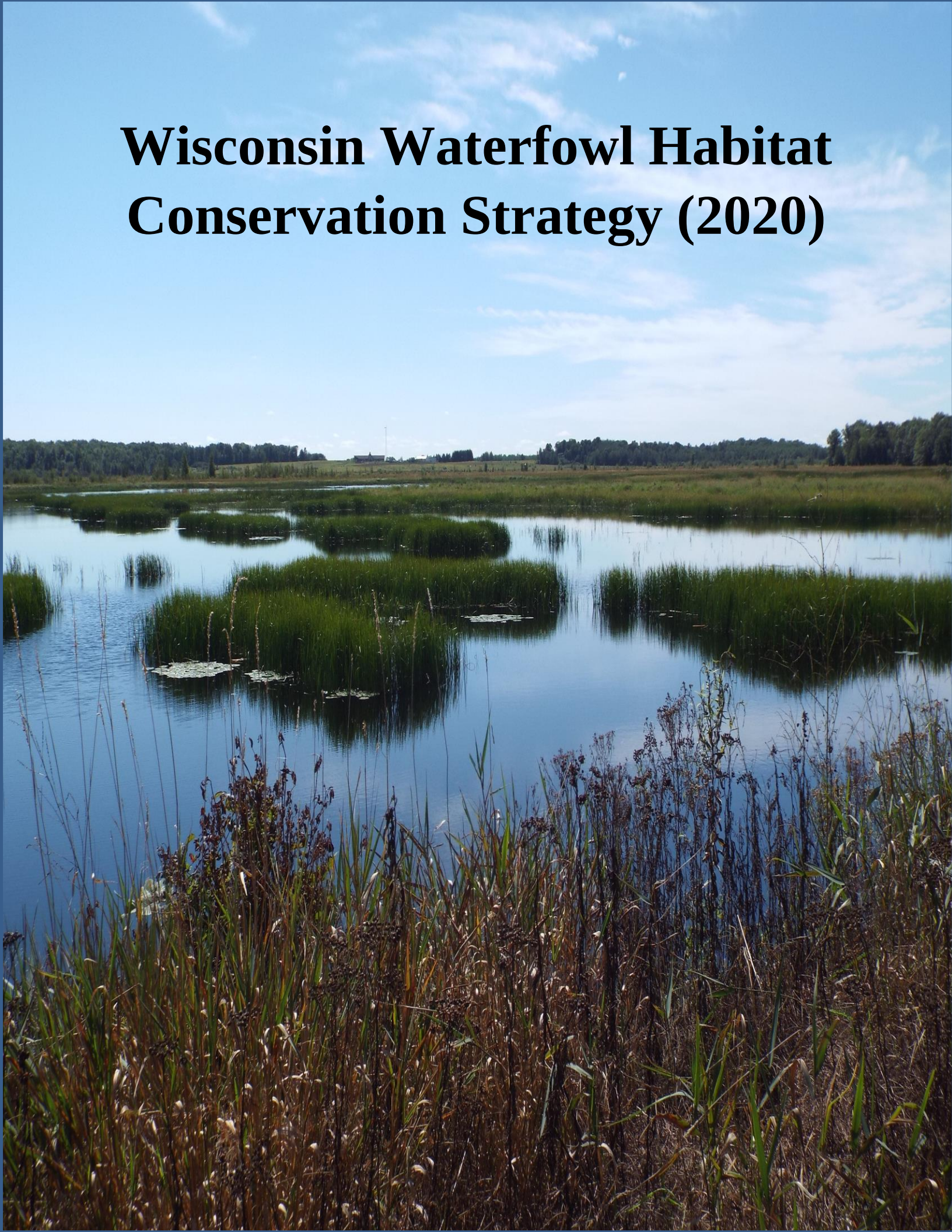
Wisconsin Waterfowl Habitat Conservation Strategy (2020)



Wisconsin Waterfowl Habitat Conservation Strategy Design and Writing Team

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History

Waterfowl conservation in the state of Wisconsin has rich and vibrant history. Conservation pioneers such as Aldo Leopold (1887-1948), John Muir (1838-1914), and Gaylord Nelson (1916-2005) not only inspired philosophical ideas, but also provided a framework for sound management principles. Additional academic descendants or partners with ties to Wisconsin include Art Hawkins (1913 – 2006), Al Hochbaum (1911- 1988), Lyle Sowls (1916-2002), Bob Ellarson (1916-1993), Dick Hunt (1926-2014), and James March (1942 -). These champions for conservation as well as strong foundational and fiscal support from state, federal and non-government organizations set the stage for Wisconsin's first waterfowl habitat plan published in 1992. The "WI Plan" and hereafter 'Original Plan' (WDNR 1992) as it is collectively known, was the first state-based waterfowl habitat plan directly linked to the North American Waterfowl Management Plan (NAWMP 1986). Even more, the Original Plan was and remains the only state-based waterfowl habitat plan that has stepped-down guidance from International (via NAWMP) and regional (e.g. Joint Ventures [JVs]) conservation planning efforts.

In response to declining continental waterfowl populations and declining and degrading habitats, the inaugural NAWMP was finalized in 1986. The original NAWMP has had several long-lasting impacts on habitat conservation including establishing regional bird-habitat partnerships called Joint Ventures. The Upper Mississippi/Great Lakes (UMGL) Joint Venture (JV) was established as one of the primary regional bird-habitat partnerships in 1991 and was formed to achieve goals of the NAWMP. The completion of the original NAWMP inspired managers, biologists, and planners in Wisconsin to write and implement their own waterfowl habitat management plan. In fact, in 1991, one year before the first UMGL JV Implementation Plan was produced (USFWS 1993), the Wisconsin Department of Natural Resources (WDNR) internalized waterfowl habitat priorities by developing the Upper Mississippi River and Great Lakes Region Joint Venture – Wisconsin Plan (WDNR 1992). This Original Plan was based on the JV Concept Plan (USFWS 1990) and established population and habitat objectives for waterfowl primarily during the breeding season. The Original Plan was unique in as many ways as it was useful. Some key components included:

- Wisconsin was prioritized into two strata, (Priority I [greatest priority] and II)
    - Priority 1 was further subdivided into nine focus areas of regional importance and within focus areas, priority townships were subjectively identified by consensus of field managers as having critical habitat needs.
- Quantitative habitat objectives for the protection, restoration, and enhancement of both upland grass and wetlands in a 3:1 ratio (grass to wetland) on both private and public lands.
- Quantitative waterfowl population objectives for different regions of the state.

Since its inception, the Original Plan served state, federal, and private waterfowl management well in focusing millions of dollars of North American Wetlands Conservation Act (NAWCA) grants, state Duck Stamp funds, USDA conservation programs, Ducks Unlimited Initiatives, and other wetland habitat conservation efforts towards high priority areas in Wisconsin. However, while guidance of priority focus areas and townships was sound, it was based on subjective professional biological input from the time. Tools, technology, landscape change, societal shifts, and more objective methods have

evolved in the nearly 30 years since the 1992 Original Plan was published. For instance, since the 1986 NAWMP, there have been updates or revisions (NAWMP 1994, 1998, 2004, 2012, 2018) and the UMGL JV has produced two regional waterfowl habitat conservation strategies (Soulliere et al. 2007, 2017). An update of the Original Plan using new tools and contemporary information is overdue especially one that is consistent with continental and regional strategies.

Summary

We designed and developed a new waterfowl habitat conservation strategy for the State of Wisconsin because the Original Plan is almost 30 years old, and the social, political, and environmental landscape has changed dramatically during this time. Our approach is rooted in NAWMP principles and parallels guidance provided by the UMGL JV's waterfowl habitat conservation strategy (Soulliere et al. 2017). Our strategy has seven main sections that address:

1. Waterfowl habitat accomplishments since 1992, which indicate partners have conserved more than 450,000 acres of waterfowl habitat distributed primarily in "Priority Townships" identified in the Original Plan.
2. Specific habitat objectives for the next 15 years, which encourage conservation partners to strive to
    - retain 1,270,896 wetland acres,
    - restore 183,218 wetland acres,
    - retain 1,157,104 upland nesting acres, and
    - restore 290,694 upland nesting acres.
3. A summary of landscape change since 1992.
4. A summary of waterfowl population changes since 1992.
5. A detailed habitat delivery decision support process, built with contemporary and novel biological and societal statewide datasets, with data layers and maps for Conservation Capital, Conservation Opportunities, and an Aggregate waterfowl habitat decision support layer that categorizes and ranks all watersheds and Ecological Landscapes in Wisconsin from greatest to least priority.
6. Research, monitoring, and planning priorities to improve future waterfowl habitat conservation.
7. Guidance on implementing the decision support data and layers.

We developed a strategy to have a 15-year time horizon (through 2035), meaning habitat restoration and retention objectives are ideally met by then. We also developed a strategy to complement the forthcoming Wisconsin Waterfowl Management Plan published by the WDNR (Finger and Rohrer 2019 *in final preparation*). While our plan has a 15-year time horizon, in today's world technical advancements, data sources and reliability are quickly evolving. Our spatial data layers, while static in this document, may more aptly be considered fluid from a conservation planning perspective. We strongly encourage appropriate updates to our spatial data layers and decision support process before the time horizon of this plan, especially if managers and planners see obvious opportunities for

improvement. All spatial data layers are supported with appropriate metadata. Source digital files are available upon request from the WDNR.

Waterfowl Habitat in Wisconsin: *Past accomplishments*

Background

Conservation partners in Wisconsin have been actively engaged in waterfowl habitat conservation for decades where they have protected, restored, or enhanced hundreds of thousands of acres of waterfowl habitat since the Original Plan was published. In fact, while the actual total is elusive, it is certainly more than 450,000 acres. This is a testament to the commitment, service, and passion by many individuals and organizations for waterfowl and their habitats. In addition, the Original Plan has served the test of time as it has guided conservation delivery to key regions of the state for more than 25 years.

Traditionally, conservation planners categorize habitat conservation delivery into metrics, such as protection, restoration, and enhancement and then summarize these into area (i.e., acres) and fiscal accomplishments. The UMGL JV has submitted measures of conservation delivery for wetland and upland habitats to the US Congress each year since 1997, fulfilling federal government performance and accountability requirements related to the NAWMP. These reports are compared to habitat objectives so evaluations can be made regarding area of bird habitat influenced along with providing an estimate of funding expended (Kahler et al. 2014, Kahler 2015). For a detailed breakdown of waterfowl habitat accomplishments from the UMGL JV from 2007 – 2014, see Soulliere et al. (2017).

In the traditional sense, the term ‘accomplishments’ refers to summaries of acres and dollars toward protection, restoration, and enhancement of habitats. While this satisfies congressional mandates, conservation partners influence waterfowl habitat in other meaningful ways. For instance, consulting, infrastructure maintenance and replacement, fund-raising, land stewardship, political advocating, technical assistance, education, outreach, and research can be ‘accomplishments.’ These kinds of accomplishments are more difficult to track and quantify but partners in Wisconsin have actively been involved in each for decades. We summarize the traditional accomplishments in this report but underscore the value of the collective accomplishments and their role in conserving waterfowl habitat in Wisconsin.

Since the Original Plan was published, definitions of habitats and types of conservation delivery (Appendices A and B), goal statements, focus area boundaries, and JV reporting requirements have changed. These changes are to be expected and represent adaptive thinking and science-based goal refinement, as well as revised guidance from various iterations of both the NAWMP and the regional JV waterfowl habitat conservation strategy. Changes such as these, however, can make accurately tracking accomplishments challenging, especially over a long period. In addition, while the WDNR has submitted annual habitat accomplishments to the JV since 1997, partner contributions in these reports are not consistent. A partner’s annual contributions in acreage for reporting requirements to the JV might range from all, to some, to none of their acres influenced. Partners are not mandated to report, so some do not. In addition, some accomplishments fall outside of the traditional framework for reporting. As an example, private landowners who don’t participate in a private lands program (e.g., Conservation

Reserve Program, Partners for Fish and Wildlife, etc.) rarely if ever report their habitat accomplishments. Conversely, some reported accomplishments are short-lived (e.g., prescribed burning of grassland, impoundment drawdowns, etc.) or even ecologically unsuccessful at achieving an increase in high-quality waterfowl habitat. Lastly, sometimes partners are confused as to which accomplishment-type they performed per the JV definitions, although the JV has recently clarified conservation delivery definitions (Soulliere et al. 2017; Appendix B) and we provide detailed examples at the end of this strategy (Appendix C). Accomplishment reporting, both to the JV and in this report, is not exact and should be reviewed with an appropriate understanding of the reporting nuances.

While the first portion of this section summarizes partner accomplishments, the next section sets ambitious habitat objectives for the future. We 'stepped down' objectives with guidance from the UMGL JV's Waterfowl Habitats Conservation Strategy and proposed habitat retention and restoration targets for wetland and upland habitats in Wisconsin. The objectives are ambitious but are based in science-driven population and habitat models for key waterfowl species that use Wisconsin's wetland and upland habitats. In other words, these bold habitat objectives rely on separate but inherently linked goals for waterfowl populations that originate at the continental level (NAWMP 2012, 2018, Fleming et al. 2017).

Finally, although conservation partners have been active in reporting objectives for habitat *acreage*, they must not discount the role of habitat *quality*. The UMGL JV's recent Waterfowl Habitat Conservation Strategy has emphasized a need to better understand the value of habitat quality (see pages 56-58 in Soulliere et. al. 2017). Unfortunately, habitat monitoring and evaluations of quality are rare in Wisconsin and elsewhere. Blake-Bradshaw (2018) studied hundreds of wetlands in Illinois and found most, or at least substantial areas within wetlands, were not suitable as habitat for migrating or breeding waterbirds, although these same acres are traditionally counted as habitat. Schultz et al. (2019 *in review*) and Straub et al. (2019) performed a habitat assessment of restored wetlands in Wisconsin's Glacial Habitat Restoration Area (GHRA). Their findings demonstrated that most wetlands in this landscape were used by migrating waterfowl but the vegetative community, particularly the lack of plant diversity, and the associated lack of suitable upland habitats near wetlands limited the value of those habitats to breeding waterfowl. These studies and others highlight that not all acreage is equal, and many complex factors influence the quality of waterfowl habitats. We suggest scientists, managers, and planners monitor and then evaluate the quality of wetland and upland habitats, especially as they relate to enhancing key vital rates for breeding waterfowl in Wisconsin.

In the sections that follow, we summarize habitat accomplishments in Wisconsin from major contributors and programs; the WDNR's Knowles-Nelson Stewardship and State Waterfowl Stamp Programs, US Fish and Wildlife Service (USFWS) NAWCA, Pittman-Robertson grants and Partners for Fish and Wildlife Programs, the USDA Farm Service Agency (FSA) CRP, USDA Natural Resource Conservations Service (NRCS) Wetland Reserve and Floodplain Easement programs, and projects reported and aided by Ducks Unlimited. Other partners and programs have contributed to accomplishments, but these partners and programs listed had datasets and databases available for

summaries. In addition, sometimes accomplishments from one partner might also be reported by another, so the summaries below may include some 'double-counting' of habitat. When possible, we summarized accomplishments back to 1992, when the Original Plan was published. This section is designed to;

A) Highlight what, where, and how much waterfowl habitat work has been accomplished since 1992, to serve as a historical account for future planning efforts to reference and compare, and
B) Provide new 'stepped down' waterfowl habitat objectives, for Wisconsin Conservation Partners for the next 15 years.

Waterfowl Habitat Accomplishments 1992-2019

A diverse group of conservation partners have placed over 450,000 acres of waterfowl habitat on the ground in Wisconsin since 1992. Federal, State, County, and many NGO's have made that possible through a variety of funding sources. This section is not a comprehensive list of all partners and programs but focuses on a few of the most impactful partners and programs that benefit waterfowl habitat.

The WDNR delivers waterfowl habitat through a variety personnel and programs on public and private lands. Since 1992, WDNR has shifted personnel from implementing work on private lands to focus on public lands. The WDNR still maintains a strong partnership to accomplish waterfowl habitat objectives on private lands, but this period has seen the elimination of dedicated WDNR Private Lands Biologists that once focused heavily on wetland restoration. This shift has allowed for increased protection and management potential on public lands. However, an overall reduction in WDNR staffing levels, particularly in the Bureau of Wildlife Management, combined with reduced funding and diminished buying power has limited delivery of waterfowl habitat in the last 25 years. Regardless, two major WDNR programs are responsible for much of their habitat delivery along with the support from the sale of hunting and fishing licenses. The Knowles-Nelson Stewardship Program and State Waterfowl Stamp Program not only directly deliver waterfowl habitat objectives, but also provide the base non-federal match used to leverage significant federal dollars to contribute to these objectives.

In 1989, Governor Tommy Thompson and the Wisconsin Legislature created the Knowles-Nelson Stewardship Program to preserve valuable natural areas and wildlife habitat, protect water quality and fisheries, and expand opportunities for outdoor recreation. The program was funded using general obligation bonding authority and enjoyed many years of broad bi-partisan support. A portion of the Stewardship program supports acquisition of lands (title and easements) by WDNR and acquisition grants to nonprofit conservation organizations and local governments. As of June 30, 2018, WDNR owned 685,569 acres (43% easements and 57% fee title) that were acquired in full or part with Stewardship funds. These properties are located across the state in 71 of Wisconsin's 72 counties. Stewardship program funds also support capital development projects on WDNR properties and on property owned by non-state partners. In the past five years, approximately 12% of WDNR Stewardship

capital development funds were used to develop or enhance water control structures that support waterfowl habitat and public access to wetland areas. More than 50% of Stewardship-funded acquisitions by nonprofit conservation organizations had a water-resource focus, including wetland protection (Hepler 2019).

The Wisconsin Waterfowl (Duck) Stamp has generated over $18 million through 2019 for habitat work since it was authorized in 1978. According to Wisconsin State Statutes, s. 29.191(1)(b), 67% of these revenues are to be allocated for habitat project work within the state of Wisconsin, and 33% are allocated to conservation organizations to carry-out habitat conservation programs for the propagation of waterfowl within Mississippi Flyway portions of Canada. The stamp was first issued in 1978 at a price of $3.25. The stamp price increased in 1991 to $5.25 and again in 1997 to $7.00. The 22-plus years since the last increase has resulted in diminished buying power and overall effectiveness of this program to deliver objectives. Since the inception of the program, the Duck Stamp program has funded hundreds of waterfowl habitat projects across public and private lands. Between 2010 and 2019, the program funded approximately 160 projects in Wisconsin. For in-state projects, stamp funds have been directed to projects that restore and enhance wetland hydrology and habitat, restore and enhance waterfowl nesting habitat in associated uplands, renovate dikes, replace water control structures, and provide other benefits to waterfowl habitat. Over time, demand of these funds for maintaining and renovating wetland infrastructure has increased as the infrastructure base has increased and aged. Funding allocations for projects are determined through a competitive application process in which WDNR managers, conservation organizations, and other government entities apply for funding. The WDNR's Migratory Game Bird Advisory Committee provides recommendations for funding projects, which are approved by WDNR's Wildlife Leadership Team. Inflation, increasing user demand, increasing public land base, and the cost of maintenance for large wetland infrastructure means that Duck Stamp dollars are not going as far, and many habitat activities are going unfunded. For example, the FY2020-21 project requests for in-state projects totaled over $1.9 M for approximately $700,000 of available funding (J. Fleener personal communication). The dollars and acres affected by this program often are multiplied by leveraging these funds to secure federal dollars for waterfowl conservation work. Most Waterfowl Stamp projects are applied for and managed by WDNR staff. Key partners including Wisconsin Waterfowl Association, Ducks Unlimited, Pheasants Forever and others have also been crucial in delivering waterfowl habitat work through this program.

The WDNR has submitted annual habitat accomplishment reports to the UMGL JV since 1997. The reports document conservation delivery actions for them and all contributing conservation partners regarding land area influenced and financial costs of achieving these actions in Wisconsin. The USFWS and NRCS have reported their habitat accomplishments separately, directly to the UMGL JV. Accomplishment reports are designed to measure progress toward landscape-scale habitat targets set by the JV to theoretically restore and retain waterfowl populations at objective levels (Soulliere et al. 2017). Habitat objectives are allocated among states within the JV and since 2009, are further subdivided by Bird Conservation Region (BCR; Figure 1).

