 1962. Relationship of beaver to forests, trout, and wildlife in Wisconsin. Wisconsin Conservation Department, Technical Bulletin Number 25, Madison, Wisconsin, USA.

Knudsen, G. J. 1963. History of beavers in Wisconsin. Wisconsin Department of Natural Resources, Miscellaneous Research Report No. 7, Madison, Wisconsin, USA.

Kohn, B. E., and J. E. Ashbrenner. 1995. Beaver population status. Statewide Wildlife Research. Wisconsin Department of Natural Resources, Project W-160-P, Madison, Wisconsin, USA.

Kucharik, C. J., S. P. Serbin, S. Vavrus, E. J. Hopkins, and M. M. Motew. 2010. Patterns of climate change across Wisconsin from 1950 to 2006. Physical Geography 3:1–28.

Kunelius, D. 1990. Tailor-made for beaver. Wisconsin Natural Resources. 14(1):5–18.

Lawrence, W. H., L. D. Fay, and S. A. Graham. 1956. A report on the beaver die-off in Michigan. Journal of Wildlife Management. 20:184–187.

Manfredo, M. J. 2008. Who cares about wildlife? Social science concepts for exploring human-wildlife relationships and conservation issues. Springer Press, New York, New York, USA.

McKinstry, M. C., P. Caffrey, and S. H. Anderson. 2001. The importance of beaver to wetland habitats and waterfowl in Wyoming. Journal of the American Water Resources Association 37:1571-1577.

McMaster, R. T. and N. D. McMaster. 2000. Vascular flora of beaver wetlands in western Massachusetts. Rhodora 102: 175–197.

McRae, G., and C. J. Edwards. 1994. Thermal characteristics of Wisconsin headwater streams occupied by beaver: implications for brook trout habitat. Transactions of the American Fisheries Society 123:641–656.

Minnesota Department of Natural Resources. 1993. Managing your wooded wetland. Minnesota Department of Natural Resources, St. Paul, Minnesota, USA.

Mitchell, G. 1995. Stories of the Potawatomi people: from the early days to modern times. Gary Mitchell, Mayetta, Kansas, USA.

Mitro, M. G., S. Marcquenski, K. Soltau, and P. Kanehl. 2014. Gill lice as a proximate cause of Brook Trout loss under changing climatic conditions. Pages 200-206 in R. F. Carline and C. LoSapio, editors. Looking back and moving forward: Proceedings of Wild Trout XI. Bozeman, Montana, USA.

Mladenoff, D. J., L. A. Schulte, and J. Bolliger. 2008. Broad-scale change in northern forests: from past to present. pages 61–73 in D. M. Waller, and T. P. Rooney, editors. The vanishing present: Wisconsin's changing lands, waters, and wildlife. University of Chicago Press, Chicago, Illinois, USA.

NorthStar Economics. 2008. The economic impact of recreational trout angling in the Driftless area. ccessed Sep. 13, 2013._

Novak, M. 1987. Beaver. Pages 283–312 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, editors. Wild furbearer management and conservation in North America. Ontario Trappers Association and Ontario Ministry of Natural Resources, Toronto, Ontario, Canada.

Nummi, P. 1992. The importance of beaver ponds to waterfowl broods: An experiment and natural tests. Annales Zoologici Fennici 29:47–55.

Nummi, P., and A. Hahtola. 2008. The beaver as an ecosystem engineer facilitates teal breeding. Ecography 31: 519–524.

Nummi, P., and S. Holopainen. 2014. Whole-community facilitation by beaver: ecosystem engineer increases waterbird diversity. Aquatic Conservation: Marine and Freshwater Ecosystems. Published online, Feb. 2014.

Patterson, D. 1951. Beaver-trout relationships. Wisconsin Conservation Department. Fishery Biology Section Investigational Report No. 822, Madison, Wisconsin, USA.

Payne, N. F., and R. P. Peterson. 1986. Trends in complaints of beaver damage in Wisconsin. Wildlife Society Bulletin 14:303–307.

Perry, C. H., V. A. Everson, I. K. Brown, J. Cummings-Carlson, S. E. Dahir, E. A. Jepsen, J. Kovach, M. D. LaBissoniere, T. R. Mace, E. A. Padley, R. B. Rideout, B. J. Butler, S. J. Crocker, G. C. Liknes, R. S. Morin, M. D. Nelson, B. T. Wilson and C. W. Woodall. 2008. Wisconsin's Forests 2004. U.S. Forest Service, Northern Research Station, Resource Bulletin NRS-23, Newton Square, Pennsylvania, USA.