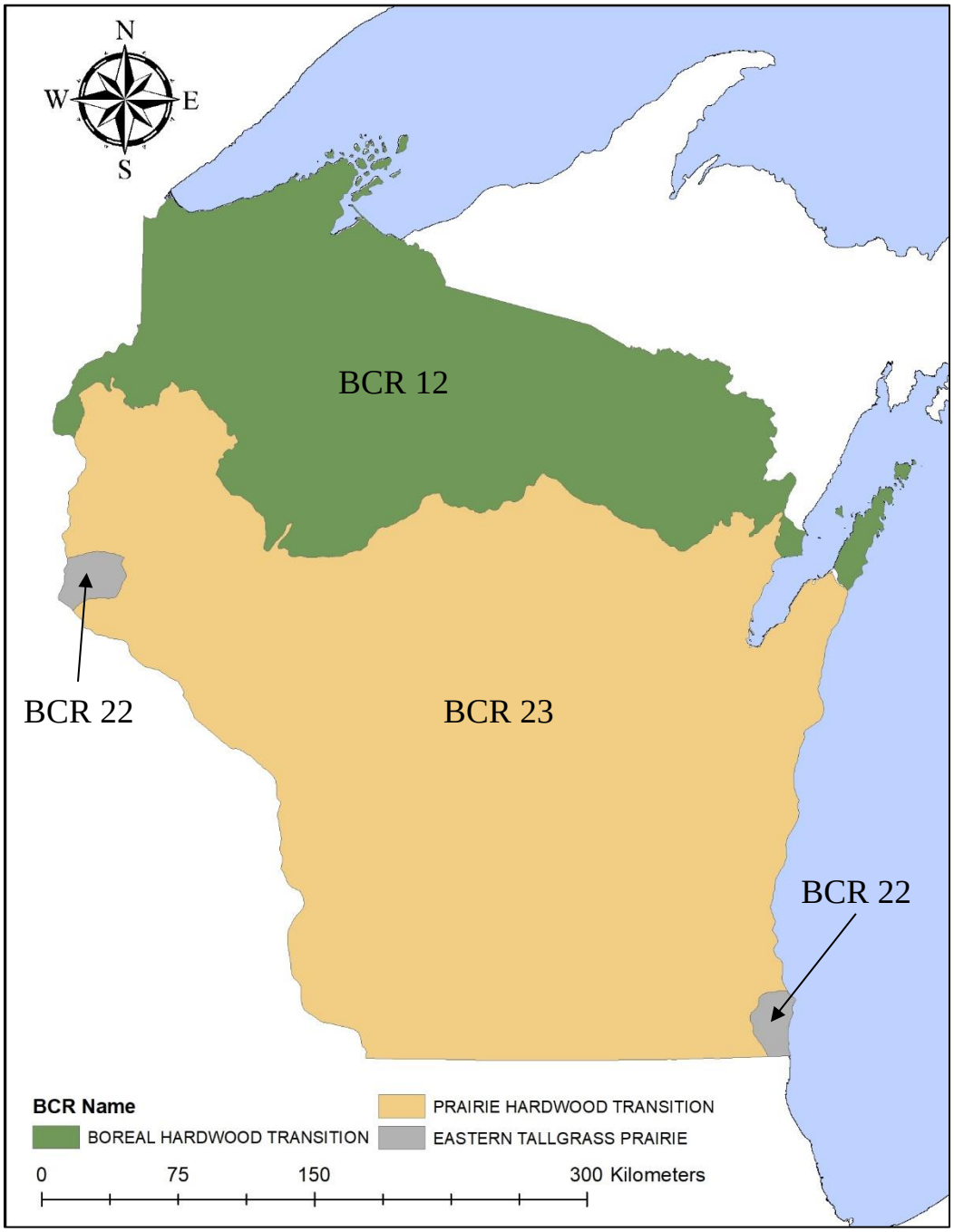


Figure 1. Bird Conservation Regions (BCRs) within Wisconsin including Prairie Hardwood Transition (23), Boreal Hardwood Transition (12) and Eastern Tallgrass Prairie (22).

Reporting guidelines, wetland definitions, and forms have changed numerous times since they were initiated in 1997 (Appendix A). Changes to reporting guidelines reflect adaptive thinking and understanding of how partners can better design and implement activities to meet objectives. The number and type of conservation partners contributing to annual reporting has varied from year to year (Figure 2). While states are not required to report acreage or properties sold, WDNR started reporting sold acreage to the UMGL JV in 2016. Acreage transferred from State to private ownership, however, does not necessarily reflect a loss in habitat quantity or quality, especially if the new owner practices better wildlife management. Because these acres cannot be confirmed as remaining in habitat of any type, for the purposes of this plan we are reporting sold acreage as habitat losses. Habitat definitions provided by the JV have changed with each iteration of the JV's Regional Waterfowl Conservation Strategy (Appendix B). Key changes to accomplishment reporting from 1997 – 2018 are below.

Timeline of key changes and modifications to JV accomplishment reporting

Subdivision of reporting units

1998- 2008
Accomplishments reported by county within states

2009 - present
Accomplishments reported by BCR

Types of habitats

1998 – 2006
Accomplishments summarized as either wetland or upland

2007 - 2017
Accomplishments summarized for three aquatic habitats (marsh, mudflat/shallows and open water/beach) and two upland habitats (grassland and woodland)

2018 - present
Accomplishments summarized by four aquatic habitats (emergent, forested, aquatic bed and unconsolidated bottom/shore). Upland habitats unchanged.

Others

2009
Formal definitions of protection, restoration, and enhancement are provided by JV

2015
JV revised definitions for protection, restoration, and enhancement

2016
WDNR begins reporting number of acres sold

2017
JV replaces *protection* with *retention* and provides a definition for it
JV revises definitions of *restoration* and *enhancement*
JV provides definitions of *operational management* and *maintenance*

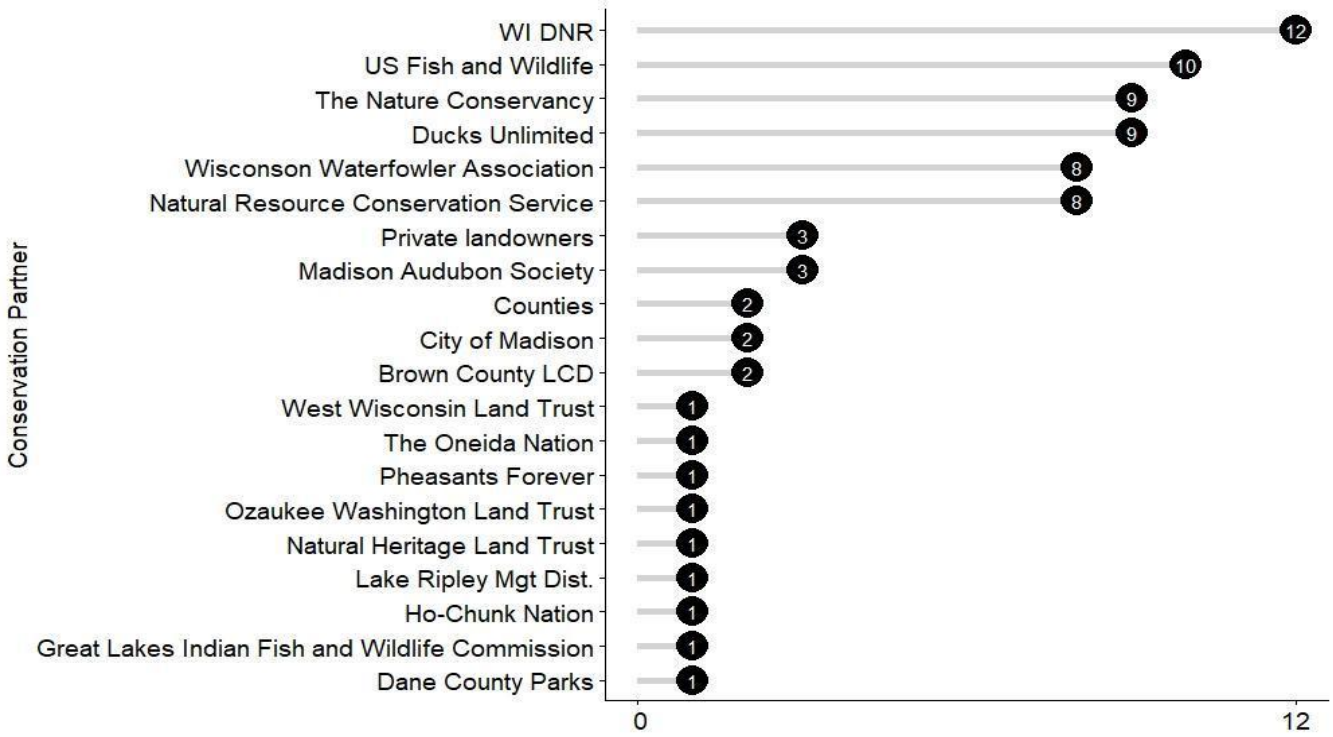


Figure 2. The frequency a conservation partner was listed on an Upper Mississippi Great Lakes Joint Venture habitat accomplishments report submitted by the Wisconsin Department of Natural Resources 2007 – 2018.

Despite the changes and modifications to accomplishment reporting, conservation partners in Wisconsin have consistently ranked as one of the most productive states in the JV in terms of delivering conservation acres and financial contributions (Kahler 2015; Al-Saffar and Sidie-Slettedahl 2018). For instance, a total of 153,045 acres of wetland and 170,868 acres of upland habitat were reported among protection, restoration, and enhancement categories since 1997 (Figure 3). For wetland habitats, the annual acres influenced has slowed, as 52% of overall habitat accomplishments occurred by 2005 (first eight years; Figure 4). For upland habitats, 51% of total acres reported occurred by 2002 (first five years) and has slowed since then (Figure 5). In 2009, the JV began requiring accomplishments by BCR. Since that time, Wisconsin has focused most of its upland accomplishments in BCR 23 (Prairie Hardwood Transition; 86%), followed by BCR 12 (Boreal Hardwood Transition; 13%) and the very small area of BCR 22 occurring in Wisconsin (Eastern Tallgrass Prairie; 1% of total upland accomplishments reported). However, wetland accomplishments have been distributed more equally between BCR 23 (52%) and BCR 12 (48%) with <1% coming from BCR 22.

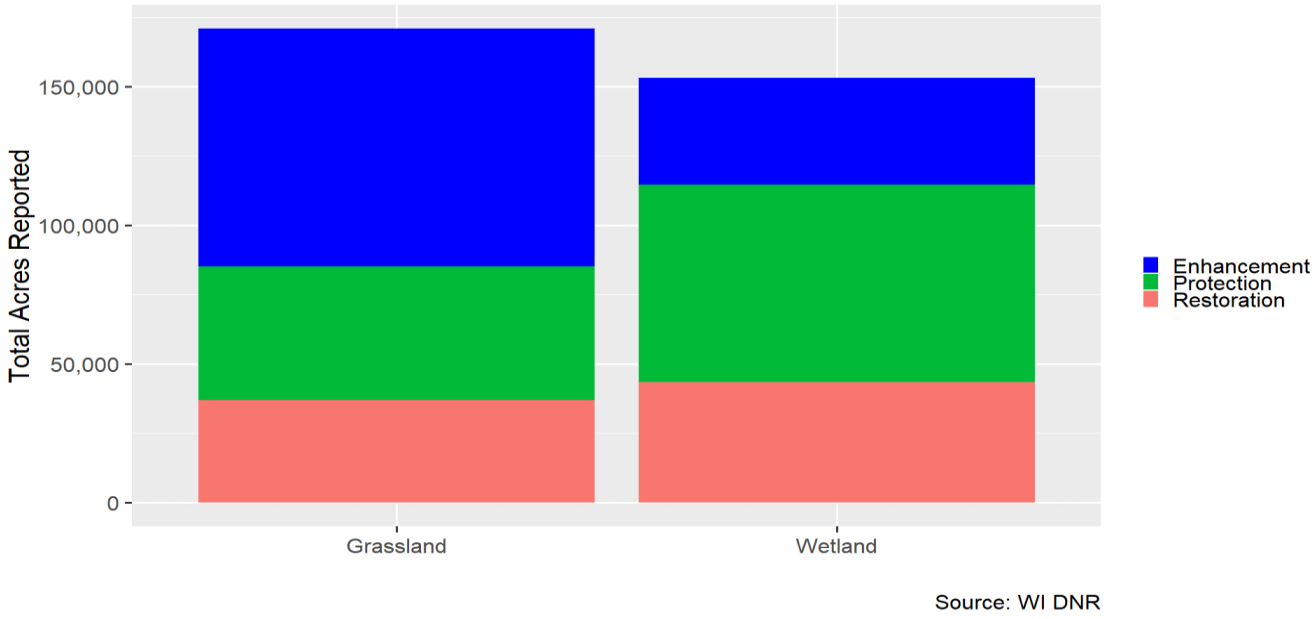


Figure 3. Total acres protected, restored or enhanced for upland and wetland habitats in Wisconsin according to Wisconsin Department of Natural Resources habitat accomplishment reports, 1997-2018.

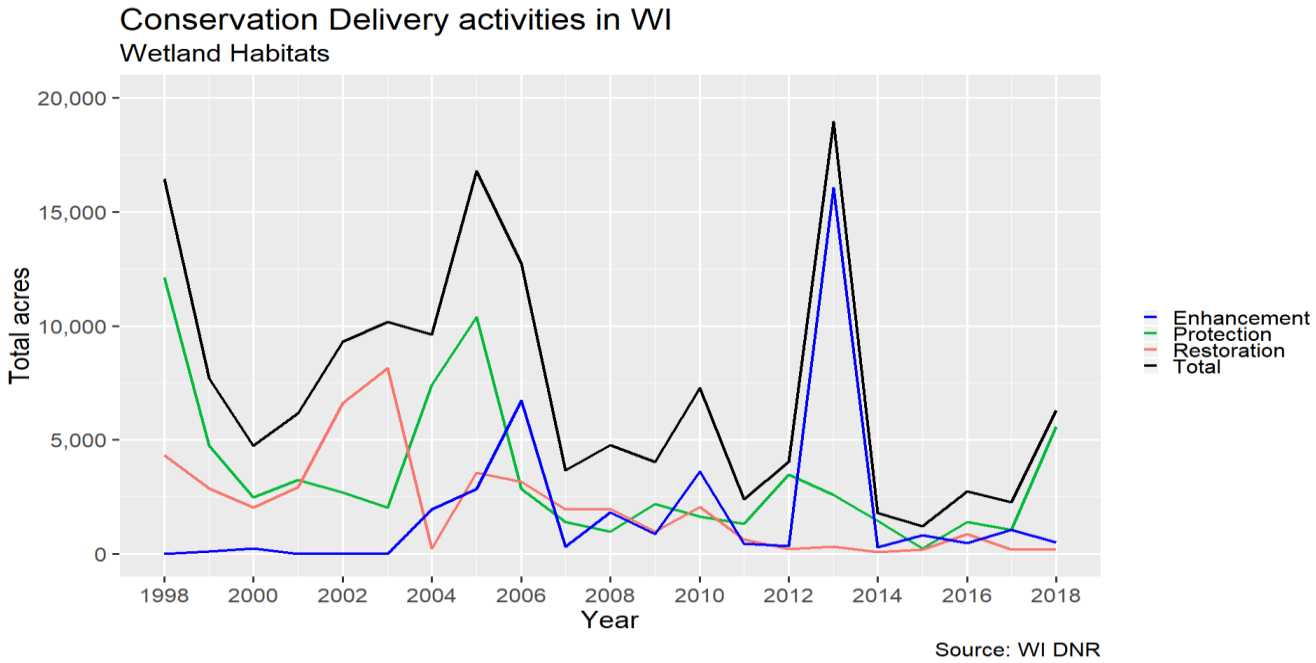


Figure 4. Time series of annual wetland habitat accomplishments* by conservation action (protection, restoration, and enhancement) reported to Upper Mississippi Great Lakes Joint Venture, 1998–2018.

* Large increases, especially for enhancement, in a single year can be related to many things and typically are not real changes in the amount of quality waterfowl wetland habitat. For example, a big year for drawdowns on managed areas, control-structure replacement on one or more large flowages, or characterization of habitat accomplishments incorrectly reported among the three reporting categories (e.g. maintenance or routine management work reported as enhancement).

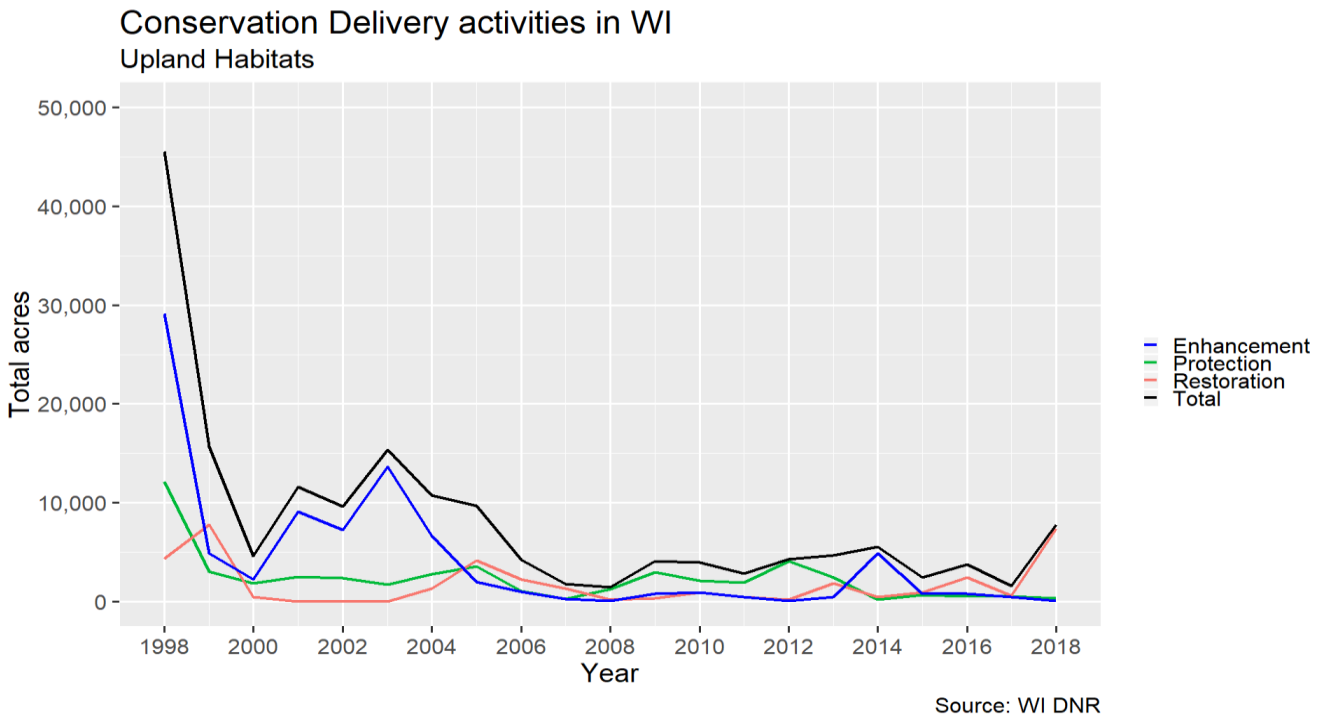


Figure 5. Time series of annual upland habitat accomplishments* by conservation action (protection, restoration, and enhancement) reported to Upper Mississippi Great Lakes Joint Venture, 1998–2018.

* Large increases, especially for enhancement, in a single year can be related to many things and typically are not real changes in the amount of quality waterfowl upland habitat. For example, thousands of acres of prescribed burning activities, which would be a routine management action, may have been counted as enhancement acres if those reporting did not clearly understand the types of activities to be reported. As the reportable activities may have not been clearly defined in the earlier years of the habitat accomplishment reporting, those reporting may have been much more inclusive on the types of habitat conservation activities that they reported.

Federal Government

The Federal Government has a broad reach and tremendous impact on delivering waterfowl habitat in Wisconsin. While the recent influence of Great Lakes Restoration Initiative (GLRI) funds and other federal programs (Sterner et al. 2017) have made significant contributions towards waterfowl objectives this section focuses on federal programs that have consistently delivered throughout the past 22-plus years. The USFWS, USDA-FSA and NRCS have made a long-term investment to deliver and fund waterfowl habitat through dedicated staff, a variety of partnerships, and diverse suite of programs.

The USFWS approves federal funding annually to WDNR through the Wildlife Restoration Act of 1937, also known at the Pittman-Robertson (PR) Act. These funds are generated through excise sales taxes of firearms, ammunition, and archery equipment. To receive the funding, each state must provide non-federal match. In Wisconsin, the source of match provided has largely originated from segregated funds, that originate from the sales of WDNR hunting licenses. Some of the PR funding is spent annually on wetland maintenance and management activities, also known as operational funding.

Specifically, the funds are used by Bureau of Wildlife Management staff for routine activities to manage and maintain WDNR managed properties, such as minor dike repairs, repairing rodent damage on dikes, inspecting and maintaining water control structures, mowing and spraying brush, and invasive species removal or control. Funds also are used annually to support engineering staff who work on wetland infrastructure projects. Between 2009 and 2019, the annual trend of PR revenues generally increased, a phenomenon commonly referred to as the "PR bump." With such an increase, the WDNR had an opportunity to fund additional project work beyond the traditional routine operational activities. Approved by the USFWS, WDNR proposed several special PR projects designed to improved wildlife habitat and hunting access and opportunities. Of those approved projects were several back-logged water control infrastructure projects that needed renovation work on >20 impoundments. While the "bump" helped WDNR catch up on many major wetland infrastructure funding needs, many more unfunded needs exist on high priority wetland impoundment sites throughout the state, and PR revenues are not expected to continue funding special projects such as these in the long-term.

The Partners for Fish and Wildlife program (PFW), administered by the USFWS was established in 1987 as part of an effort in the Upper Midwest Prairie Pothole Region to restore wetlands in the face of declining waterfowl populations. The Fish and Wildlife Act of 1956 and Fish and Wildlife Coordination Act were used to justify the expense of Federal funding for wildlife on private lands. These private lands initiatives grew into the PFW that Director John Turner requested funding from Congress as a separate program. Since the first appropriation of $100,000, the Program has steadily grown to where the Partners for Fish and Wildlife Act in 2006 authorized up to $75,000,000 (Partners for Fish and Wildlife Act of 2006; 16 USC 3771). The PFW works with private landowners to improve fish and wildlife habitat on their lands. Private lands include local units of government, NGOs, and corporations. Five primary goals are identified in the strategic plan for the PFW's 2017-2021 Midwest Region (USFWS 2017) including: A) conserve habitats, B) broaden and strengthen partnerships, C) improve information sharing and communication D) enhance our workforce and E) increase accountability. Managers have effectively implemented these goals in Wisconsin and the PFW program has been an active conservation partner working in wetland and upland habitats, especially on private lands.

The PFW program maintains a spatial database (HabITS) of wetland and upland projects dating back to 2001, which includes among other things, information pertaining to acres influenced, dollars invested, and type of conservation delivery (enhancement, establishment, maintenance/ follow up, and restoration). From 2001-2018, the PFW program has been responsible for 14,722 and 33,111 acres of accomplishments on wetland and upland habitats, respectively (Figure 6), totaling more than $8.5 million dollars in service cash.

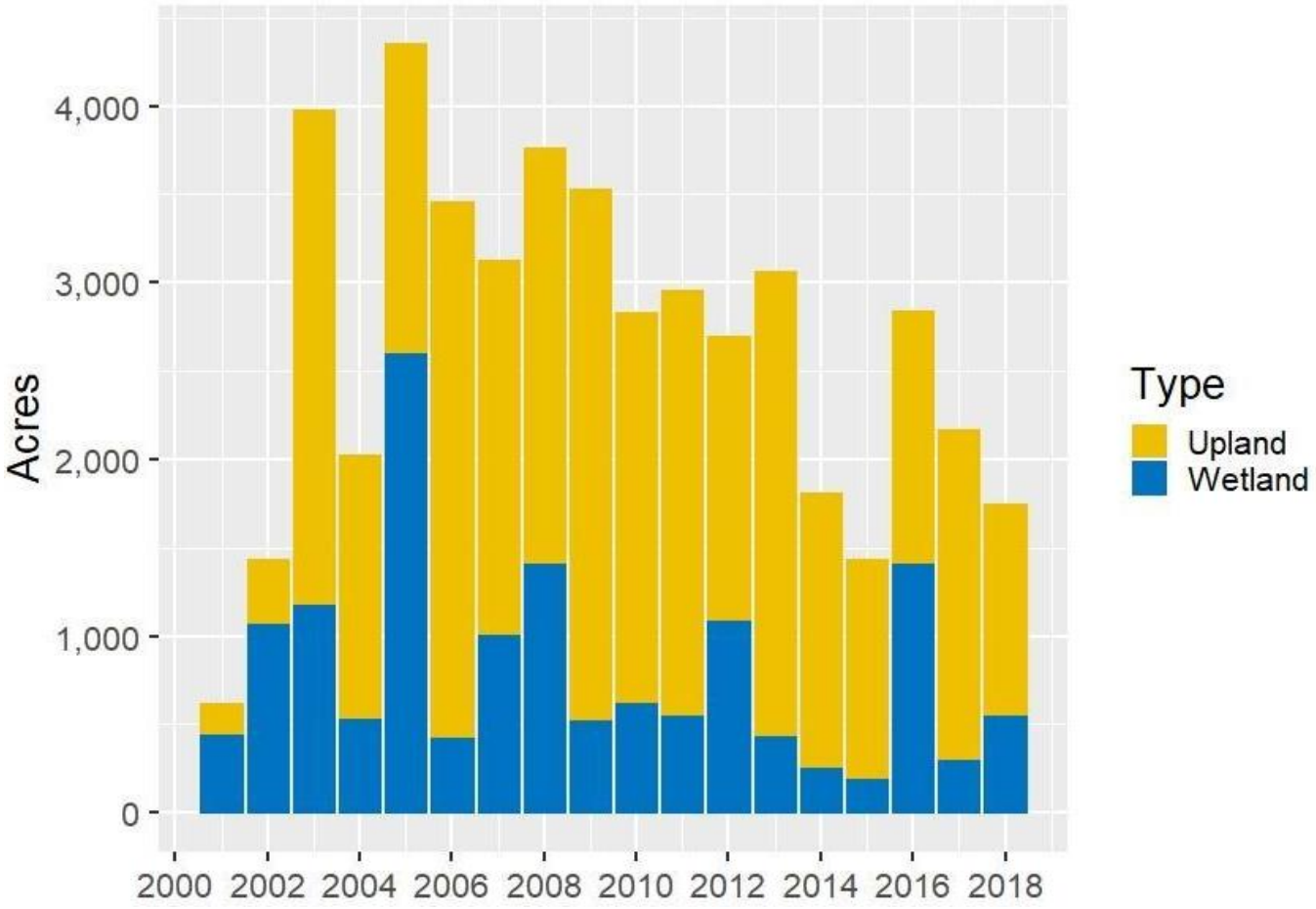


Figure 6. Annual habitat accomplishments in uplands and wetlands from the Partners for Fish and Wildlife Program in Wisconsin, 2001-2018.

The North American Wetlands Conservation Act (NAWCA) program, established in 1989, provides matching grants to wetlands conservation projects in the United States, Canada, and Mexico. All NAWCA grants require matching contributions on no less than a 1-to-1 ratio, thereby enhancing the collaborative nature of this program. Wisconsin has been one of the more successful States in the nation and as of 2018, has had 104 NAWCA projects either completed or underway that have conserved 173,838 acres of wildlife habitat. Due to the collaborative nature of NAWCA grants, many of these acres were captured in the previously mentioned WDNR and PFW reporting. However, there are acres represented here from land trusts, local units of government, and other non-governmental organizations (NGO's) that may have gone unreported if the entity did not coordinate with WDNR data requests. The ability of partners to leverage non-federal dollars to bring over $36 million dollars of federal NAWCA funding to Wisconsin has had a significant impact on deliverables to meet JV objectives. Most NAWCA grants and matching projects have resulted in several conservation deliverables, including land acquisition (retention/protection), wetland and grassland restoration, and wetland and grassland enhancement.

The United States Department of Agriculture's (USDA) Conservation Reserve Program (CRP) was created by the Food Security Act of 1985 and is considered the largest private-lands conservation program in the United States with over 24 million acres. The CRP is a land conservation program that encourages farmers to enroll, on 10- to-15-year contracts, acres of their land in exchange for annual rental payments. The land is removed from traditional agricultural practices and reverted to plant communities that are considered valuable to improve environmental health and quality. For a detailed review of the CRP see Hellerstein (2017). Importantly, the CRP benefits waterfowl, and many other birds, by replacing mostly unsuitable tillable lands with, in many cases, upland nesting cover (Reynolds et al. 2001). Farmers can choose to re-enroll their lands or decide to put the land back into production when contracts expire. This, coupled with policies and priorities at the national level (e.g., acreage enrollment caps) and grain commodity prices, has caused the cumulative enrollment of acres in the CRP to fluctuate and decrease over time, at a national level and within Wisconsin (Brandon Soldner personal communication; Figure 7).

In Wisconsin, enrolled acres in the CRP peaked in 1993 and 1994 at 713,022 acres and remained around 600,000 acres from 1998-2007. Since then, acres enrolled in CRP have steadily declined (Figure 7). Enrollment declined to a statewide low of 205,268 in September 2019, which is 71% below the maximum in 1993 and 1994**.** Starting in 2006, prices for corn, Wisconsin's most abundant agricultural crop, started to increase and topped out at $6.92/bushel in 2012 (Figure 7). Increased commodity prices along with reduced national enrollment caps established by Congress have led many farmers to not renew their CRP contracts and instead put their land back into production or remain idle. The 2008 Farm Bill reduced the national enrollment cap from 39 million acres to 32 million acres. This national cap was further reduced by the 2014 Farm Bill to 24 million acres by 2018. The 2018 Farm Bill provides a modest increase in the national enrollment cap which will be 27 million acres nationwide by 2023. The net decrease of nearly 500,000 acres in CRP from 1994 to 2017 represents one the largest and most substantial losses of wildlife habitat (e.g., nesting waterfowl) over the last few decades in Wisconsin. Regardless of the declines over the past decade, lands in CRP are important accomplishments toward meeting waterfowl habitat and population goals as many species use these lands for needed nesting cover (Halvorsen 2004).

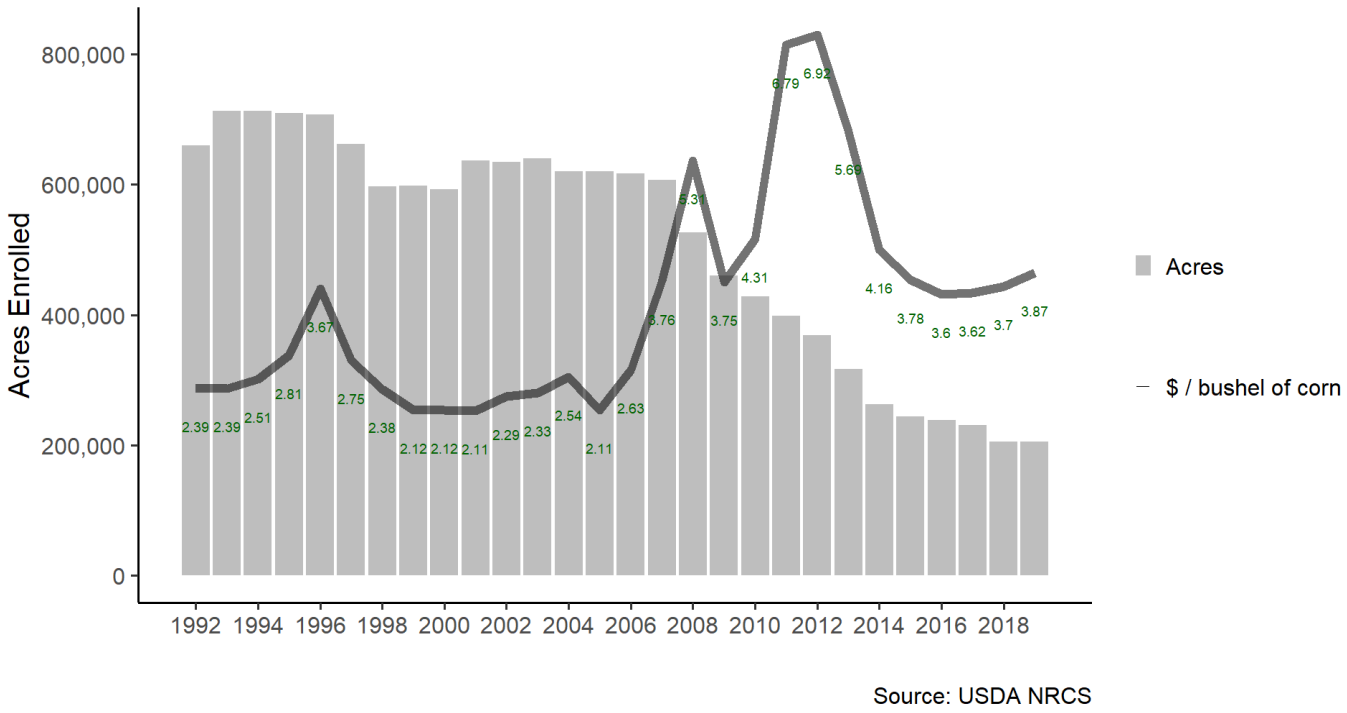


Figure 7. Annual acres of land enrolled (gray bars) in the United States Department of Agriculture Conservation Reserve Program in Wisconsin and national average corn prices (dark gray line; $/bushel), 1992-2019*.

* 2019 corn prices are through September

The USDA NRCS has permanently protected most waterfowl related habitat under authorization from the Farm Bill and established through the Agricultural Conservation Easement Program-Wetland Reserve Easements (ACEP-WRE) and the Emergency Watershed Protection Program-Floodplain Easements (EWPP-FPE). Before the formal establishment of the ACEP program, these programs were known as the Wetlands Reserve Program (WRP) and Emergency Watershed Protection Program (EWP). These two programs are administered solely by the USDA NRCS, a federal agency that provides technical and financial assistance to landowners who wish to maintain or enhance their land to benefit the environment. Additional Farm Bill programs include the Conservation Security Program (CSP) and Environmental Quality Incentive Program (EQIP), which provide only a minimal acreage of annual restored waterfowl habitat and are limited to 5- or 10-year contracts.

Since 1992, over 68,000 acres of wetland and associated upland habitat in Wisconsin have been restored and/or protected through WRE and FPE. The lands enrolled in WRE and FPE in Wisconsin typically break down into the following habitat types: 71% emergent wetland, 10% forested wetland, 2% open water, 1% riparian habitat, and 16% associated upland. Most (85%) of the acres enrolled in these easement programs are protected in perpetuity while the remaining (15%) are in 30-year easements. For every restorable acre enrolled in the program, policy allows for an additional existing acre of wetland or

an acre of upland. On average over the last 25 years, Wisconsin restores about 1,400 acres of wetland per year and about 100 acres of associated upland (Figure 8).

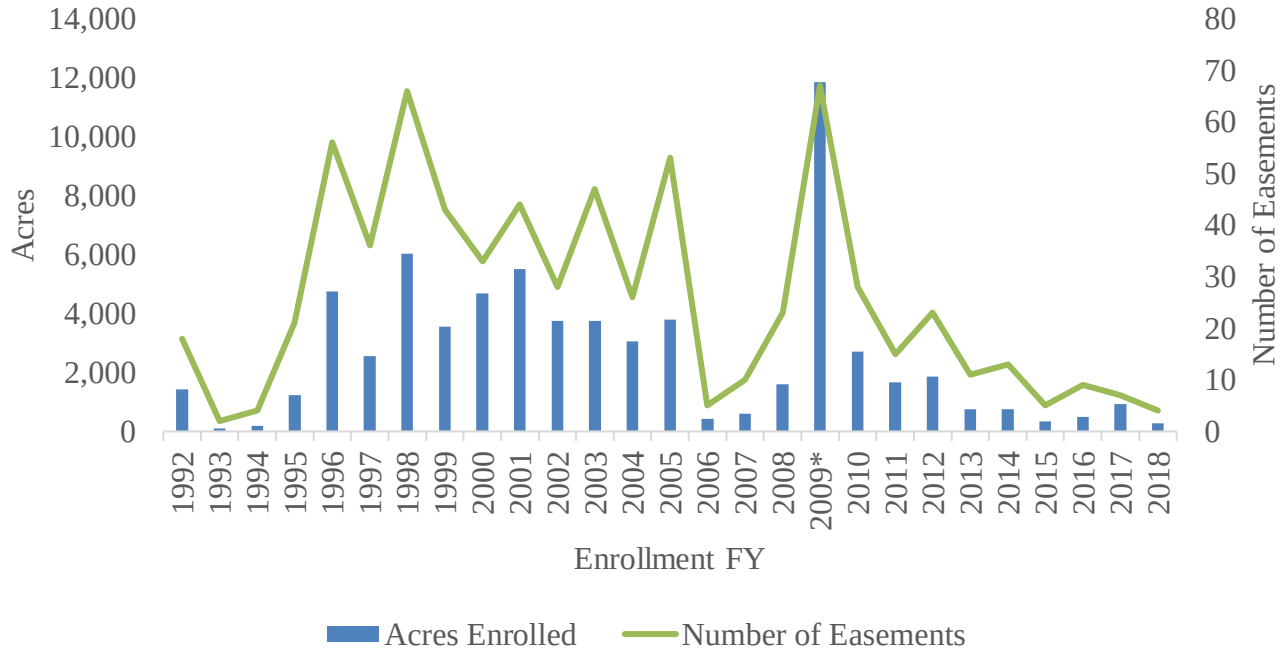


Figure 8. Total acres and total easements enrolled annually through the Wetlands Reserve Program (WRP) and Emergency Watershed Protection Program (EWP), 1992-2018.
Source: NRCS Olson NEST data
*American Recovery and Reinvestment Act Funding

Non-Governmental Organizations

Most often working in conjunction with many of the programs, NGO's provide a variety of protection, restoration, and enhancement deliverables through land trusts and conservation organizations. Ducks Unlimited (DU) is representing this sector due to their broad reaching partnerships and inclusion of many of these other NGO's in their conservation delivery. Ducks Unlimited conserves, restores, and manages wetlands and associated habitats for North America's waterfowl. In Wisconsin, DU maintains a strong partnership with state and federal agencies and NGO's to deliver waterfowl habitat by participating at various levels (i.e., research, grant-writing, engineering, education, advocacy, construction management, etc.). One of the primary mechanisms by which DU delivers wetland conservation is through establishing partnerships to secure and then administer NAWCA grants.

Ducks Unlimited has been a key partner in leveraging state, local, and NGO dollars to secure additional federal funding such as NAWCA to achieve the greatest impact for waterfowl in Wisconsin. Ducks Unlimited often focuses its conservation efforts strategically to address regional and state-wide initiatives. Since 1992, DU has worked with partners on habitat projects in nearly every part of Wisconsin with a heavy focus in priority townships identified in the Original Plan (Figure 10). These projects are linked to established partnerships and focused delivery of NAWCA grants in the state with six phases of the NW Wisconsin Pothole Initiative, six phases of the SE Coastal Habitat Initiative, and

five phases of the Glacial Habitat Restoration Area (Figure 10). They represent projects delivered from many of the state and federal programs listed above. Ducks Unlimited maintains a database (CONSRV) of conservation delivery. Since 1992, DU has delivered over 118,000 acres of waterfowl habitat (Figure 9). Many of these deliverables would be captured in the previously mentioned datasets but certainly not all.