Petchenik, J. 2014. Trout fishing in Wisconsin: angler behavior, program assessment and regulation and season preferences. Wisconsin Department of Natural Resources Report, Madison, Wisconsin, USA.

Peterson, R. P., and N. F. Payne. 1986. Productivity, size, and age structure of nuisance beaver colonies in Wisconsin. Journal of Wildlife Management 50:265–268.

Peterson, C., and S. Solin. 1996. Beaver subsidy program: 1989–95. Pages 32–36 *in* A. Roth and B. Dhuey, editors. Wisconsin Wildlife Surveys: April 1996. Wisconsin Department of Natural Resources, Bureau of Science Services, Madison, Wisconsin, USA.

Pils, C., and J. Addis. 1992. The Wisconsin beaver management plan – quality management. Abstract. The Fourth North American Symposium on Society and Resource Management. Madison, Wisconsin, USA.

Pollock, M. M., M. Heim, and D. Werner. 2003. Hydrologic and geomorphic effects of beaver dams and their influence on fishes. Pages 213–233 *in* S. V. Gregory, K. L. Boyer, and A. M. Gurnell, editors. The ecology and management of wood in world rivers. American Fisheries Society, Symposium 37, Bethesda, Maryland, USA.

Pollock, M.M., G. Lewellan, K. Woodruff, C.E. Jordan and J.M. Castro (Editors) 2015. The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands and Floodplains. Version 1.0. United States Fish and Wildlife Service, Portland, Oregon. 189 pp. Online at: http://www.fws.gov/oregonfwo/ToolsForLandowners/RiverScience/Beaver.asp

Radeloff, V. C., R. B. Hammer, P. R. Voss, A. E. Hagen, D. R. Field, and D. J. Mladenoff. 2001. Human demographic trends and landscape level forest management in the northwest Wisconsin pine barrens. Forest Science 47:229–241.

Rolley, R. E., J. F. Olson, and M. L. Worland. 2009. Beaver population analysis 2008. Wisconsin Wildlife Surveys. Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Rolley, R. E., D. M. MacFarland, and J. F. Olson. 2012. Beaver population analysis 2011. Wisconsin Wildlife Surveys. Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Roy, V., M. Amyot, and R. Carignan. 2009. Beaver ponds increase methylmercury concentrations in Canadian Shield streams along vegetation and pond-age gradients. Environmental Science Technology 43: 5601–5611.

Scheller, R. M., and D. J. Mladenoff. 2008. The potential futures of Wisconsin's forested landscapes. Pages 453–461 *in* D. M. Waller and T. P. Rooney, editors. The vanishing present: Wisconsin's changing lands, waters, and wildlife. University of Chicago Press, Chicago, Illinois, USA.

Schorger, A. W. 1953. Large Wisconsin beaver. Journal of Mammalogy 34:260–261.

Sheffy T. B., and J. R. St. Amant. 1982. Mercury burdens in furbearers in Wisconsin. Journal of Wildlife Management 46:1117–1120.

Shieff, A., and J. A. Baker. 1987. Marketing and international fur markets. Pages 862–877 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, editors. Wild furbearer management and conservation in North America. Ontario Trappers Association and Ontario Ministry of Natural Resources, Toronto, Ontario, Canada.

Smith, A. E., and G. J. Knudsen. 1955. Beaver control in Wisconsin. Wisconsin Conservation Bulletin 20:21–24.

Smith, D. W., D. R. Trauba, R. K. Anderson, and R. O. Peterson. 1994. Black bear predation in beavers on an island in Lake Superior. American Midland Naturalist 132:248–255.

Stenlund, M. H. 1953. Report of Minnesota beaver die-off, 1951–1952. Journal of Wildlife Management 17:376–377.

Stricker, H., and K. L. Lambrecht. 2010. Forest County Potawatomi Community Beaver Management Plan. Forest County Potawatomi Community, Natural Resources Department, Crandon, Wisconsin, USA.

Swanston, C., M. Janowiak, L. Iverson, L. Parker, D. Mladenoff, L. Brandt, P. Butler, M. St. Pierre, A. Prasad, S. Matthews, M. Peters, D. Higgins, and A. Dorland. 2011. Ecosystem vulnerability assessment and synthesis: a report from the climate change response framework project in northern Wisconsin. U.S. Forest Service, General Technical Report NRS-82, Wisconsin, USA.