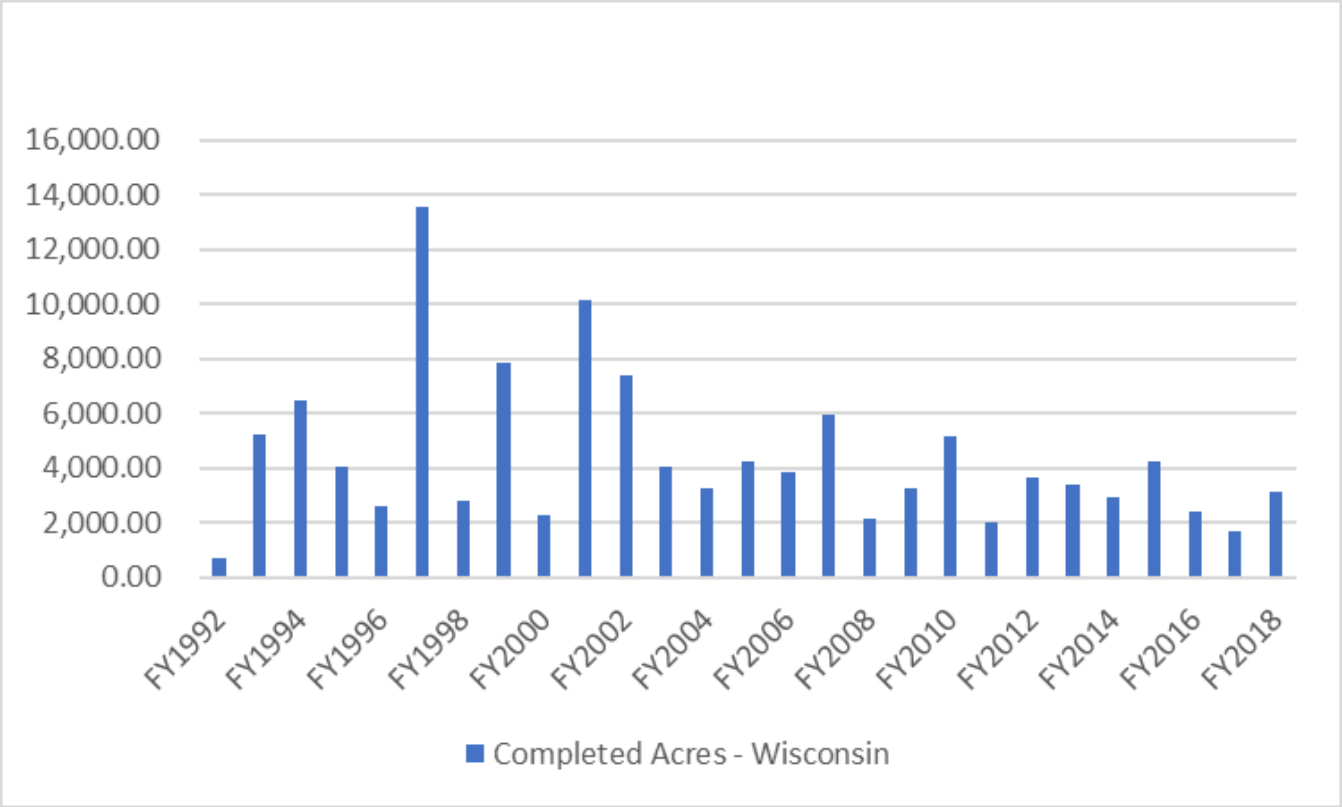


Figure 9. Acres affected (e.g., restoration, enhancement, protection, etc.) by Ducks Unlimited in Wisconsin, 1992-2018. *Source: CONSRV database*

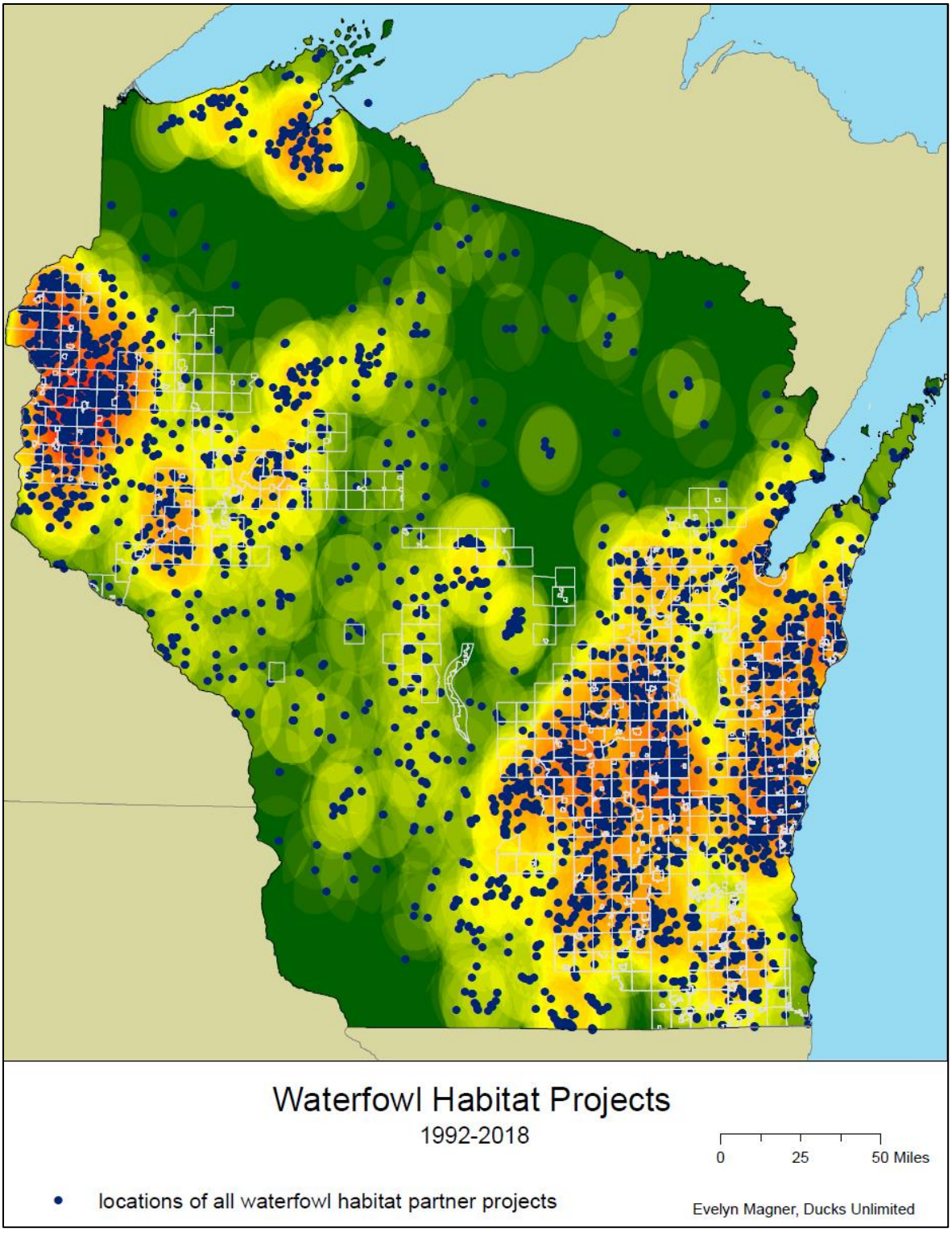


Figure 10. Spatial distribution of habitat projects (blue dots) in relation to Priority Townships (white boundaries) from the 1992 Original Plan. Projects include Duck Unlimited, Wisconsin Department of Natural Resources, and lands enrolled in the United States Department of Agriculture-Natural Resource Conservation Service Wetland Reserve Program, 1992-2018.

Waterfowl Habitat in Wisconsin: *Future Objectives*

Wisconsin, being one of ten states in the UMGL region, is critical for meeting regional waterfowl habitat retention and restoration objectives. The UMGL JV regional habitat retention objectives rank Wisconsin first in the amount of emergent wetlands (29% of total JV) needed, first in the amount of forested wetland habitats (26% of total JV) needed and third in the amount of aquatic bed habitat (27% of total JV) needed. Similarly, for restoration objectives, Wisconsin ranks first in the amount of emergent habitats (32% of total JV) needed across the region, first in the amount of forested wetland habitats (27% of total JV) needed, and second in the amount of aquatic bed habitat (13% of total JV) needed (Soulliere et al. 2017).

The UMGL JV has identified objectives for waterfowl populations and habitat acreage for all states (or portions of states) within its boundary. These objectives are linked to desired waterfowl population levels identified in the NAWMP (Fleming et al, 2017). Habitat objectives at the JV level are partitioned among BCRs and Wisconsin contains BCR 12 (Boreal Hardwood Transition), 22 (Eastern Tallgrass Prairie) and 23 (Prairie Hardwood Transition; Figure 1). We adopted or modified JV habitat objectives herein, and these objectives are consistent with those proposed in the Wisconsin Waterfowl Management Plan (Finger and Rohrer 2019 *in final preparation*). For guidance on how habitat objectives at the JV regional scale were derived see Soulliere et al. (2017 p. 60-62). Below are key background and modifications to JV habitat targets.

Key Background

- The UMGL JV estimated habitat needed for breeding and non-breeding waterfowl, separately.
    - Objectives for breeding waterfowl habitat were established using models informed by factors likely to limit population growth, typically an abundance of high-quality habitat. Optimal breeding habitat was described, and the habitat area required per breeding pair was calculated for each of four JV breeding focal species.

    - Objectives for non-breeding (migrating and wintering) habitat were developed using a bioenergetics model based on the assumption that food energy is a primary factor limiting non-breeding populations. Although quality non-breeding habitat has many features, forage energy has served as an accepted currency across JVs with a focus on non-breeding habitat.

- Objectives for breeding and non-breeding habitat are linked to and derived from specific species-habitat guilds (Table 1). Each species-habitat guild has at least one focal species assumed to represent the needs of other waterfowl in that guild. The UMGL JV implicitly assumes, for landscape-scale planning purposes, that species within a guild primarily use the habitat type to which they are assigned, but habitat descriptions typically include multiple cover types (i.e., emergent wetland with aquatic bed and grassland/herbaceous).

- The UMGL JV establishes separate objectives for habitat retention and restoration.
    - Retention objectives in the JV waterfowl strategy are estimates of high-quality habitat needed to support populations at NAWMP objective levels. However, waterfowl populations are dynamic, reflecting changing environmental conditions (e.g., wetland and grassland coverage). Thus, objectives for habitat retention established by the JV reflect estimated carrying capacity needs when continental waterfowl populations are relatively high – the 80th percentile of long-term average (LTA) abundance levels.

    - Habitat restoration objectives reflect the estimated additional habitat needed in the region to support continental populations when they are at these higher levels (80th% population abundance). Requirements for wetland restoration reflect the estimated area of new habitat needed to increase landscape carrying capacity to meet the needs of breeding and non-breeding populations when at objective levels (habitat deficit = objective carrying capacity – current carrying capacity).

Table 1. Species-habitat associations for waterfowl in the Upper Mississippi Great Lakes Joint Venture region during the breeding season. Individual species regularly use multiple wetland types and bird groupings are for general planning purposes. Multiple focal species were used for a single category to encompass larger geographic areas and or foraging sub-guilds.

Habitat	**JV Focal Species**	**Other Species**
Emergent herbaceous wetland, with aquatic bed or unconsolidated bottom	Mallard, blue-winged teal	Gadwall, green-winged teal, northern shoveler
Forested wetland, with aquatic bed / emergent or scrub-shrub	Wood duck	common goldeneye, hooded merganser
Aquatic bed, with emergent and unconsolidated bottom	Ring-necked duck	American black duck, redhead, trumpeter swan
Unconsolidated bottom/shore (open water), with aquatic bed or emergent wetland	none	Common merganser, red-breasted merganser

Modifications

Wisconsin has diverse habitats and ecophysiology that differ at a state scale relative to a regional scale, such as differences identified across BCRs of the JV region. Therefore, we made modifications of the

JV habitat objectives but retained the overall acreage requirements identified in UMRL JV's Waterfowl Habitat Conservation Strategy (Soulliere et al. 2017; *see Tables 17 and 18*). Our intention is for conservation partners in Wisconsin to adopt these waterfowl habitat objectives for the next 15 years (through 2035).

Modifications include:

- We *exclusively* adopted the UMGL JV objective for breeding season habitat, because wetland management and conservation activities in Wisconsin primarily are geared toward breeding season management. We recognize that the bird conservation community has increasingly emphasized the need to improve understanding of full life-cycle requirements, so that habitat conservation addresses factors most limiting population growth, which might be outside the breeding period. We confidently assume that by planning to attain breeding habitat objectives, we simultaneously will meet non-breeding habitat objectives. We believe this is a justified approach, because habitat preferences and use by waterfowl overlap between breeding and non-breeding season.

- The waterfowl species associated with unconsolidated bottom/shore (open water) and aquatic bed or emergent wetland (Table 1) primarily are absent from Wisconsin during the breeding season and the UMGL JV does not provide breeding season habitat objectives for this guild. As such, we do not suggest any objectives for restoration for this habitat type, but we do propose retention objectives below.

- The UMGL JV assumes that species that require aquatic bed habitats do not have a habitat limitation during the breeding season and therefore do not have any requirements for breeding season habitat restoration for aquatic bed habitats. As such, we decided to adopt the JV's non-breeding aquatic bed restoration objective of 13,700 acres given the population demographics of ring-necked ducks in nearby Minnesota (Roy et al. 2013; Roy et al. 2019), the relatively unknown distribution of them in Wisconsin, and the focus by many conservation partners on restoring and enhancing lacustrine habitats with submerged aquatic vegetation.

- The UMGL JV regional Waterfowl Habitat Conservation Strategy partitions objectives for habitat acreage down to the BCR polygons within Wisconsin. While this spatially strategic approach can serve to target conservation activities in areas of the JV region perceived to have the greatest need, we have developed a more spatially refined Wisconsin-specific approach to target conservation (*see Decision Support Framework*). Therefore, we suggest the requirements for habitat retention and restoration be applied to Wisconsin according to our decision support layers to help guide where spatially they can be most effective. Our decision support layers have high impact watersheds in all three BCRs found in WI.

- Objectives for Grassland acreage are not specifically identified in the UMGL JV plan although they are recognized as critical components in the their habitat models for mallards and blue-winged teal. In the habitat models, the UMGL JV assumes a >1:1 ratio of grassland to wetland for mallards and a >2:1 ratio for blue-winged teal. Because of the importance of grasslands for A) mallard and blue-winged teal recruitment B) general grassland cover for other ground-nesting waterfowl C) other grassland birds, and D) the decrease in this critical component over the last few decades, we suggest the following:
    - To sustain and grow grassland nesting waterfowl in Wisconsin; a 2:1 ratio of grassland cover to wetland restorations in the emergent habitat guild should be maintained in the Southeast Glacial Plains and other appropriate ecological landscapes. The restored grassland should be no farther than 500 yards from suitable brooding wetland habitat to count toward the upland restoration objective. However, opportunities to restore grasslands that are closer to these wetlands (<200 yards) should be prioritized over those that are farther away. In addition, opportunities to restore grasslands that are within 500 yards of existing wetland habitat also are critical and will count toward meeting the grassland acreage goals. This minimum 2:1 ratio of grassland to wetland is critical for sustaining local populations of ground-nesting waterfowl while at the same time helping to improve and retain water quality in the associated wetlands.

    - We also suggest the 2:1 ratio of grassland cover to emergent wetland be applied for retention objectives. Therefore, we recommend and objective of grassland retention at 1,157,104 acres (the objective for emergent wetland retention is [578,552] X 2).

We recommend that Wisconsin conservation partners strive to retain 1,270,896 acres and restore 183,218 acres of wetland waterfowl habitat, distributed among different habitat types (Table 2) by 2035. In addition, we recommend that conservation partners strive to retain 1,157,104 and restore 290,694 acres of grassland habitat by 2035 (Table 2). Conservation partners are advised to use our decision support framework in the appropriate ecological landscapes and watersheds to prioritize where grassland conservation delivery is conducted as they would for wetland conservation delivery, to ensure that both habitats are strategically prioritized in conjunction with each other across the landscape.

Table 2. Estimated wetland and upland retention and restoration requirements to support waterfowl populations in Wisconsin through 2035. Values presented are in acres.

	Habitat Type				
Objective Type	Emergent	Forested	Aquatic Bed	Unconsolidated	Grassland[1]
Retention	578,552	99,845	270,002	322,497	1,157,104[2]
Restoration	145,347	24,172	13,700[3]	0	290,694

[1]Grassland acres were calculated as emergent acres * 2

[2] Objectives for grassland retention were not derived by the JV

[3] This is a JV non-breeding habitat objective

The objective of retaining 1.27 million acres of high-quality breeding wetlands (those capable of supporting successful nesting and brood rearing) is ambitious, especially if one considers there is about 5 million acres of wetlands remaining in Wisconsin. Just over 1 acre should be 'high quality' waterfowl habitat for every 5 acres of wetland habitat in Wisconsin. This objective represents the estimated amount of habitat it takes to sustain (not grow) current population objectives for waterfowl in Wisconsin. It stands to reason that if this number decreases over time, so do population levels. Given the importance of protecting these acres over the next 15 years and beyond, its critical to understand how and where these habitats currently are distributed among the state, their distribution among private and public land, to what extent these areas are stable (i.e., easement perpetuity vs. short term conservation contracts), and to the degree they represent high quality habitat. We recommend managers and planners begin to evaluate these unknowns in the coming years.

Objectives for restoring upland (290,694 acres) and wetland habitats (183,218 acres) for waterfowl also are ambitious, especially considering the annual rate of accomplishments from conservation partners in Wisconsin has slowed (Figures 4,5,8 and 9). The UMGL JV recently revised definitions of habitat delivery (p.13 -14 Soulliere et al. 2017 *and see* Appendix A) and we developed a flow chart designed to assist conservation partners in better understanding which actions can be applied toward restoration accomplishments (Appendix C). To focus these acres on the landscape, we encourage partners use our Habitat Decision Support Framework and data layers to spatially target critical Ecological Landscapes and watersheds. This Decision Support Framework integrates social and biological values identified in the NAWMP (NAWMP 2012, 2018, Krainyk et al. 2019).

We proposed objectives for restoration of grassland acres to be associated with all emergent wetland restoration acres because we believe these areas are critical, given their importance for nesting waterfowl habitat in Wisconsin. A large decrease in CRP acreage enrollment (Figure 7) associated with concomitant declines in Wisconsin's breeding population of blue-winged teal (*see waterfowl population change*), and to some degree mallards, has led many researchers to identify a lack of nesting cover near brood rearing wetlands as a limiting factor for population growth (Thompson et al. 2012). In addition, grasslands are critical for many other birds and wildlife. Synergies exist with other conservation groups and entities that have a simultaneous interest in grassland management.

While we identified retention objectives of 322,497 acres for the unconsolidated bottom/shore (i.e., open water) habitats, we excluded objectives for restoration of this habitat type. While we recognize some sea ducks and diving ducks are highly abundant during migration and winter, few practical or reasonable means exist to restore or create these deep and open water habitats at meaningful spatial scales. Water quality degradation and sedimentation are the greatest threats to these habitats. Efforts to clean and protect these environments will be important to restoring and enhancing these communities which waterfowl depend on, particularly diving ducks. The exclusion of this habitat for planning purposes should not be viewed as de-valuing the species, or the policy issues that affect this community, but the habitat objectives are not conducive with habitat delivery mechanisms in Wisconsin.

Land Cover Changes

To assess the change in land cover since the 1992 Original Plan, we assessed statewide and focus-area level differences in land cover between the Wiscland 1 and Wiscland 2 datasets. The periods of time in which the data collected for these mapping products roughly corresponds with periods in which both plans were written. Wiscland 1 is a land cover dataset developed by The Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND), a consortium of government and private organizations formed in 1993 to promote development of digital geographic data for Wisconsin. Wiscland 1 was based on 1991 to 1993 satellite imagery. The Wiscland 2 land cover project was a collaborative effort of the WDNR, University of Wisconsin-Madison (UW), and the Wisconsin State Cartographer's Office (SCO) based on 2010-2014 satellite imagery and conducted between the fall of 2013 and August 2016. (Wiscland 2 Land Cover User Guide 2016).

Both datasets held in common some broad-level classifications, referred to as level 1 land cover classification types. The level 1 cover type classifications that were assessed included agriculture, grassland, urban/developed, wetland, open water, and forest. The changes in percent cover among the focus areas of the Original Plan are shown in Table 3 comparing the Wiscland 1 and Wiscland 2 level 1 classifications. Caution is required, however, if conclusions are made for land cover changes while interpreting the changes in the classifications. According to the Wiscland 2 Land Cover User Guide, the approaches to assess accuracy between the datasets differ, which should be taken into consideration when comparing the two Wiscland products side-by-side.

The most notable uncertainties with change in land cover are for the grassland and wetland cover types. In Wisconsin, acres enrolled in CRP through USDA peaked in the mid 1990s but hundreds of thousands of acres of these grasslands have since been lost due to expiring contracts and the conversion of grasslands back into agricultural production (Figure 7). Likewise, the amount of grasslands used to pasture livestock has significantly declined due to conversion to crop land during the same period. The analysis of the Wiscland datasets would suggest otherwise, particularly in the Priority II – Driftless (increase of 12%), Mississippi River (increase of 6%) and Southeast (increase of 3%) Focus Areas. The accuracy for the Grassland classification was 71% for Wiscland 1 and 94% for Wiscland 2. Such uncertainty in the accuracy in Wiscland 1 may account for some false gains in this cover type between the two products.

A similar story may hold true for comparing changes in wetland cover. Accuracy was 81% for Wiscland 1 and 91% for Wiscland 2. The User Guide further explains, "*One notable observation was that Wetlands represent a slightly larger class in Wiscland 2 than the Wisconsin Wetlands Inventory (WWI). Because the WWI is both sampled for training points and used as a classification input feature, the Wiscland 2 wetland classification often does align with WWI wetlands areas, but the WWI was not used to explicitly define lowland areas as it had been in Wiscland 1*." Comparisons in Table 3 suggest that wetlands have made modest gains across the state (up to 4% in some areas), except for the Marquette-Waupaca, Central and Mississippi River Focus Areas (-1% - 0%). While the implementation of wetland

restoration programs spurred by programs like the NAWMP, NAWCA, and Wetlands Reserve Program (WRP) have resulted in the gains of tens of thousands of acres in wetlands across the state, substantial losses in wetlands also occurred due to continued draining and filling of wetlands for agricultural purposes and unmitigated development. Information related to activities that result in the draining or filling of wetlands (legally and illegally) has been difficult for agencies to track. Thus, actual net gains or losses in wetland acres is not well understood (WDNR 2014).

Table 3. Percent change in cover types in Original Plan Focus Areas measured Wiscland 1 and Wiscland 2 landcover datasets.