Teel, T. L., and M. J. Manfredo. 2010. Understanding the diversity of public interests in wildlife conservation. Conservation Biology 24:128–139.

Teel, T. L., M. J. Manfredo, and H. M. Stinchfield. 2007. The need and theoretical basis for exploring wildlife value orientations cross-culturally. Human Dimensions of Wildlife 12:297–305.

United State Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control. 1996. Environmental assessment: beaver damage management to protect wildlife habitat, forest resources, and property in Wisconsin. U.S. Department of Agriculture, Sun Prairie, Wisconsin, USA.

United State Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. 2013. Final environmental assessment: beaver damage management to protect coldwater ecosystems, forest resources, roads and bridges, sensitive habitats and property in Wisconsin. http://www.aphis.usda.gov/regulations/pdfs/nepa/2013_Final_EA_%20WI_Beaver.pdf Accessed on July 29, 2013.

United States Department of Agriculture Forest Service. 2004. Chequamegon-Nicolet National Forests Land and Resource Management Plan. USDA Forest Service. Eastern Region. R9-CN-FP-0404.

Unites States Department of Agriculture Natural Resources Conservation Service. 2013. Driftless Area Landscape Conservation Initiative Factsheet.

Van Horn, K., T. Finger, and B. Dhuey. 2014. 2013 Wisconsin Canada Goose Harvest Report. Wisconsin Wildlife Surveys. Vol.22, Issue 3. Wisconsin Department of Natural Resources.

Voigt, D. R., G. B. Kolenosky, and D. H. Pimlott. 1976. Changes in summer foods of wolves in central Ontario. Journal of Wildlife Management 40:663–668.

Wisconsin Department of Natural Resources. 1990. Beaver management plan. Beaver Project Team, Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Wisconsin Department of Natural Resources. 2000. Wisconsin Forests at the Millennium, an Assessment. WDNR Division of Forestry, Publication number FR0161, Madison, Wisconsin, USA.

Wisconsin Department of Natural Resources. 2002. Wisconsin trout streams. Wisconsin Department of Natural Resources, PUB-FH-806, Madison, Wisconsin, USA.

Wisconsin Department of Natural Resources. 2010. Wisconsin's Forestry Best Management Practices for Water Quality: Field Manual for Loggers, Landowners and Land Mangers. Wisconsin Department of Natural Resources, Publication number FR093, Madison, WI, USA.

Wisconsin Initiative on Climate Change Impacts. 2001. Wisconsin's changing climate: impacts and adaptation. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Wilde, S. A., C. T. Youngberg, and J. H. Hovind. 1950. Changes in composition of ground water, soil fertility, and forest growth produced by the construction and removal of beaver dams. Journal of Wildlife Management 14:123–128.

Zeckmeister, M. T., and N. F. Payne. 1998. Effects of trapping on colony density, structure, and reproduction of a beaver population unexploited for 19 years. Transactions of the Wisconsin Academy of Sciences, Arts and Letters 86:281–291.

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Appendices

Appendix 1. Beaver trapping seasons in Wisconsin, 1850–1960. Data from 1850 to 1947 were compiled by N. R. Barger, and from 1948 to 1960 were taken from beaver research project records (Knudsen 1963).