Original Plan Focus Area	Urban/ Developed	Agriculture	Grassland	Forest	Open Water	Wetland
Priority II – Door Co.	2	-13	7	2	-5	2
Priority II - Milwaukee	23	-1	-14	-3	-4	1
Priority II – Driftless	2	-16	12	1	0	1
Forest Fringe	1	-2	-3	4	-1	3
Northwest	3	-1	-2	1	0	1
Marquette-Waupaca	2	-6	-2	7	0	0
Green Bay	0	-2	0	-1	-9	2
Southeast	7	-10	3	1	-1	1
Central	1	-4	-1	7	0	-1
Mississippi River	3	-12	6	0	1	0
Wild Rice	1	-2	-2	1	0	4

Another useful tool to analyze changes in Wisconsin land cover is the USDA Natural Resources Inventory (NRI) report (U.S. Department of Agriculture 2018). It should be noted, however, that NRI collects land cover data in a point-based approach, whereas Wiscland takes a raster approach. The NRI report documented land cover abundance across broad classification categories across the United States since 1982. For comparison, we assessed statewide changes in land cover between 1992 and 2015, but we did not analyze spatial NRI data at the priority focus area level. The NRI report appears to tell a different story than the Wiscland assessment for grasslands. The NRI system contains classifications for CRP and pastureland, which would be the best equivalent of the grassland classification in Wiscland when combined. The NRI suggested CRP and pastureland statewide decreased 15.7% between 1992 and 2015 and wetlands (palustrine forested and non-forested) were stable between 1992 and 2015 (+0.1%). Th NRI suggests a greater increase in developed land coverage compared to Wiscland between 1992 and 2015, with a statewide increase of 25.3%. Agricultural lands (cultivated and non-cultivated cropland) decreased by 4.7% statewide between 1992 and 2015, which appears to be less of a decrease compared to loss of Wiscland agricultural lands. Statewide, forested lands increased 3% between 1992 and 2015, a trend similar to Wiscland forest classification during the same period. Lastly, the NRI indicated open water increased 0.8% between 1992 and 2015; a trend that also was supported by Wiscland data.

The UMGL JV also analyzed land cover changes across the JV region, using the National Land Cover Database (NLCD). Their comparisons in land cover were between the 2001 and 2006 NLCD datasets. The JV further assessed these changes by BCR by state. The JV did not conduct an assessment for BCR 22 in Wisconsin, due to its limited coverage (Pierce et al. 2014). Thr BCR 12 roughly corresponds with the Original Wisconsin Plan's Wild Rice and Forest Fringe Focus Areas, while BCR 23 roughly corresponds with the remaining Focus Areas in Wisconsin. During the 5-year timeframe, the NLCD suggested similar land cover trends within Focus Areas in BCR 23 with conversions of farmland and grassland to urban/developed lands. Grassland/hay/pasture cover was relatively stable with a 0.3% net decrease, row crops decreased 0.6%, and urban cover increased 4.4%. The BCR 12 (northern Wisconsin) was dominated by upland and wetland forest. The NLCD suggested a loss of 0.9% upland forest and a loss of 0.4% wetland forest from 2001 to 2006. Most of this loss resulted in a conversion to grassland/pasture/hay, which increased by 10%. Some of this classification may be reflective of early-successional forest stages following clear-cuts, rather than longer-term cover of grassland/hay/pasture.

We used and compared three separate approaches (Wiscland, NRI and UMGL JV's NLCD) to examine statewide landscape change since 1992. Trends from all three methods consistently show increases in urban and suburban development which is likely the leading cause of loss of wetlands, upland habitat, and agricultural land. Wetland habitat appeared to be stable overall, with some areas showing slight increases and others slight decreases. Grassland acreage was more variable, as some regions have seen large increases (Driftless Area; Table 3), but most regions have seen declines. With increasing human populations, especially near existing population centers, development likely will continue to be a leading cause of habitat alteration in the future. As the Wisconsin landscape changes over the horizon of this plan, it will be critical for planners and managers to identify critical regions that have existing habitat resources (*see Conservation Capital*) and those that have the potential to support habitat resources (*see Conservation Opportunities*). We should deliver appropriate conservation in these areas.

Waterfowl Population Changes

The Waterfowl Breeding Population Survey for Wisconsin (WBPS) is modeled after the stratified double sampling framework of the Waterfowl Breeding Population and Habitat Survey conducted by the conducted by the USFWS and Canadian Wildlife Service in north-central and northeastern United States, central and eastern Canada, and Alaska (March et al. 1973, Anonymous 1977). In Wisconsin, the WBPS has been conducted annually since 1973 and timing of the survey is focused on early nesting species, occurring typically near the end of April through early May. In 1973, three strata were delineated within Wisconsin based on waterfowl densities and habitat (Figure 11). Fifty-five east-west aerial transects, each 30 miles long and ¼ mile wide were randomly distributed within the South-East Central (SEC) stratum, Northern High (NHI) stratum, and Northern Low (NLO) stratum (Table 4). In 1997 11 aerial transects were added to a South-West Driftless (SWD) stratum. This region was not surveyed before 1997 because of low wetland density (Figure11) Milwaukee (MIL) was not surveyed and not categorized as a stratum.

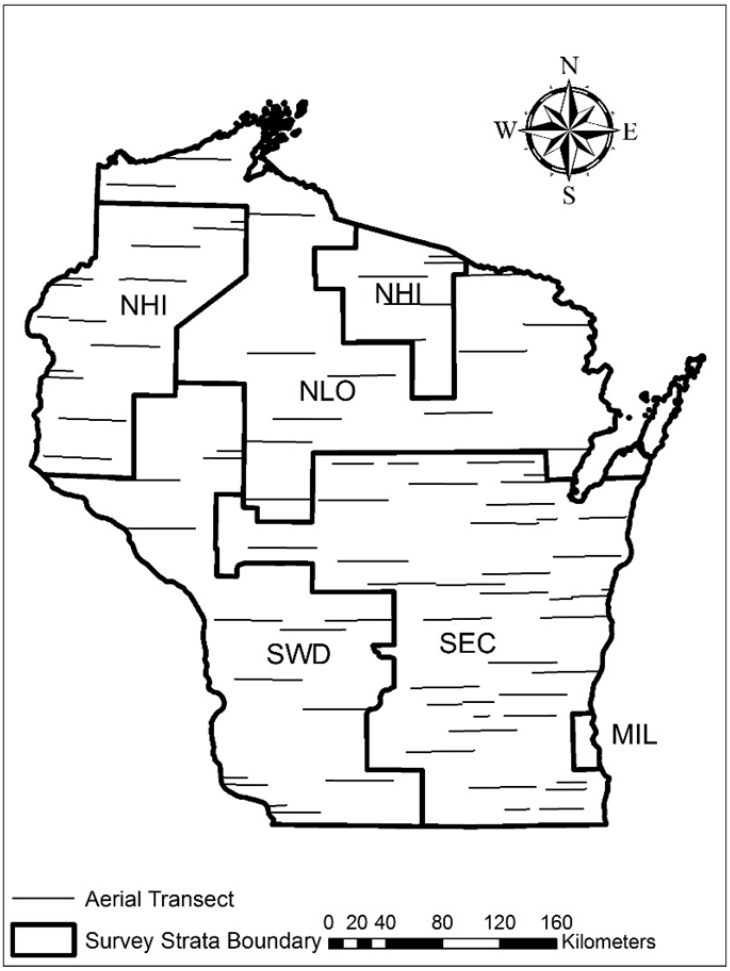


Figure 11. Wisconsin's Waterfowl Breeding Population Survey (WBPS) strata and transects including NHI (Northern High), NLO (Northern Low), SWD (Southwest Driftless), SEC (Southeast Central), and MIL (Milwaukee).

Table 4. Area encompassed in Wisconsin's Waterfowl Breeding Population Survey (WBPS) Strata.

Stratum	Area (Square Miles)
Southwest Driftless	12,311
Southeast Central	18,005
Northern High (East)	2,881
Northern High (West)	6,969
Northern Low	15,772
Milwaukee	244

The Original Plan also prioritized waterfowl habitat across the state based on a hierarchy of Priority Regions (I and II), focal areas, and townships to provide guidance on where to focus waterfowl habitat conservation efforts. These regions were based on waterfowl density, habitat distribution, and geopolitical boundaries. The boundaries for WBPS and Priority Regions are similar but do not align (Figure 12).

The Original Plan proposed waterfowl population objectives "to provide habitat and management necessary to add 200,000 ducks, including 50,000 mallards and 125,000 blue-winged teal to the average spring breeding population in Priority I joint venture counties by 2005." This objective was further separated by northern and southern counties within the Priority I region. The objective for the southern population was based on the average of the three greatest spring population estimates for the SEC stratum during 1973 to 1979.

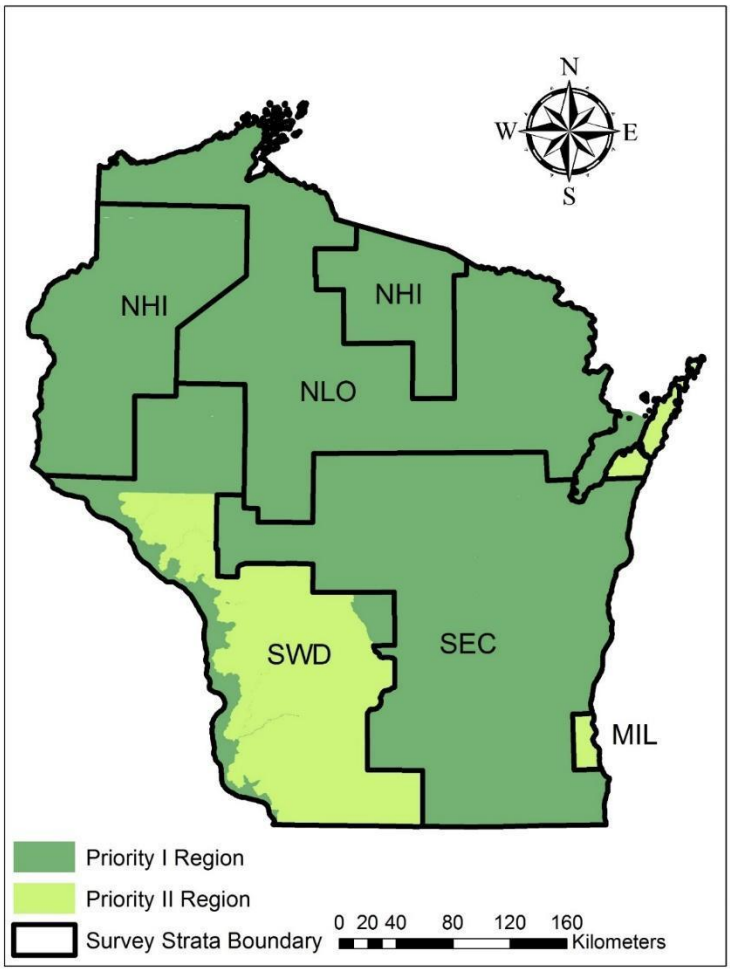


Figure 12. Original Plan Priority I, Priority II regions and Wisconsin Waterfowl Breeding Population (WBPS)Survey strata.

This estimate was 59,700 mallards and 120,100 blue-winged teal. Within the southern counties of the Priority I region (i.e., SEC strata) the objective was to add "30,000 mallards and 80,000 blue-winged teal to the average spring breeding population" by 2005, therefore increasing the average mallard breeding population to 89,700 and the average blue-winged teal breeding population to 200,100, by 2005. The objective for the northern population was based on the average of the three greatest spring population estimates for the western Northern High stratum and the adjoining counties in the Northern Low stratum during 1980 to 1988. Estimates of the breeding population of mallard and blue-winged teal for the western Northern High stratum were 34,000 and 25,300, respectively and 10,300 and 5,400, respectively for a portion of the Northern Low stratum. Therefore, the estimates for northern counties of the Priority I region were 44,300 mallards and 30,700 blue-winged teal. Within the northern Priority I region, the objective was to add "20,000 mallards and 20,000 blue-winged teal to the average spring breeding population" by 2005, therefore increasing the average mallard breeding population to 64,300

and the average blue-winged teal breeding population to 50,700. The Original Plan developed objectives for waterfowl populations for Priority II regions.

We categorized transects according to a combination of Priority Region and WBPS stratum to calculate population estimates that were applicable to objectives of the Original Plan and spatially relevant to the Priority regions of the state.

- We derived population estimates for the Southern Priority I region from the 29 aerial transects in the SEC stratum from 1992 to 2017. The area of the combined transects (stratum) was18,005.3 square miles (Yellow lines, Figure 13).

- We derived population estimates for the Northern Priority I region from the 26 aerial transects across the NHI and NLO strata from 1992 to 1996. The stratum encompassed 25,111.57 square miles. Two transects were added from 1997 to 2017, for a total of 28 transects with a combined area of 27,717.68 square miles (Orange lines, Figure 13).

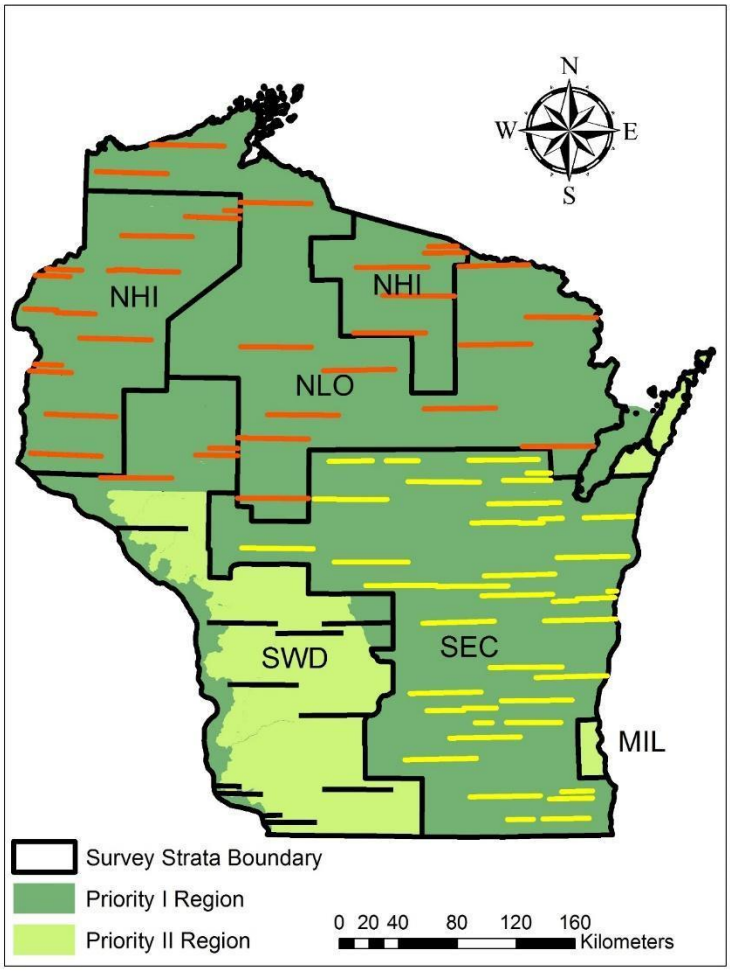


Figure 13. The distribution of aerial transects within the Original Plan Priority Regions and Waterfowl Population Breeding Survey (WBPS) survey strata used to calculate region-specific population estimates for focal species in Wisconsin.

- We calculated population estimates for the Priority II region from nine aerial transect within the SWD stratum from 1997 to 2017. This region excluded the Mississippi River watersheds within Wisconsin but included a portion of the Priority I region that was not included in the SEC, as a portion of transect overlapped this section of the state. This Southwest Priority II Region encompassed 8,570.93 square miles (Black lines, Figure 13).

We calculated annual population estimates for the southern Priority I region, northern Priority I region, and southwest Priority II region. The regional population estimates were based on the equation:

$$P = B * A * R$$

Where *P* is the population estimate, *B* is the count of ducks per square mile in the region, *A* is the area of the region, and *R* is visual correction factor. We pooled data from 1992 to 2017 throughout the state to calculate visual correction factors for each species. We calculated raw population count estimates for mallard, blue-winged teal, wood duck, and ring-necked duck. Because these annual raw population count estimates contain some unknown annual observation error, we used a Bayesian state-space density-independent growth model to decompose estimates into a process variation (true population dynamics) and observation error component (Schaub and Kéry 2012). We plotted the modeled annual population estimates with 95% credible intervals and included the 2005 population objective from the Original Plan within figures for population estimates of mallard and blue-winged teal. We used the modeled annual population estimates to assess changes in abundance since the Original Plan.

Southern Priority Region 1

Estimates of population abundance for mallards steadily declined from an estimated high of 166,845 breeding individuals in 1992 to 79,254 individuals in 2017 (Figure 14). However, population goals defined in the Original plan were based on data from the 1970s when mallard abundance was much lower. Coincidently, the mallard population estimate in 2005 was 18.7% higher than the stated goal of 89,700 individuals. In the last decade, (2007 to 2017) estimates largely stabilized but the mean estimate in 2017 was 11.6% below (79,254) the 2005 objective of 89,700 individuals. Nonetheless, 95% credible intervals of the modeled mean abundance estimate in 2017 contained the stated 2005 objective.

Estimates of blue-winged teal declined from 186,214 breeding individuals in 1992 to 25,127 individuals in 2017. The objective in the Original Plan called for a population of 200,100 breeding individuals by 2005, but it was not realized. The estimate in 2005 was 49,511 which is 120.7% below the target objective. Wood ducks remained stable throughout 1992 to 2017. The long-term average was 48,052 breeding individuals.

Population estimates of ring-necked ducks from 1992-1997 should be viewed cautiously, considering their large 95% credible intervals. In addition, raw population estimates of ring-necked ducks varied greatly from 1992 to 1997 and they were rarely recorded during surveys from 2007 to 2017. The average number of breeding individuals in the Southern Priority 1 Region during 2005-2017 was 431 individuals, but there is a high degree of uncertainty in this estimate.

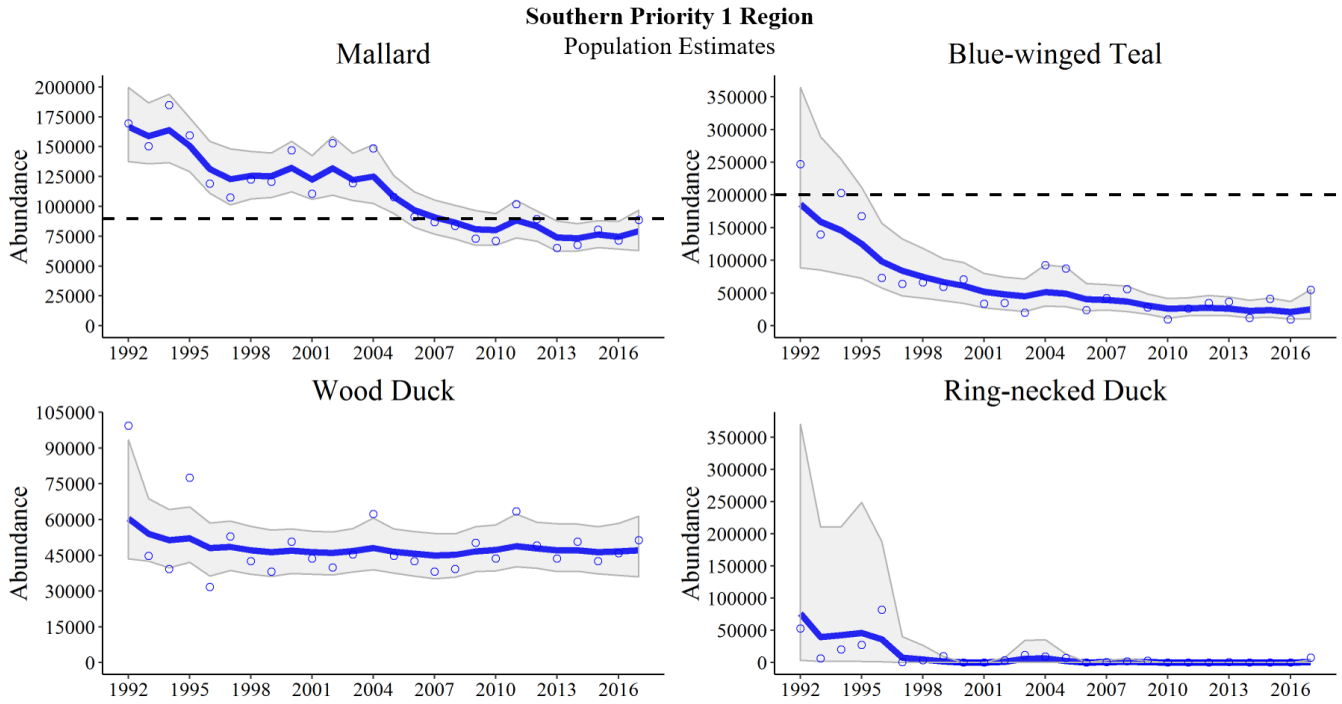


Figure 14. Trends in estimates of population abundance for priority waterfowl species in the Southern Priority 1 Region identified in the Wisconsin Original Plan. Trends were assessed using Bayesian state-space density-independent model estimates (solid blue line) derived from raw population estimates (open blue circles). Uncertainty in modeled annual estimates are described with 95% credible intervals (gray polygon). Dashed horizontal lines depict target objectives of population abundance for 2005, outlined in the Original Plan. No population objectives were defined for wood ducks or ring-necked ducks.