Year	Dates	Length	No. Counties open	Bag limit	Avg. pelt price	No. licenses sold	Harvest	Avg. no. taken/ trapper
1850–64	All year	All year	- *	-	-	-	-	-
1865–79	Nov. 1 – May 1	6 months	-	-	-	-	-	-
1880–92	All year	All year	-	-	-	-	-	-
1893–98	Closed season							
1899–1902	All year	All year	-	-	-	-	-	-
1903–16	Closed season							
1917–20	Dec. 1 – Dec. 31	1 month	3	-	-	-	-	-
1921–23	Feb. 1 – Mar. 31	2 months	12	-	-	-	-	-
1924–33	Closed season							
1934	Feb 19 – Mar 4	13 days	17	15	$7.44	1,154	2,205	2
1935	Feb 19 – Mar 4	13 days	15	15	$6.73	818	1,869	2
1936	Mar. 1 – Apr. 15	1 ½ months						
1937	Mar. 15 – Apr. 15	1 month	18	20	$13.89	900	6,867	8
1938	Feb. 1 – Mar. 31	2 months	13	15	$9.53	558	4,355	8
1939	Mar 1. – Mar 31	1 month	15	10	$11.70	769	5,135	7
1940	Closed season							
1941	Mar. 1 – Mar. 31	1 month	19	10	$21.04	1,523	5,992	4
1942	Mar. 1 – Mar. 31	1 month	13	10	$20.98	978	3,910	4
1943	Mar. 1 – Mar. 31	1 month	24	10	$28.77	969	4,564	5
1944	Mar. 1 – Mar. 31	1 month	22	10	$35.00	1,830	7,720	4
1945	Closed season							
1946	Mar. 5 – Mar. 25	20 days	43	10	$46.00	3,674	15,280	4
1947	Closed season							
1948	Feb. 10 – Feb. 19	9 days	37	5	-	3,125	5,582	2
1949	Feb. 10 – Feb. 28	18 days	51	8	$19.00	3,367	9,150	3
1950	Feb. 15 – Mar. 16	1 month	30					
	Feb. 15 - Mar.31							
	(Ext. to Apr. 9)	53 days	6					
	Feb. 15 – Mar. 6	20 days	13	12	$15.23	2,863	11,544	4
1951	Feb. 15 – Mar. 31							
	(4 Cos. To Apr. 10)	44 day	18					
	Feb. 15 – Mar. 15							
	(2 Cos. To Mar. 31)	1 month	40	12	$21.20	2,243	13,146	6

Year	Dates	Length	No. Counties open	Bag limit	Avg. pelt price	No. licenses sold	Harvest	Avg. no. taken/ trapper
1952	Feb. 15 – Mar. 31	1 ½ months	31					
	Feb 15 – Apr. 15	2 months	6					
	Feb. 15 – Mar. 15	1 month	16	15	$11.81	1,822	10,305	6
1953	Feb. 20 – Apr. 20							
	(Small area to May 5)	2 months	46					
	Feb. 20 – Mar. 21	1 month	6	20	$12.39	1,442	13,477	9
1954	Feb. 25 – Apr. 10							
	(Small area to May 1)	1 ½ months	52	20	$11.42	1,174	8,969	8
1955	Feb. 25 – Mar. 26							
	(2 small areas to Apr. 10 & 30)	1 month	18					
	Feb. 25 – Mar. 16							
	(5 cos. to Mar. 31)	20 days	22	20	$15.54	847	6,083	7
1956	Feb. 25 – Mar. 26							
	(2 small areas to Apr. 10 & 30)	1 month	31	20	$10.27	766	5,905	8
1957	Feb. 25 – Apr. 10	1 ½ months	35					
	Feb. 25 – Mar. 26	1 month	22	20	$8.83	975	9,192	9
1958	Feb. 25 – Apr. 20	2 months	23					
	Feb. 25 – Mar. 26	1 month	23					
	Feb. 25 – Apr. 10	1 ½ months	12	25	$10.91	1,164	14,232	12
1959	Feb. 1 – Apr. 20	2 ½ months	23					
	Feb. 25 – Mar. 26	1 month	24					
	Feb. 25 – Apr. 10	1 ½ months	11	35	$9.96	938	11,515	12
1960	Feb. 1 – Apr. 20	2 ½ months	23					
	Feb. 25 – Mar. 26	1 month	24					
	Feb. 25 – Apr. 10	1 ½ months	11	35	$12.69	- **	10,595	- *

* No records available
** Beaver license requirement dropped, so no calculation of total number of beaver trappers possible.

Appendix 2. Beaver seasons and bag limits by area (if applicable) and dates in Wisconsin, 1926–2013.

Year	Bag Limit	Area	Open Date	Close Date	Comment
1926	None	Statewide	01/01/1926	12/31/1926	Season Closed
1935	25	Ashland, Barron, Bayfield, Burnett, Douglas, Eau Claire, Florence, Forest, Iron, Langlade, Marinette, Oneida, Rusk, Sawyer, Vilas, and Washburn counties	03/01/1936	04/15/1936	
1936	20	Ashland, Barron, Bayfield, Burnett, Douglas, Eau Claire, Florence, Forest, Iron, Langlade, Lincoln, Marinette, Oneida, Polk, Rusk, Sawyer, Vilas, and Washburn counties	03/15/1937	04/15/1937	
1937	15	Ashland, Douglas, Florence, Forest, Iron, Langlade, Lincoln, Marathon, Marinette, Oneida, Sawyer, Vilas, and Washburn counties	02/01/1938	03/31/1938	
1938	10	Ashland, Bayfield, Chippewa, Dunn, Eau Claire, Florence, Forest, Iron, Langlade, Marinette, Oneida, Price, Rusk, Sawyer, and Vilas counties	03/01/1939	03/31/1939	
1939	None	Statewide	01/01/1939	12/31/1939	Season Closed
1940	10	Ashland, Bayfield, Buffalo, Burnett, Clark, Dunn, Eau Claire, Florence, Forest, Iron, Jackson, Langlade, Oconto, Oneida, Pepin, Polk, Sawyer, Vilas, and Washburn counties	03/01/1941	03/31/1941	
1941	10 per season	Clark, Florence, Forest, Iron, Langlade, Lincoln, Marathon, Marinette, Oconto, Oneida, Price, Taylor and Vilas	03/01/1942	03/31/1942	
1942	10	Adams, Barron, Buffalo, Burnett, Chippewa, Clark, Door, Dunn, Eau Claire, Florence, Forest, Jackson, Juneau, Langlade, Marinette, Monroe, Oconto, Pepin, Polk, Portage, Sawyer, Trempealeau, Washburn, and Wood counties	03/01/1943	03/31/1943	
1943	10	Ashland, Bayfield, Door, Douglas, Florence, Forest, Iron, Jackson, Juneau, Langlade, Marathon, Marinette, Monroe, Oconto, Oneida, Portage, Price, Sawyer, Taylor, Vilas, Washburn, Wood counties	03/01/1944	03/31/1944	

Year	Bag Limit	Area	Open Date	Close Date	Comment
1944	None	Statewide			Closed; Special season possible in Necedah NWR
1945	10	Adams, Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Door, Douglas, Dunn, Eau Claire, Florence, Fond du Lac, Forest, Green Lake, Iron, Jackson, Juneau, La Crosse, Langlade, Lincoln, Marathon, Marinette, Marquette, Monroe, Oconto, Oneida, P	03/05/1946	03/25/1946	
1946		Necedah NWR			No season in remainder of state, no info given on Necedah season
1947	None	Statewide	01/01/1947	12/31/1947	Season Closed
1952	20	Adams and Juneau (north of Hwy 21), Clark, Eau Claire, Jackson, Marathon, Monroe, and Wood counties	02/20/1953	03/21/1953	
1952	20	Adams and Juneau (south of Hwy 21), Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Columbia, Crawford, Dane, Door, Douglas, Dunn, Florence, Forest, Grant, Green Lake, Iowa, Iron, La Crosse, Lafayette, Langlade, Lincoln, Marinette, Marquette, Oconto	02/20/1953	04/20/1953	
1952	20	Upper Mississippi NWR	02/20/1953	03/20/1953	
1952	Unlimited	Peshtigo and Wolf rivers and all their tributaries in Forest and Langlade counties	04/21/1953	05/15/1953	
1958	35	Central Zone	02/25/1959	03/26/1959	Closures in SE counties, see regulations
1958	35	North of Hwy 64	02/01/1959	04/20/1959	
1958	35	Southwestern Zone	02/25/1959	04/10/1959	
1959	35	North of Hwy 64	02/01/1960	04/20/1960	
1959	35	Remainder of State (Except closures in Brown, Calumet, Columbia and Dane counties east of Hwy 73, all areas of Dodge Co. east of Hwy 73, Jefferson, Kenosha, Kewaunee, Manitowoc, Milwaukee, Ozaukee, Racine, Rock east of Hwy 51, Walworth, Washington, and Waukesha	02/25/1960	03/26/1960	
1959	35	Southwest Zone (south of Hwys 16-33, west of 73)	02/25/1960	04/10/1960	
1960	35	Central	02/25/1961	03/26/1961	
1960	35	Northern	02/01/1961	04/20/1961	