Northern Priority Region 1

Estimates of population abundance for mallards were cyclic between 1992 and 2017 (Figure 15). Mallard abundance was greatest in 1992 with 156,066 breeding individuals and lowest in 2008 with 65,999 individuals before climbing again to 114,280 in 2013. Despite fluctuations, mallard abundance in the Northern Priority Region 1 appears to have met, and exceeded, the objective of 64,300 breeding individuals by 2005.

Estimates of blue-winged teal followed a similar pattern of decline. Peak abundance started in 1992 at 76,415 breeding individuals and was 68.1% below the target objective of 50,700 individuals (actual 2005 abundance estimate = 24,945) by 2005. A continued gradual decline in abundance occurred such that abundance in 2017 (15,695 individuals) was 37.1% lower than it was in 2005.

The estimated abundance of breeding wood ducks increased slowly from 1992 to 2008 to 73,831 breeding individuals. Since 2008, the population has decreased slightly but appears to remain stable and produced an estimated 54,136 breeding individuals in 2017.

Estimates of the annual raw population of ring-necked ducks varied greatly. Variation in part may be related to the timing of the aerial surveys, which were designed to detect maximize breeding pairs of mallards, an earlier nester. Modeled annual abundance estimates suggest that the breeding population remained largely stable with a long-term average of 20,463 breeding individuals.

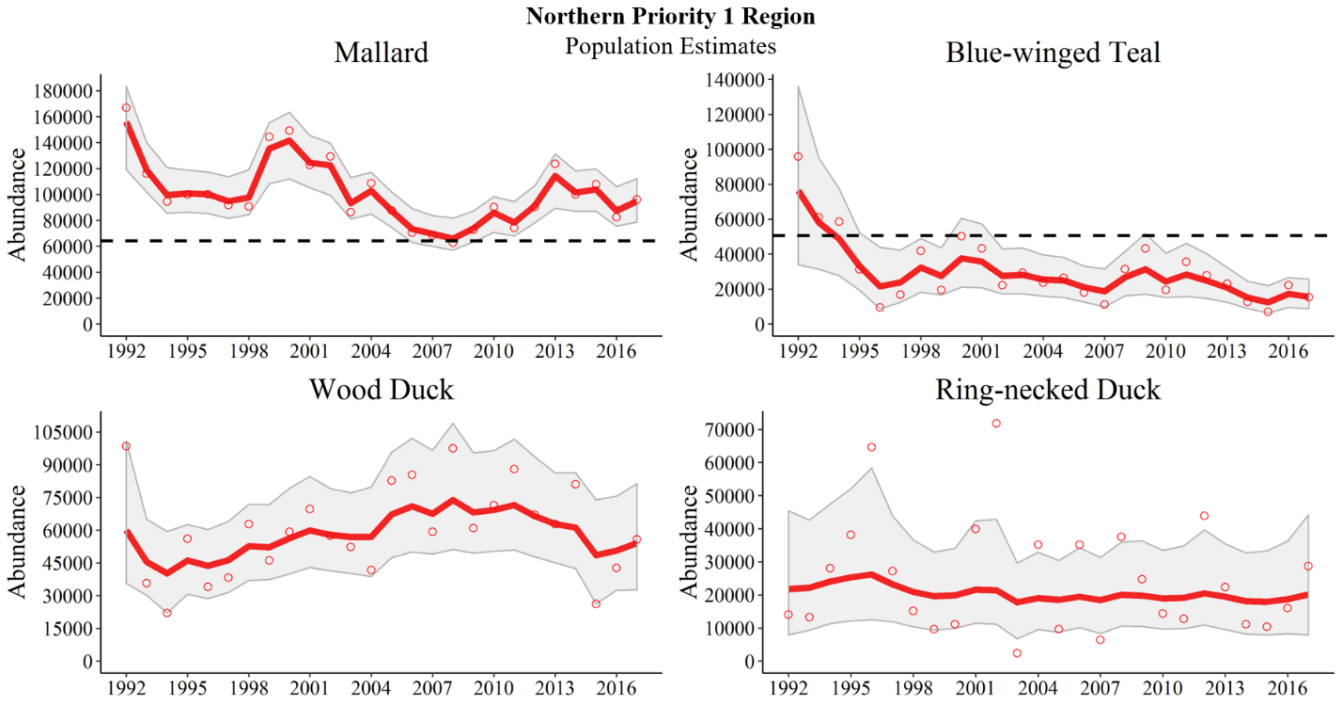


Figure 15. Trends in estimates of population abundance for priority waterfowl species in the Northern Priority 1 Region identified in the Wisconsin Original Plan. Trends were assessed using Bayesian state-space density-independent model estimates (solid red line) derived from raw population estimates (open red circles). Uncertainty in modeled annual estimates are described with 95% credible intervals (gray polygon). Dashed horizontal lines depict target objectives of population abundance for 2005, outlined in the Original Plan. No population objectives were defined for wood ducks or ring-necked ducks.

Southern Priority 2 Region

The Southern Priority 2 Region has historically been the least productive region for breeding waterfowl in Wisconsin and no target objectives were established in the Original Plan. Nonetheless, this region still provides an important contingent of breeding waterfowl, specifically for mallards and wood ducks (Figure 16).

Estimates of population abundance in mallards and wood ducks went different directions during the survey period of 1997 to 2017. Mallards peaked in abundance in 2000 with 20,015 breeding individuals but began to slowly decline to 10,450 individuals by 2017 (30.7% decrease). By contrast, wood ducks grew 78.6% from 6,198 individuals in 1992 to 11,068 individuals in 2017.

The abundance of blue-winged teal appeared to be cyclic during the survey period but modeled annual estimates were marked with high uncertainty because of the year-to-year variability in raw population estimates. Over the 20-year survey period, blue-winged teal averaged 7,715 breeding individuals.

With exception in 2004 and 2009, ring-necked ducks appeared to be absent from the Southern Priority 2 Region. Estimates of the population were 4,608 and 3,720 breeding individuals in 2004 and 2009, respectively, but these estimates fall well outside of the modeled 95% credible intervals. Observations recorded in 2004 and 2009 likely were of groups of migrating ring-necked ducks rather than actual breeding pairs.

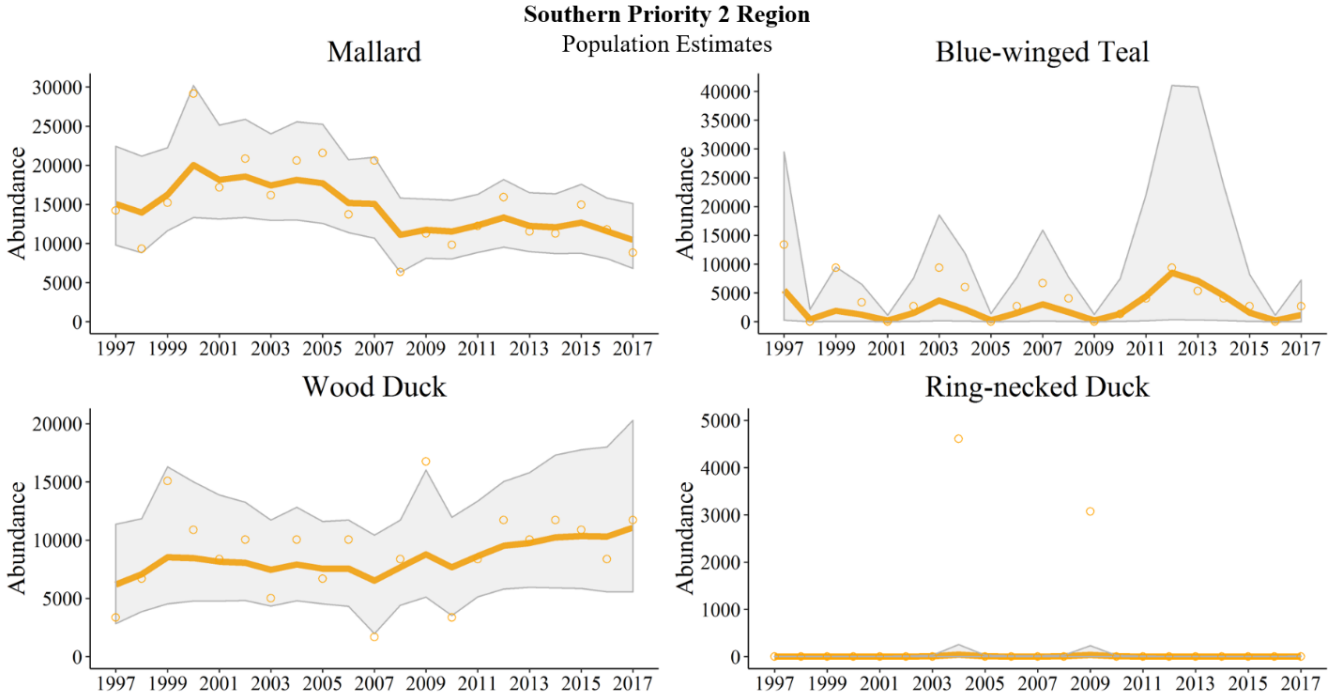


Figure 16 – Trends in estimates of population abundance for priority waterfowl species in the Southern Priority 2 Region identified in the Wisconsin Original Plan. Trends were assessed using Bayesian state-space density-independent model estimates (solid yellow line) derived from raw population estimates (open yellow circles). Uncertainty in modeled annual estimates are described with 95% credible intervals (gray polygon). No population objectives were defined for any waterfowl species in the Original Plan.

Wisconsin Waterfowl Habitat Decision Support Framework

A Contemporary Path Forward

We developed a novel strategy to identify important landscapes and watersheds for conserving waterfowl habitat in Wisconsin. The strategy maintains key continental and regional priorities and builds of the success of the Original Plan. Our approach is guided by the UMGL JV conservation decision support tool (Soulliere and Al-Saffar 2017) but it uses Wisconsin-specific datasets. Model assumptions are assigned by collaborative researchers, managers, and biologists with vast experience and several years working in Wisconsin. Key components of the Wisconsin Waterfowl Habitat Decision Support Framework include:

- Wisconsin-specific guidance from researchers, managers, and biologists;
- refined and revised habitat suitability models for breeding waterfowl that include:
    - new National Wetland Inventory definitions suitable for mallards, blue-winged teal, wood ducks, and ring-necked ducks; and
    - use of the WDNR Waterfowl Breeding Population Survey to "ground- truth" the habitat suitability map with known locations of breeding waterfowl;
- new habitat models for mallards, blue-winged teal, wood ducks, and ring-necked ducks that address spring and fall distributions;
- for the first time in a state-based plan, inclusion of
    - ecological goods and services spatial datasets; and
    - human dimensions spatial datasets;
- introduction of decision support layers that include Conservation Capital (CC) and Conservation Opportunities (CO); and
- a cumulative decision support layer that considers professional guidance on weighting all spatial datasets and one that:
    - identifies three-tiered Priority Ecological Landscapes, and
    - identifies nine-tiered Priority HUC 12 watersheds.

Our state-scale waterfowl habitat plan provides greater resolution within the broad-brush guidance of UMGL JV habitat objectives and identifies heterogeneity of conservation potential that is not apparent in the Upper Mississippi Great Lakes Waterfowl Habitat Conservation Strategy. Local detail is critical for implementing the UMGL JV habitat objectives with the most efficient use of funds for waterfowl management. Our approach is grounded in the following goal and corresponding objectives.

Goal: Develop a Waterfowl Habitat Decision Support Framework that assists practitioners on where to guide conservation activity.

Objectives:

A. Guide conservation activities in the most geographically relevant areas in Wisconsin by identifying priority Ecological Landscapes.
B. Within Landscapes, further guide practitioners to the most impactful watersheds.
C. Outside of Landscapes guide practitioners to other impactful watersheds.

Selecting and Building Biological and Social Datasets

Several JVs have developed and implemented model-based approaches to identifying priority regions and wetlands for waterfowl habitat delivery (Jones et al. 2016, Soulliere et al. 2017). Most models originally were based on biological assumptions of habitats available for a suite of waterfowl using areas. The 2012 NAWMP ushered in the need to better understand the relevancy of how stakeholders (hunters and non-hunters alike) use and perceive waterfowl habitat. At the same time, collective ecological goods and services provided by waterfowl habitat are increasingly important from an economic, societal, and biological perspective (Jenkins et al. 2010, Green and Elmberg 2014). Recognition of societal needs in both continental (NAWMP 2012) and regional waterfowl plans (Soulliere et al. 2017) combined with traditional biological needs of waterfowl inspired us to develop Wisconsin-specific spatial coverages of both societal and biological phenomenon relevant to waterfowl conservation.

Producing and integrating biological and societal statewide datasets is challenging but the UMGL JV provides a template for doing so (Soulliere and Al-Saffar 2017). We used this template but developed, in most cases, new or modified spatial coverages for Wisconsin. Our procedure started with identifying key stakeholders to help guide and inform the development of each spatial data layer. We worked with a core-group of biologists and managers and stakeholders from the Wisconsin JV Management Board. In the process of model conceptualization, it became clear stakeholders were concerned that the draft layers were weighted too heavily toward areas and habitat that already existed, which would lead conservation partners to work with "existing resources" and ignore "potential" resources. While some forms of conservation delivery (e.g., enhancements or management) are well suited for existing wetlands, restoration of waterfowl habitat often is best directed toward areas that currently are in a different land use, especially agriculture in a state such as Wisconsin. Therefore, we assigned data layers into those we believed were depicting areas already providing habitat (CC) and those we believed could potentially provide habitat (CO). Following JV guidance, we built a decision matrix with relevant objectives, spatially explicit model-based maps related to each objective, weighted objective parameters, and an amalgamation of spatial data to produce a set of maps (Figure 17).

In the end, we created eight separate and unique state-wide layers representing both biological and societal objectives (Figure 17). This process is documented, understandable, repeatable, and adjustable over time as new information becomes available. Each spatial layer was given a weight intended to represent perceived importance. Models with greater weight reflect more heavily in final decision support layers. Our weights were obtained from a forum of experts, related discussion with the Wisconsin Waterfowl JV Management Board, and our core group of stakeholders. Specifically, we asked stakeholders to weight each of the eight spatial data layers where the sum of their weights came to 1.0 and each layer needed to be given at least 0.05. For a detailed and complete review of spatial modelling procedures see Soulliere and Al-Saffar (2017 p. 4).

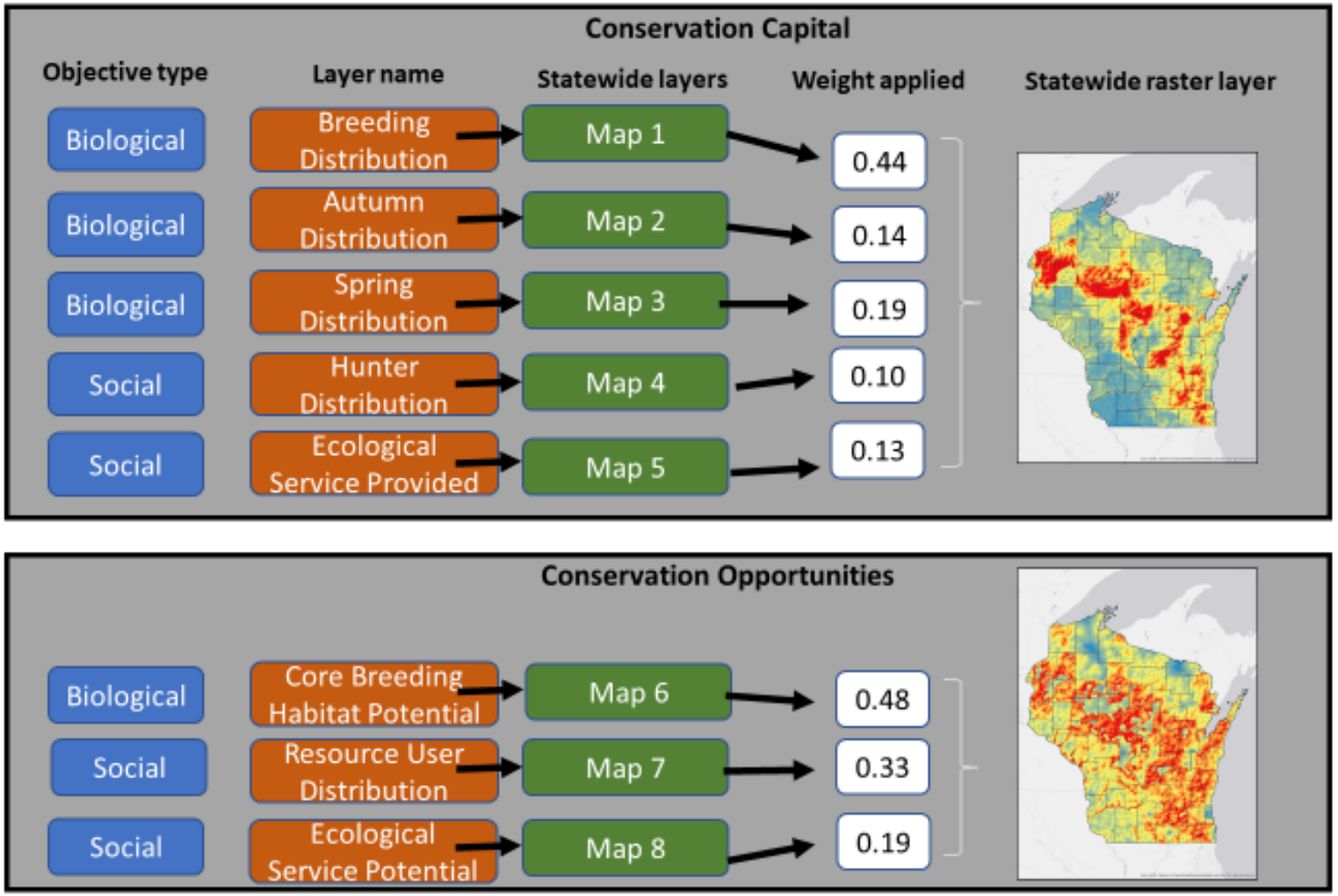


Figure 17. A matrix for Conservation Capital (top) and Conservation Opportunities (bottom) including the eight spatial data layers that guide the 2020 Wisconsin Waterfowl Habitat Decision Support Layer.

Conservation Planning Units

The UMGL JV use BCRs (Figure 1) to delineate conservation planning units. Planners and mappers from Canada, the United States, and Mexico developed BCRs from 1998 to 1999 to better implement and evaluate conservation planning (Bird Studies Canada and NABCI 2014). These BCRs are meant to represent ecologically distinct eco-regions with similar habitats, resource management issues, and bird communities. Wisconsin harbors three BCRs with the largest area in the Prairie Hardwood Transition (BCR 12) followed by Boreal Hardwood Transition (BCR 23) and Eastern Tallgrass Prairie (BCR 22). For more details on these BCRs relative to waterfowl conservation planning see Soulliere et al. (2017). While BCRs have proven effective and efficient at a JV-scale, Wisconsin has even more geographically defined eco-regions at the within-state scale. For this reason, we adopted the Ecological Landscapes (ELs) of Wisconsin as our broadest ecological planning unit as a replacement for BCRs. Wisconsin has 16 ELs that are delineated by key natural communities, habitats, aquatic features, and native plants and animals from an ecosystem management perspective (Figure 18). For a comprehensive review of ELs see WDNR (2015). We added a 17th EL for the Mississippi River area using the same boundary as the Original Plan. While ELs can serve effectively for landscape-scale decisions and planning, we wanted to provide more spatial resolution for local managers and biologists. For this reason, we divided all Wisconsin ELs into planning watersheds. We adopted the EPA Hydrologic Unit Code (HUC) 12 sub-watersheds for fine-scale planning. These HUC 12s typically are 10,000 to 40,000 acres in size and always are nested within ELs. Therefore, the two-tiered approach to planning units includes the larger ELs and the smaller and more numerous HUC 12 watersheds (Figure 18). When watersheds crossed EL boundaries, we assigned a HUC12 to the EL in which the centroid of the HUC 12 was located.