Year	Bag Limit	Area	Open Date	Close Date	Comment
1960	35	Southern	02/25/1961	04/10/1961	
1961	35	Central Zone	02/25/1962	03/26/1962	Possession limit of 35 per season
1961	35	North Central Zone	02/01/1962	04/05/1962	Possession limit of 35 per season
1961	35	Northern Zone	02/01/1962	03/26/1962	Possession limit of 35 per season
1961	35	Southwest Zone	02/25/1962	04/10/1962	Possession limit of 35 per season
1962	35	Zone A	02/01/1963	03/15/1963	
1962	20	Zone B	02/15/1963	03/15/1963	
1962	35	Zone C	02/01/1963	04/10/1963	
1962	35	Zone D	02/15/1963	04/10/1963	
1962	None	Zone E	01/01/1962	12/31/1962	Season Closed
1963	35	Zone A	02/01/1963	03/15/1963	
1963	20	Zone B	02/15/1963	03/15/1963	
1963	35	Zone C	02/01/1963	04/10/1963	
1963	35	Zone D	02/15/1963	04/10/1963	
1963	None	Zone E	01/01/1962	12/31/1962	Season Closed
1973	10	Zone B (Mississippi)	01/19/1974	02/10/1974	Total season bag limit for all zones combined is 50
1973	20	Zone C	01/05/1974	03/10/1974	Total season bag limit for all zones combined is 50
1973	50	Zone A	12/08/1973	03/21/1974	Total season bag limit for all zones combined is 50
1976	15	Zone B	02/05/1977	03/06/1977	Total season bag limit for all zones combined is 50
1976	50	Zone A	12/18/1976	03/27/1977	Total season bag limit for all zones combined is 50
1976	Unlimited	Select Problem Watersheds	04/02/1977	04/24/1977	
1977	15	Zones B and Mississippi River	02/04/1978	03/05/1978	Closure in Adams and southern Juneau counties; Season bag 50 for all zones combined; Problem watershed season possible
1977	50	Zone A	12/17/1977	03/26/1978	Season bag 50 for all zones combined; Problem watershed season possible
1978	15	Zone B	02/03/1979	03/04/1979	Closure in Adams and southern Juneau counties
1978	50	Zone A	12/16/1978	03/25/1979	Total season bag is 50 for all zones combined
1979	Unlimited	Zone A	12/15/1979	03/23/1980	
1979	Unlimited	Zone A Special Season Area	11/26/1979	12/14/1979	Class 1 trout streams
1979	Unlimited	Zone B	02/02/1980	03/02/1980	
1979	Unlimited	Zone B Special Season Area	11/26/1979	02/01/1980	Class 1 and 2 trout streams
1980	Unlimited	Zone A Special Season Area	12/01/1980	12/14/1980	Class 1 trout streams
1980	Unlimited	Zone B Special Season Area	10/25/1980	12/14/1980	All waters
1980	Unlimited	Zone C	02/07/1981	03/01/1981	
1980	Unlimited	Zone C Special Season Area	12/01/1980	01/25/1981	Class 1 and 2 trout streams
1980	Unlimited	Zones A and B	12/20/1980	03/22/1981	
1981	Unlimited	Zone A Special Season Area	11/30/1981	12/13/1981	Class 1 trout streams
1981	Unlimited	Zone B Special Season Area	10/24/1981	12/13/1981	Class 1 trout streams

Year	Bag Limit	Area	Open Date	Close Date	Comment
1981	Unlimited	Zone C	02/06/1982	03/07/1982	
1981	Unlimited	Zone C Special Season Area	11/30/1981	01/24/1982	Class 1 and 2 trout streams
1981	Unlimited	Zones A and B	12/19/1981	03/28/1982	
1982	Unlimited	Zone A Special Season Area	11/29/1982	12/12/1982	Class 1 trout streams
1982	Unlimited	Zone B Special Season Area	10/23/1982	12/12/1982	Class 1 trout streams
1982	Unlimited	Zone C	02/05/1983	03/06/1983	
1982	Unlimited	Zone C Special Season Area	11/29/1982	01/23/1983	Class 1 and 2 trout streams
1982	Unlimited	Zones A and B	12/18/1982	03/27/1983	
1983	Unlimited	Zone A	12/03/1983	03/31/1984	
1983	Unlimited	Zone A Special Season Area	10/22/1983	04/30/1984	
1983	Unlimited	Zone B	12/03/1983	03/04/1984	
1983	Unlimited	Zone B Special Season Area	10/29/1983	04/30/1984	
1984	Unlimited	Zone A	12/01/1984	03/31/1985	
1984	Unlimited	Zone A Special Season Area	10/20/1984	04/30/1985	
1984	Unlimited	Zone B	12/01/1984	03/03/1985	
1984	Unlimited	Zone B Special Season Area	10/27/1984	04/30/1985	
1985	Unlimited	North Zone	12/07/1985	03/31/1986	
1985	Unlimited	North Zone Special Season Area	10/19/1985	04/30/1986	
1985	Unlimited	South Zone	12/07/1985	03/02/1986	
1985	Unlimited	South Zone Special Season Area	10/26/1985	04/30/1986	
1986	Unlimited	Northern Zone	12/06/1986	03/31/1987	
1986	Unlimited	Northern Zone Special Season Area	10/18/1986	04/30/1987	
1986	Unlimited	Southern Zone	12/06/1986	03/01/1987	
1986	Unlimited	Southern Zone Special Season Areas	10/25/1986	04/30/1987	
1987	Unlimited	Central Zone	10/31/1987	04/30/1988	
1987	Unlimited	Mississippi Zone	11/19/1987	04/30/1988	
1987	Unlimited	Northern Zone	10/24/1987	04/30/1988	
1987	Unlimited	Southern Zone	11/07/1987	04/30/1988	
1988	Unlimited	Central Zone	10/29/1988	03/15/1989	Special allowances for landowners begins (1988 to present date)
1988	Unlimited	Mississippi Zone	11/14/1988	03/15/1989	
1988	Unlimited	Northern Zone	10/22/1988	03/15/1989	
1988	Unlimited	Southern Zone	11/05/1988	03/15/1989	
1989	Unlimited	Central Zone	10/28/1989	03/15/1990	Subsidy zone in NE
1989	Unlimited	Mississippi Zone	11/06/1989	03/15/1990	Subsidy zone in NE
1989	Unlimited	Northern Zone	10/21/1989	03/15/1990	
1989	Unlimited	Southern Zone	11/04/1989	03/15/1990	
1990	Unlimited	Central Zone	10/27/1990	04/30/1991	Subsidy zone in NE
1990	Unlimited	Mississippi Zone	11/12/1990	04/30/1991	
1990	Unlimited	Northern Zone	10/20/1990	04/30/1991	Subsidy zone in NE
1990	Unlimited	Southern Zone	11/03/1990	04/30/1991	
1991	Unlimited	Zone A	10/20/1991	03/15/1992	

Year	Bag Limit	Area	Open Date	Close Date	Comment
1991	Unlimited	Zone B	10/20/1991	04/30/1992	Zone B was a beaver subsidy zone from 1991–1996
1991	Unlimited	Zone C	12/01/1991	03/15/1992	
1991	Unlimited	Zone D	11/09/1991	03/15/1992	
1992	Unlimited	Zone A	10/24/1992	03/15/1993	
1992	Unlimited	Zone B	10/24/1992	04/30/1993	
1992	Unlimited	Zone C	12/01/1992	03/15/1993	
1992	Unlimited	Zone D	11/09/1992	03/15/1993	
1993	Unlimited	Zone A	10/23/1993	03/15/1994	
1993	Unlimited	Zone B	10/23/1993	04/30/1994	
1993	Unlimited	Zone C	12/01/1993	03/15/1994	
1993	Unlimited	Zone D	11/15/1993	03/15/1994	
1994	Unlimited	Zone A	10/22/1994	03/15/1995	
1994	Unlimited	Zone B	10/22/1994	04/30/1995	
1994	Unlimited	Zone C	12/01/1994	03/15/1995	
1994	Unlimited	Zone D	11/17/1994	03/15/1995	
1995	Unlimited	Zone C	12/01/1995	03/15/1996	
1995	Unlimited	Zone D	11/27/1995	03/15/1996	
1995	Unlimited	Zones A and B	10/21/1995	04/30/1996	
1996	Unlimited	Zone C	12/01/1996	03/15/1997	
1996	Unlimited	Zone D	11/22/1996	03/15/1997	
1996	Unlimited	Zones A and B	10/19/1996	04/30/1997	
1997	Unlimited	Zone C	11/01/1997	04/30/1998	
1997	Unlimited	Zone D	12/03/1997	03/15/1998	
1997	Unlimited	Zones A and B	10/18/1997	04/30/1998	
1998	Unlimited	Zone C	11/07/1998	04/30/1999	
1998	Unlimited	Zone D	12/02/1998	03/15/1999	
1998	Unlimited	Zones A and B	10/24/1998	04/30/1999	
1999	Unlimited	Zone C	11/06/1999	04/30/2000	
1999	Unlimited	Zone D	12/01/1999	03/15/2000	
1999	Unlimited	Zones A and B	10/23/1999	04/30/2000	
2000	Unlimited	Zone C	11/04/2000	04/30/2001	
2000	Unlimited	Zone D	11/29/2000	03/15/2001	
2000	Unlimited	Zones A and B	10/21/2000	04/30/2001	
2001	Unlimited	Zone C	11/03/2001	04/30/2002	
2001	Unlimited	Zone D	11/28/2001	03/15/2002	
2001	Unlimited	Zones A and B	10/20/2001	04/30/2002	
2002	Unlimited	Zone C	11/02/2002	04/30/2003	
2002	Unlimited	Zone D	12/09/2002	03/15/2003	Zone D begins day after Wisconsin duck season closes 2002–present
2002	Unlimited	Zones A and B	10/19/2002	04/30/2003	
2003	Unlimited	Zone C	11/01/2003	04/30/2004	
2003	Unlimited	Zone D	12/08/2003	03/15/2004	
2003	Unlimited	Zones A and B	10/18/2003	04/30/2004	
2004	Unlimited	Zone C	11/06/2004	04/30/2005	