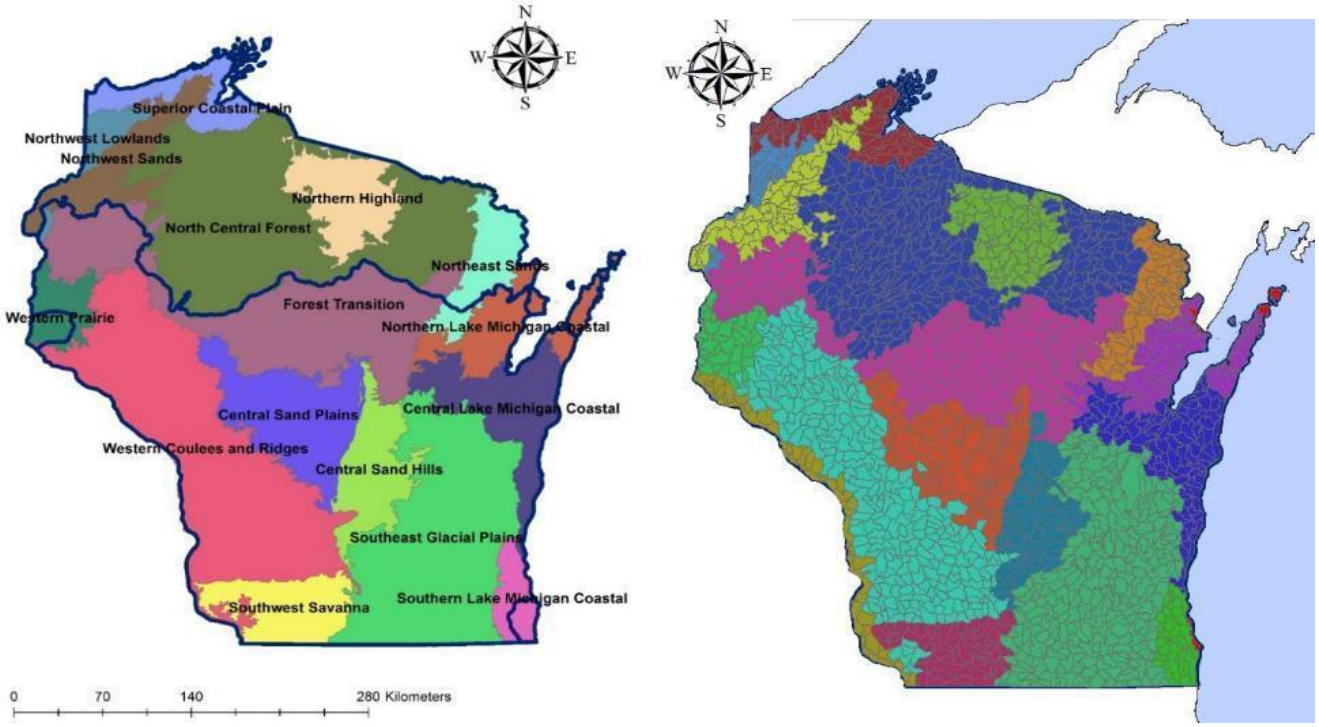


Figure 18. Ecological Landscapes (ELs, Left) and Hydrologic Unit Code 12 sub-watersheds (HUC 12s, Right) used for planning purposes for the Wisconsin Waterfowl Habitat Decision Support Framework.

Conservation Capital

Data layers of Conservation Capital (CC) depict areas currently providing resources. They are realized, 'capital' from the standpoint of waterfowl conservation habitat. These areas currently are providing waterfowl habitat and could or should be acquired, protected, maintained, managed, or enhanced, to ensure their continued value.

Breeding Habitat Density and Distribution

Layer Type - Biological

Overview - The data and resulting map (Figure 19) are designed to represent the most productive landscapes and regions of Wisconsin for breeding ducks. The approach was derived from the JV, but we made some key modifications specific to Wisconsin landscapes, habitats, and waterfowl (*see methodology below*). The map is an amalgamation of many base datasets. We "ground-truthed" the habitat suitability map with known locations of breeding waterfowl from WBPS.

Conservation objective - Maximize waterfowl populations through conservation of high-quality breeding habitats.

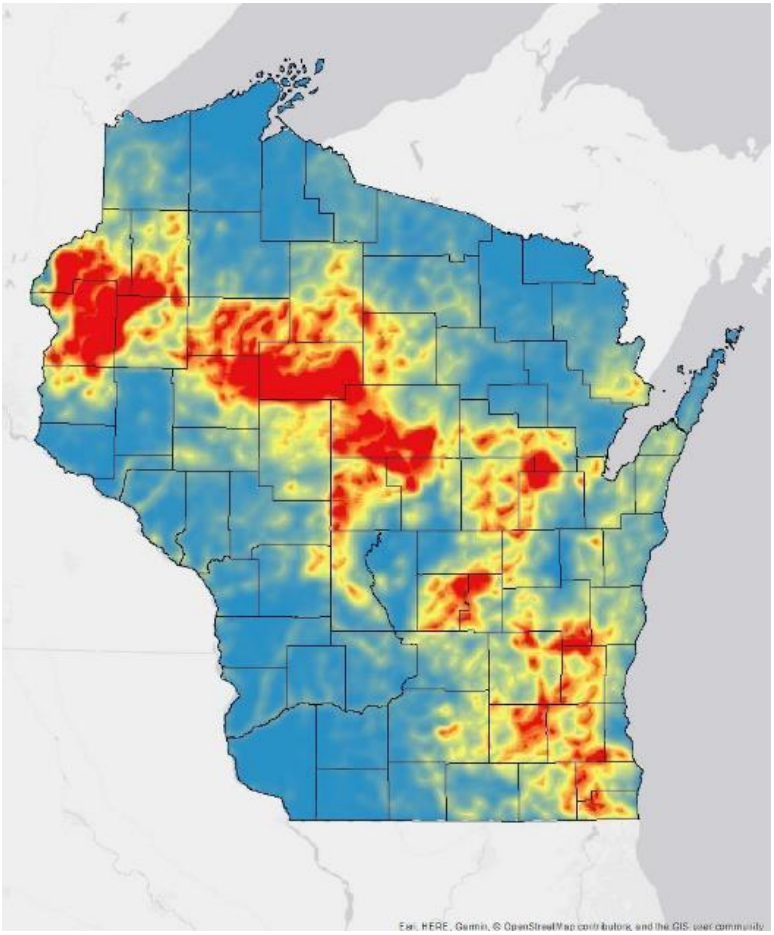


Figure 19. Raster image of modeled habitat suitability for four select species of breeding waterfowl in Wisconsin (red is highest, blue is lowest), based on existing ecological condition.

Data sources/inputs -

A. National Wetlands Inventory (NWI) wetland database.
B. Wiscland 2.0.
C. WDNR Waterfowl Breeding Population and Habitat Survey and reports from 2005 to 2014.
D. Landscape Suitability Indices (LSI) for focal species for breeding waterfowl (Appendix E).

Weight applied in Conservation Capital layer- 0.44; ranked first out of five layers

Methodology – We used the methodology of Soulliere and Al-Saffar (p. 13-14. 2017) to create the species-specific and combined focal species breeding distribution maps with the following modifications:

- We revised weights associated with each focal species in the Combined Weighted Breeding Distribution map based on the WDNR Waterfowl Breeding Population and Habitat Survey. The revised weight for each species were 44% for mallard, 22% for wood duck, 11% for blue-winged teal, and 5% for ring-necked ducks, which reflects the relative distribution of the breeding population estimate in Wisconsin as of 2017.
- We used Wiscland 2.0 instead of the National Landcover Database (NLCD) for upland habitats for Landscape Suitability Indices (LSIs).
- We revised LSIs for each species based on our interpretations of suitable habitat (Appendix E) in Wisconsin.
- We intersected the theoretical waterfowl breeding habitat layer with known observations of breeding waterfowl from the WDNR WBPS. This step essentially "ground-truthed" the LSI map with confirmed locations of breeding waterfowl.

Spatial interpretation -A map depicting where we believe the greatest density and distribution of quality breeding habitat for mallards, wood ducks, blue-winged teal and ring-necked ducks currently exists. Areas in darkest red on the map are areas with highest density of breeding duck habitat. Areas in blue may have quality nesting habitat for breeding waterfowl, but habitat density was not as great as areas in red.

Outputs / Products - A. Distributions of species-specific breeding habitat (Appendix D)
B. Distribution of breeding habitat for combined weighted focal species (Figure 19)

Autumn Habitat Density and Distribution
Layer Type - Biological

Overview – This map is designed to be a spatial representation of the distribution of fall migration habitat for the focal species using Wisconsin (Figure 20). No analogous map of fall migration habitats exists at the JV scale and our approach is the first of its kind in the UMGL Region. We developed LSIs for fall migrating focal species and weighted wetlands based on their size because we believed this represented how these species use the landscape during fall migration. Weighting by wetland size has the effect of prioritizing large wetland complexes such as Horicon NWR, George W. Mead Wildlife Area and others like them.

Conservation objective - Maximize density of habitats used by populations of fall migrating waterfowl.

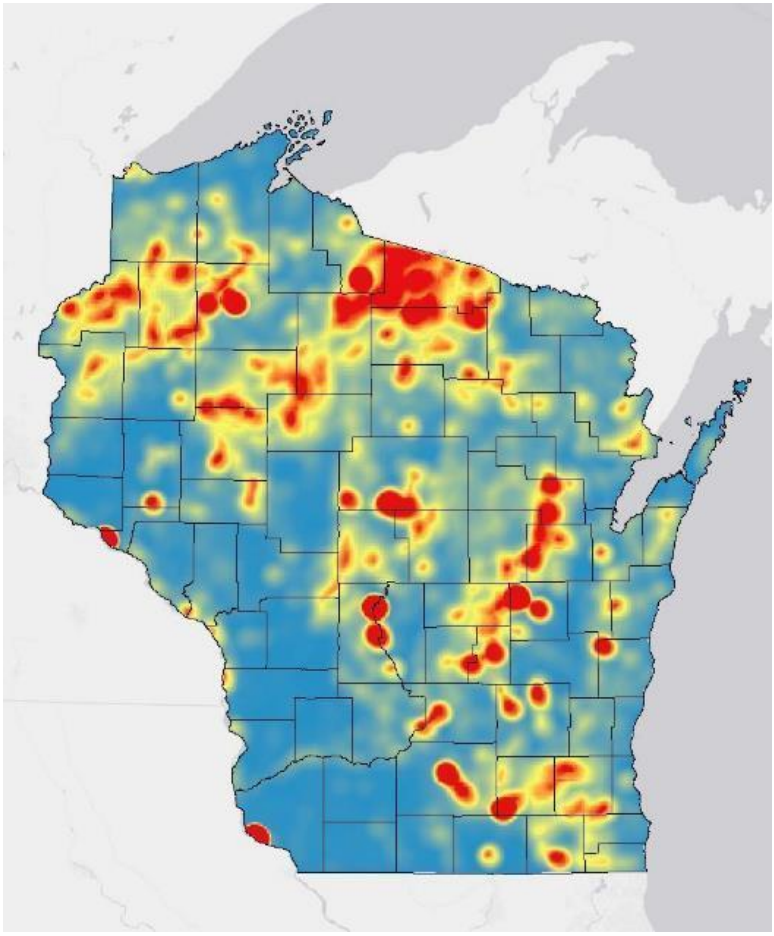


Figure 20. Raster image of modeled habitat suitability for four select species of migratory waterfowl in fall in Wisconsin (red is highest, blue is lowest), based on existing ecological condition.

Data sources/inputs –
A. NWI wetland database.
B. Wiscland 2.0.
C. LSIs for focal species for fall migrating waterfowl (Appendix F).

Weight applied in Conservation Capital layer- 0.14; ranked third out of five layers

Methodology – We first developed a new LSI for each focal waterfowl species based on how we believed habitats are used during fall migration (Appendix F) and using NWI and Wiscland 2.0 land cover types. We weighed each wetland based on its size because we believed wetland size is a good predictor of waterfowl use during fall migration. We then used the guidance of Soulliere and Al-Saffar (p. 13-14. 2017) to create species-specific fall habitat distribution maps (Appendix H). We combined distribution maps for autumn habitat for focal species with a weighted overlay approach. Weights assigned were 32%, 22%, 7% and 3% for mallards, wood ducks, blue-winged teal, and ring-necked

ducks, respectively and the relative distributions represent the average annual harvest breakdowns by species.

Spatial interpretation - A map depicting where we believe the greatest density and distribution of quality fall migration habitat for mallards, wood ducks, blue-winged teal, and ring-necked ducks currently exists. Areas in darkest red on the map have the highest theoretical fall habitat potential. Areas in blue may have substantial amounts of migrating waterfowl but habitat density was not as great as areas in red.

Outputs / Products - A. Distributions of species-specific fall migration habitat (Appendix H)
B. Distributions of fall migration habitat for combined weighted focal species (Figure 20)

Spring Habitat Density and Distribution
Layer Type - Biological

Overview - This map is designed to be a spatial representation of the distribution of spring migration habitat for the focal species using Wisconsin (Figure 21). No analogous map of spring migration habitats exists at the JV scale and our approach is the first of its kind in the UMGL Region. We developed LSIs for spring migrating focal species with the primary goal of being as inclusive as possible with wetland categories. Our primary assumption when building the LSIs was spring migrating waterfowl use the widest variety of wetland types of all sizes. This approach prioritized regions of the state with the greatest overall wetland density which occurs primarily in the northern 1/3 of the state.

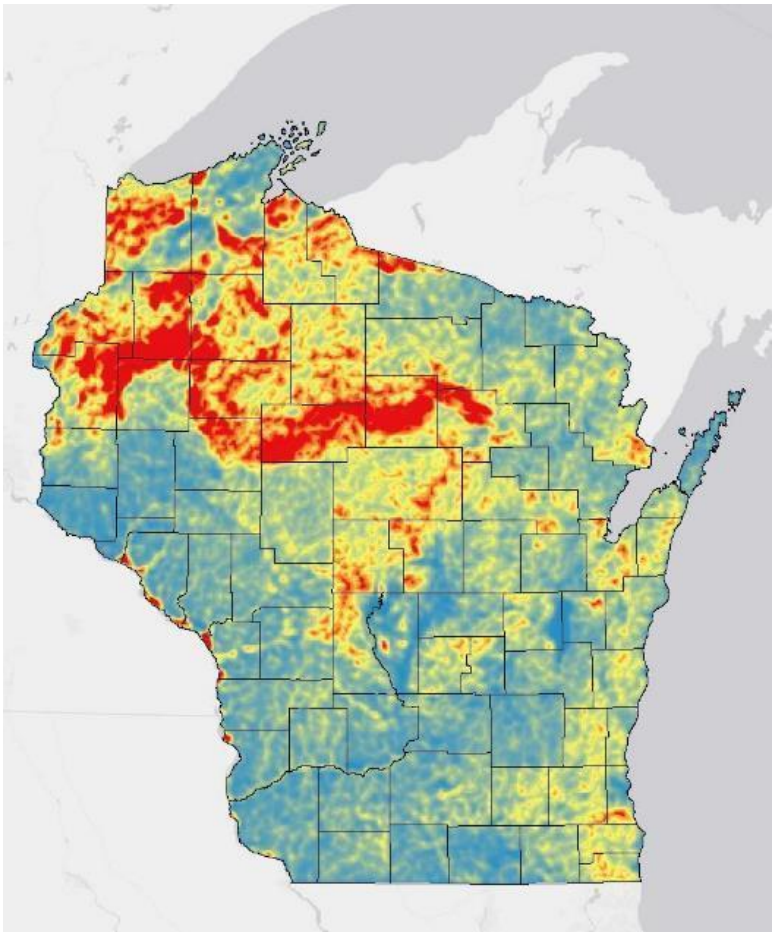


Figure 21. Raster image of modeled habitat suitability for four select species of migratory waterfowl in spring in Wisconsin (red is highest, blue is lowest), based on existing ecological condition.

Conservation Objective - Maximize focal species survival and body condition with habitat focus on cross-seasonal effect and spring fitness.

Data sources/inputs –
A. NWI wetland database.
B. Wiscland 2.0.
C. LSIs for focal species for migrating waterfowl in spring (Appendix G).

Weight applied in Conservation Capital layer - 0.19; ranked second out of five layers

Methodology – Similar to the autumn habitat density maps, we first developed a new LSI for each focal waterfowl species based on how we believed habitats are used during spring migration (Appendix G) and using NWI and Wiscland 2.0 land cover types. When building the LSIs for each species we used the most inclusive definitions of wetland categories and had no size thresholds because we assumed waterfowl use wetlands indiscriminately during spring migration. We then used the guidance of

Soulliere and Al-Saffar (p. 13-14, 2017) to create species-specific distribution maps of spring habitat (Appendix I). We combined distribution maps of spring habitat for focal species with a weighted overlay approach. Weights assigned were 48%, 20%, 17% and 14% for mallards, wood ducks, blue-winged teal, and ring-necked ducks, respectively and the relative distributions were derived from e-Bird observations (http://ebird.org/content/ebird/) from 1995 to 2014.

Spatial interpretation - A map depicting where we believe the greatest density distribution of quality spring migration habitat for mallards, wood ducks, blue-winged teal and ring-necked ducks currently exists. Areas in darkest red on the map are areas with the greatest theoretical spring habitat potential. Areas in blue may have substantial amounts of migrating waterfowl but habitat density was not as great as areas in red.

Outputs / Products -

A. Distributions of species-specific migration habitat in spring (Appendix I)

B. Distributions of combined weighted spring migration habitat for focal species (Figure 21)

Waterfowl Hunters as a Resource User
Layer Type - Social

Overview - To identify areas of greatest importance to waterfowl hunters, we used county-level waterfowl harvest data normalized by county size. Primary waterfowl hunting areas across Wisconsin are were depicted in high and low density based on a kernel density analysis of duck and goose harvest. We assumed conservation activity in these areas should be a primary focus to increase waterfowl hunter retention and recruitment.

Conservation Objective - Maximize waterfowl hunter retention and recruitment.

Data sources/inputs –
A**.** Duck and goose harvest data by county from 1995 through 2014 from the Harvest Information Program.

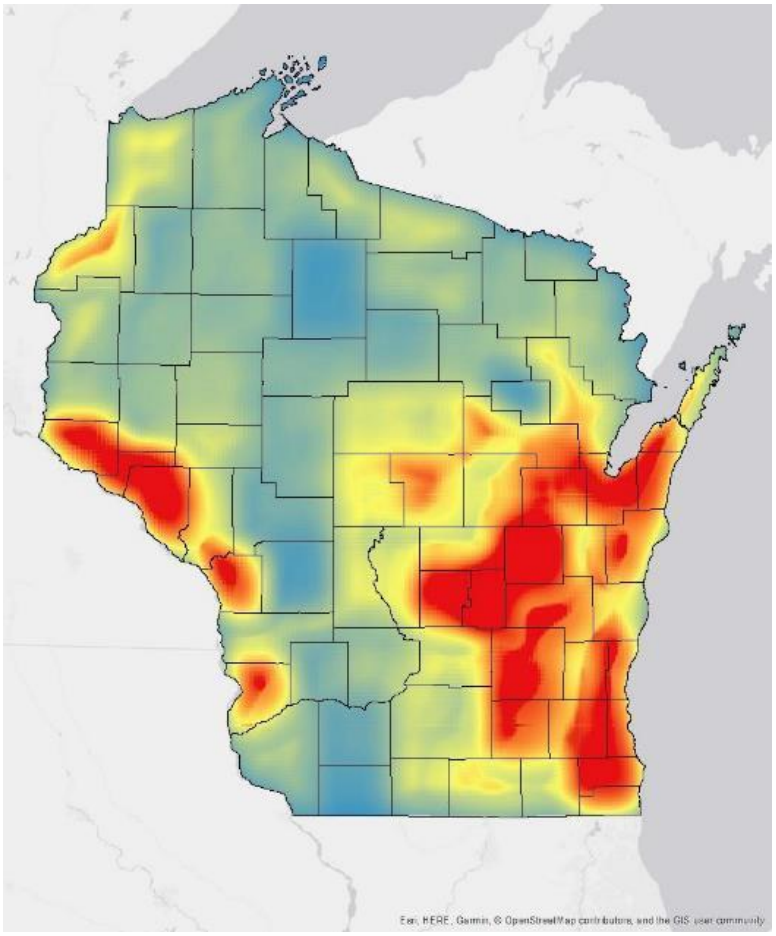


Figure 22. Distribution of important waterfowl hunting areas based on combined duck and goose county-level harvest (1995–2014) with data normalized by county size. Greatest harvest is in red and least in blue.

Weight applied in Conservation Capital layer – 0.10; ranked last out of five layers

Methodology – We used the exact data layer as provided by the UMGL JV waterfowl conservation strategy but re-scaled to counties in Wisconsin. For a complete description of methods see Soulliere and Al-Saffar (p.15, 2017).

Spatial interpretation – This map reflects the distribution of successful waterfowl hunters and areas where the hunting community is more likely to retain and recruit participants (Figure 22).

Outputs / Products – A**.** Spatial interpolation map of waterfowl harvest across Wisconsin counties (Figure 22)

Ecological Goods and Services (*Provided*)
Layer Type – Social

Overview – We developed a separate ecological goods and services layer for wetlands that is specific to wetlands and landscapes in Wisconsin. In 2017, The Nature Conservancy and the WDNR produced a statewide dataset with an associated report (Miller et al. 2017) and decision support tool (www.WetlandsByDesign.org) called *Wetlands by Design: A Watershed Approach for Wisconsin*. The Program assessed and ranked wetlands for their ecosystem service potential. These data serve as the basis for the "ecological goods and services provided" by existing wetlands. Since this layer is based on existing wetlands it represents CC.