Year	Bag Limit	Area	Open Date	Close Date	Comment
2004	Unlimited	Zone D	12/06/2004	03/15/2005	
2004	Unlimited	Zones A and B	10/23/2004	04/30/2005	
2005	Unlimited	Zone C	11/05/2005	03/31/2006	
2005	Unlimited	Zone D	12/05/2005	03/15/2006	
2005	Unlimited	Zones A and B	11/05/2005	04/30/2006	
2006	Unlimited	Zone C	11/04/2006	03/31/2007	
2006	Unlimited	Zone D	12/06/2006	03/15/2007	
2006	Unlimited	Zones A and B	11/04/2006	04/30/2007	
2007	Unlimited	Zone A	11/03/2007	04/30/2008	
2007	Unlimited	Zone B	11/03/2007	04/30/2008	
2007	Unlimited	Zone C	11/03/2007	03/31/2008	
2007	Unlimited	Zone D	12/03/2007	03/15/2008	
2008	Unlimited	Zone A	11/01/2008	04/30/2009	
2008	Unlimited	Zone B	11/01/2008	04/30/2009	
2008	Unlimited	Zone C	11/01/2008	03/31/2009	
2008	Unlimited	Zone D	12/08/2008	03/15/2009	
2009	Unlimited	Zone A	11/07/2009	04/30/2010	
2009	Unlimited	Zone B	11/07/2009	04/30/2010	
2009	Unlimited	Zone C	11/07/2009	03/31/2010	
2009	Unlimited	Zone D	12/07/2009	03/15/2010	
2010	Unlimited	Zone A	11/06/2010	04/30/2011	
2010	Unlimited	Zone B	11/06/2010	04/30/2011	
2010	Unlimited	Zone C	11/06/2010	03/31/2011	
2010	Unlimited	Zone D	12/06/2010	03/15/2011	
2011	Unlimited	Zone A	11/05/2011	04/30/2012	
2011	Unlimited	Zone B	11/05/2011	04/30/2012	
2011	Unlimited	Zone C	11/05/2011	03/31/2012	
2011	Unlimited	Zone D	12/05/2011	03/15/2012	
2012	Unlimited	Zone A	11/03/2012	04/30/2013	
2012	Unlimited	Zone B	11/03/2012	04/30/2013	
2012	Unlimited	Zone C	11/03/2012	03/31/2013	
2012	Unlimited	Zone D	12/03/2012	03/15/2013	
2013	Unlimited	Zone A	11/02/2013	04/30/2014	
2013	Unlimited	Zone B	11/02/2013	04/30/2014	
2013	Unlimited	Zone C	11/02/2013	03/31/2014	
2013	Unlimited	Zone D	12/02/2013	03/15/2014	

Appendix 3. The 1990 Beaver Management Plan Project Team

Charles Pils – Wildlife Management, Madison, Chair
Ron Eckstein – Wildlife Management, Rhinelander
Tom Hauge – Wildlife Management, Madison
Russ Heiser – Fisheries Management, Marinette
Larry Claggett – Fisheries Management, Madison
Bruce Kohn – Wildlife Research, Rhinelander
Don Thompson – Forestry, Madison
Steve Avelallemant – Fisheries Management, Woodruff
Dick Streng – Law Enforcement, Antigo
Jon Gilbert – Great Lakes Indian Fish and Wildlife Commission, Odanah
Mark Stokstad – Management and Budget, Madison, Facilitator

Appendix 4. 2015 Beaver Task Force

Wisconsin Department of Natural Resources

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