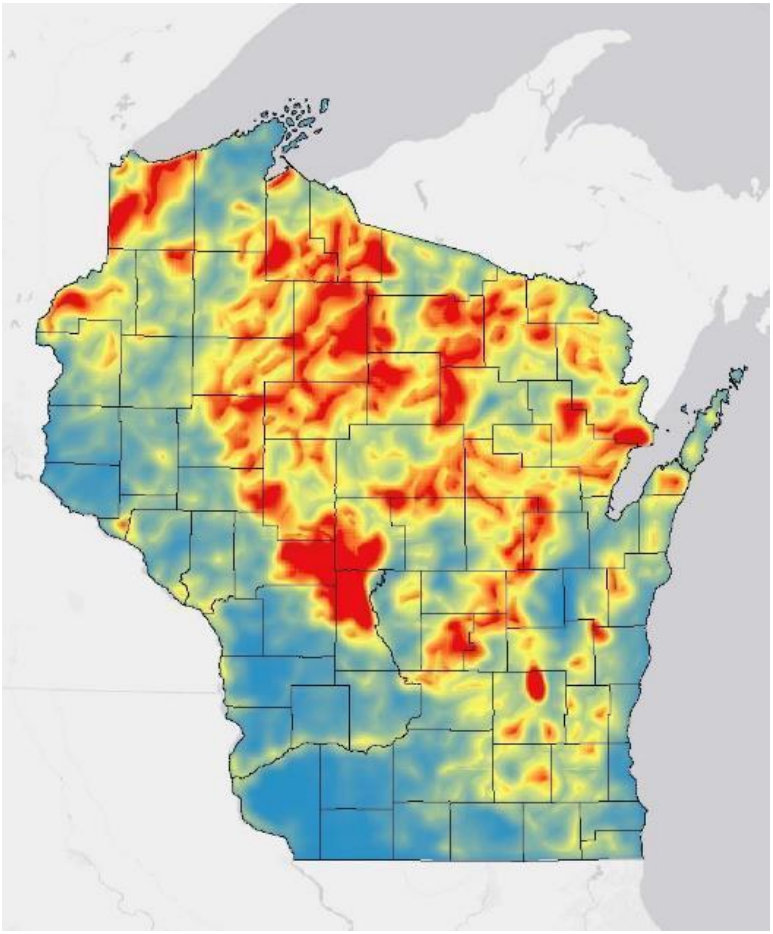


Figure 23. Raster image of levels of ecological services provided by wetlands in Wisconsin (red is highest, blue is lowest), based on existing ecological condition.

Conservation Objective - Maximize flood abatement, sediment retention, surface water supply, and fish and aquatic habitat. Minimize nutrient transformation.

Data sources/inputs –
A. NWI wetland database.
B. *Wetlands by Design* data scaled to the HUC 12 spatial scale.

Weight applied in Conservation Capital layer- 0.13; ranked fourth out of five layers

Methodology – A high-level overview of methods is provided here. Detailed methods and further context are provided in the *Wetlands by Design* report (Miller et al. 2017). Potential protection sites are current wetlands, as mapped in the Wisconsin Wetland Inventory (WWI). All WWI wetlands were assessed for their potential to provide five ecosystem services: flood abatement, fish and aquatic habitat,

sediment retention, nutrient transformation, and surface water supply (i.e., stream baseflow maintenance).

Sites were assessed for their ecosystem service potential using NWI-plus, (Tiner 2003, Tiner 2005) an approach developed by the US Fish and Wildlife Service and modified for application in Wisconsin. Using this approach, GIS analyses were conducted to assign four categories of hydrogeomorphic modifiers to all current and restorable wetland sites: landscape position (the relation of a site to a waterbody), landform (the physical shape/location of the site), water flow path (e.g., inflow, outflow, or through-flow), and waterbody type (e.g., rivers, streams, or lakes). These factors were combined with WWI data (hydrologic regime, vegetation type, etc.) and additional modifiers (e.g., incision of associated streams, groundwater discharge index). Possible combinations of modifiers were then assigned to categories of ecosystem service potential, resulting in a rank (very high, high, moderate, and not applicable) for each ecosystem service at each site.

Site-level data for individual ecosystem services were aggregated within HUC 12 watersheds to consider the potential for sites to provide all services, combined, using the following formulae:

> Current Services in each HUC 12 = flood abatement (sum of WWI acres assessed as very high or high) + fish & aquatic habitat (sum of WWI acres assessed as very high or high) + sediment retention (sum of WWI acres assessed as very high or high) + nutrient transformation (sum of WWI acres assessed as very high or high) + surface water supply (sum of WWI acres assessed as very high or high)

HUC 12 watersheds were then ranked against all others in the state by dividing each watershed's score by the highest watershed score in the state, for current services and for restorable services, respectively. The resulting dataset determines ecological goods and services provided.

Spatial interpretation – This map represents areas of Wisconsin where wetlands that currently are providing the most ecological goods and services (depicted in red, Figure 23)).

Outputs / Products - **A.** Map of wetland ecological goods and services provided (Figure 23)

Conservation Capital Decision Support Layer

Interpretation: The CC layer is an amalgamation of three biological and two social data layers described in the sections above. It is most strongly influenced by the breeding habitat distributions (0.44 weight) and least influenced by hunter distribution layer (0.10 weight). It depicts the density of current or existing waterfowl habitat resources on the landscape (Figure 24).

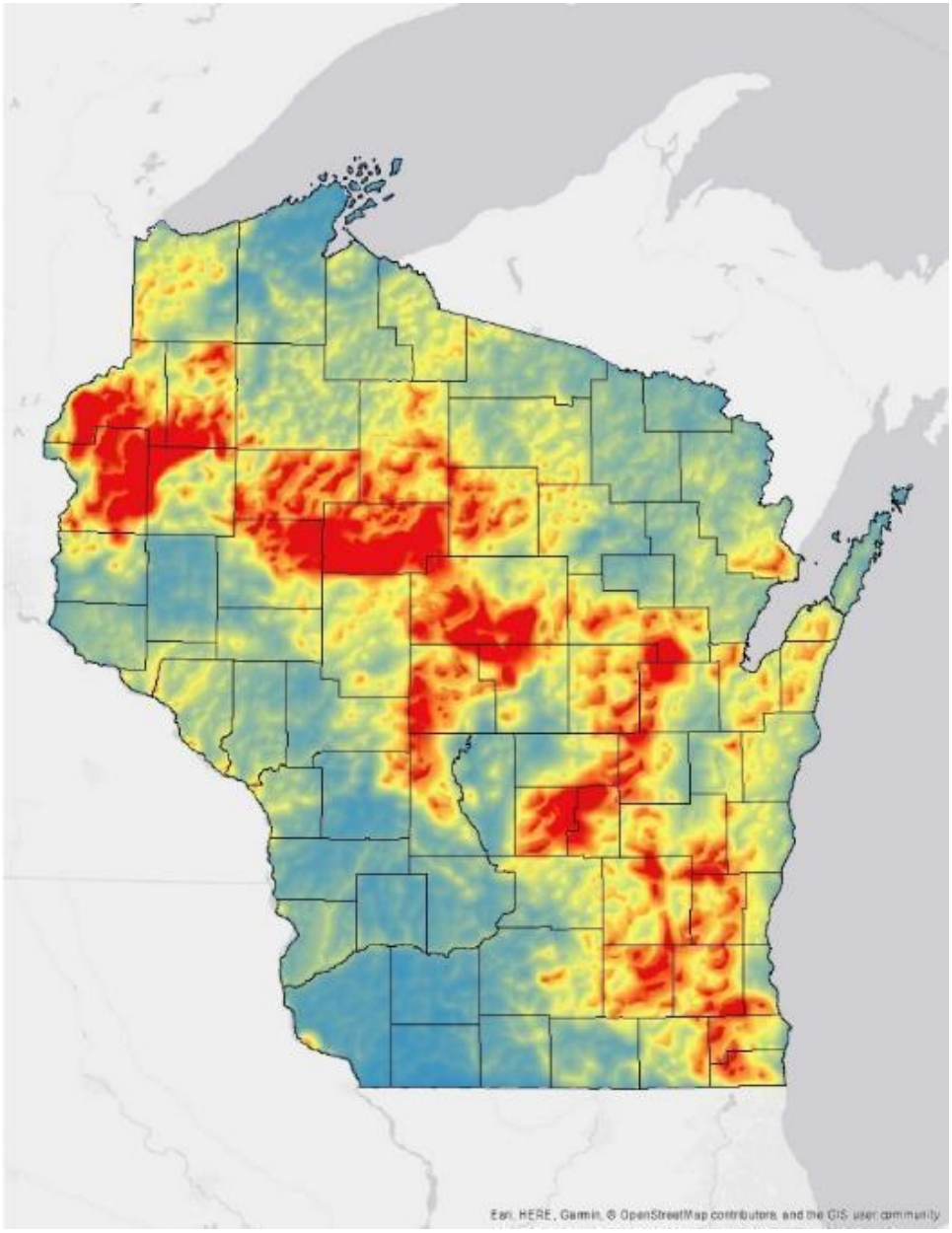


Figure 24. Raster image of cumulative Conservation Capital layers in Wisconsin. Models include the layers of breeding, spring and fall migration, and levels of waterfowl harvest and ecological services provided by wetlands (red is highest, blue is lowest), based on existing ecological condition.

Translating to Ecological Landscapes- To meet our objective of guiding "… conservation activities in the most geographically relevant areas in Wisconsin by creating priority landscapes" we overlaid the boundary of all 17 ELs onto the CC layer. This layer was a continuous surface of 1 km raster cells ranging in value from 0 (dark blue) to 1 (bright red). As each cell contained its own value, we ranked each EL relative to each other by calculating the average of all raster cells within each respective EL. Therefore, each landscape then had one CC score to represent the average of its respective region. Finally, we categorized all landscapes into quantiles. The resultant map ranks landscapes from greatest (red) to least (blue) regarding the average CC scores within a respective region (Figure 25).

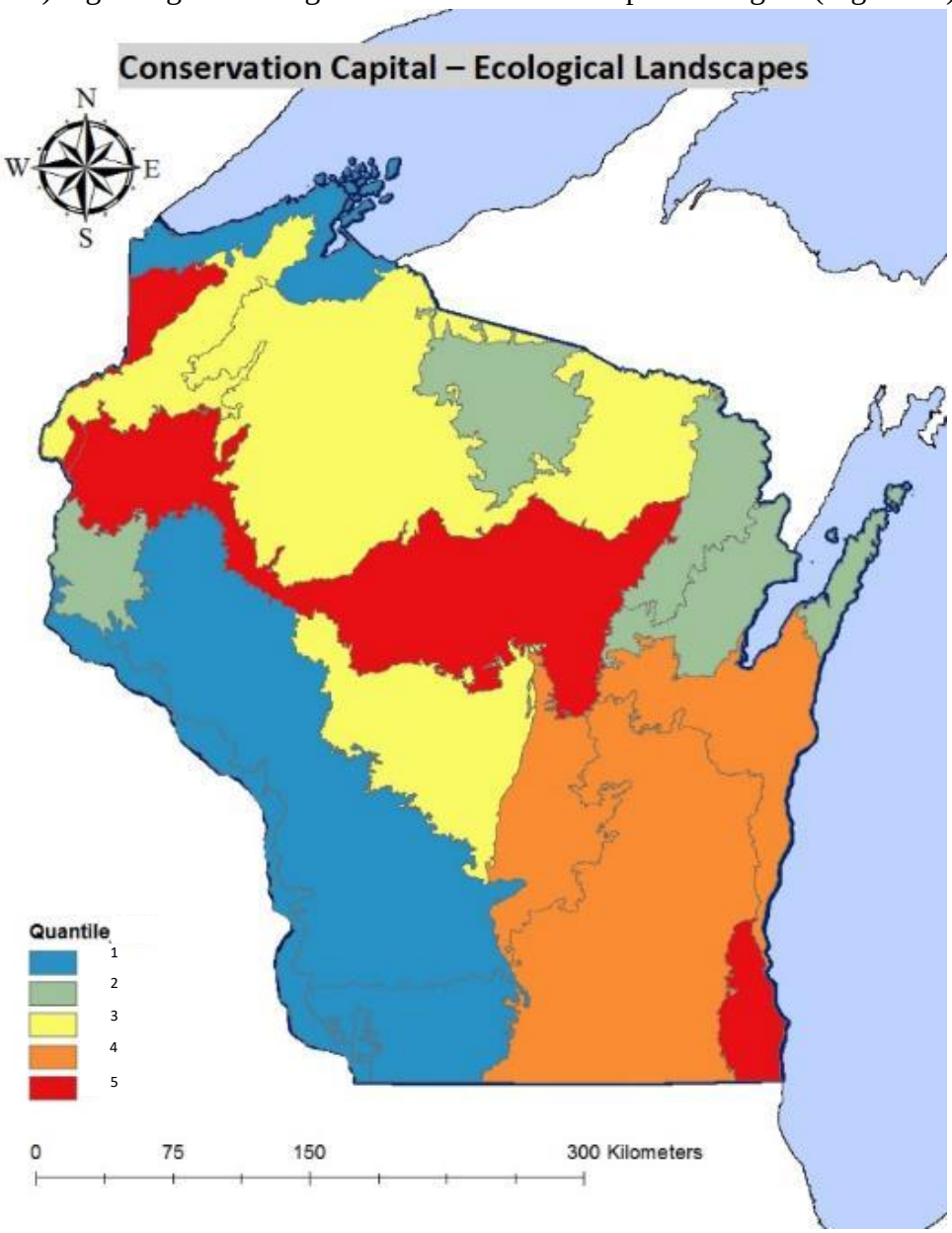


Figure 25. Ecological Landscapes of Wisconsin ranked (5 greatest priority, 1 least priority) by their cumulative Conservation Capital within each Ecological Landscape.

Translating to Watersheds - To meet our objective of guiding "… practitioners to the most impactful HUC 12 watersheds" we overlaid the boundary of all HUC 12 watersheds onto the CC layer. Within each landscape, we calculated the average CC score as an aggregate of all the cells in a watershed. Each watershed then had one composite CC score to represent the average of its respective watershed. The decision to calculate scores for watersheds within landscapes is important and noteworthy. For example, the Southwest Savanna was a low priority EL but it still has high priority watersheds. Essentially, this approach ensured that each landscape had both high and low priority watersheds. This means low priority landscapes have high priority watersheds. The decision to go with this approach was encouraged by our team of core collaborators who wanted to identify important watersheds in all landscapes in Wisconsin. Finally, we categorized all watersheds, within their respective landscape into quartiles.

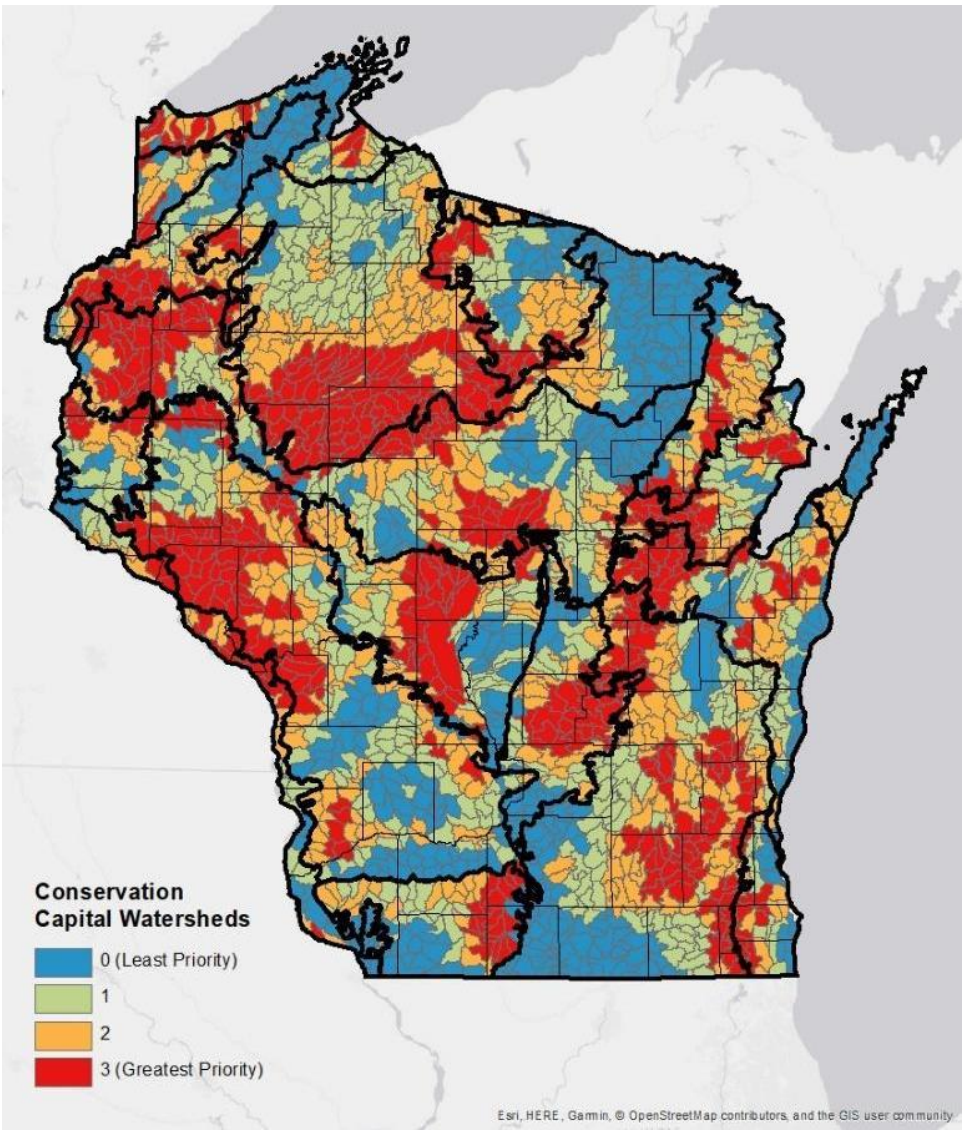


Figure 26. Priority 3 (greatest) through 0 (least) Hydrologic Unit Code 12 watersheds in Wisconsin ranked independently within each Ecological Landscape (black boundaries) for Conservation Capital.

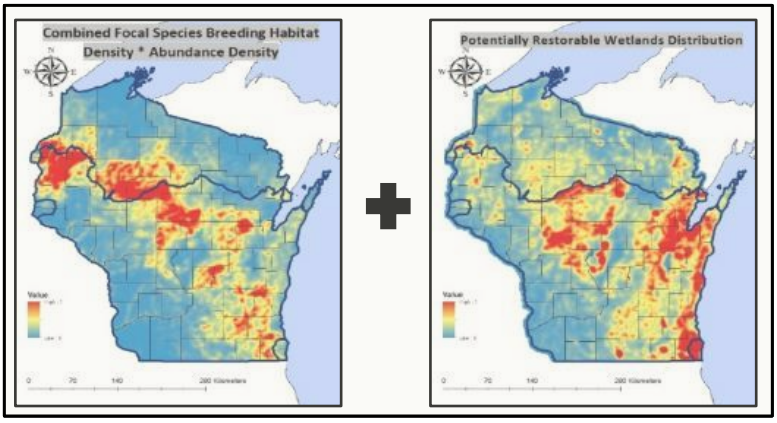
Decision Making and Potential Scenarios to apply Conservation Capital data layers - The CC decision support layer can be applied in conservation decision making that is exclusively related to existing wetlands. For example, WDNR will be undergoing a review to prioritize existing impounded wetlands. The CC decision support layer can be used as criteria to rank impounded wetlands and their associated infrastructure. Another example for applying this layer may be if an agency or non-profit organization is planning on acquiring land that would be of value to waterfowl. If an entity, however, is also going to consider acquiring land for the potential of restoring waterfowl habitat, then the combined aggregate decision support layers might be more appropriate. The JV is placing a new emphasis on maintaining quality in existing wetlands through proper maintenance and management. Therefore, this layer can be applied in processes to determine where limited funding is placed to emphasize management and maintenance of wetlands. The scope and scale of these processes should be carefully considered at the EL and regional landscape level for proper analysis.

Conservation Opportunities

Data layers of Conservation Opportunity (CO) depict areas that might be providing but more likely are potential resources for waterfowl. They are 'potential' habitats from a waterfowl conservation standpoint. These locations, in their current state, are not necessarily providing waterfowl habitat but have great potential to, if they were restored or created.

Expanding Core Breeding Habitats

Layer Type – Biological



Overview – This layer was developed to depict conservation delivery opportunities that are near or adjacent to existing high-density breeding habitat and represents opportunities and guidance on where to enhance the breeding habitat base in Wisconsin.

Conservation objective - Maximize recruitment of focal species through the restoration of habitat in proximity to core breeding areas.

Data sources/inputs –

A. Breeding Habitat Density and Distribution (inset above left)
B. Potentially Restorable Wetlands (inset above right)

Weight applied in Conservation Opportunities layer - 0.48; ranked first out of three layers in CO

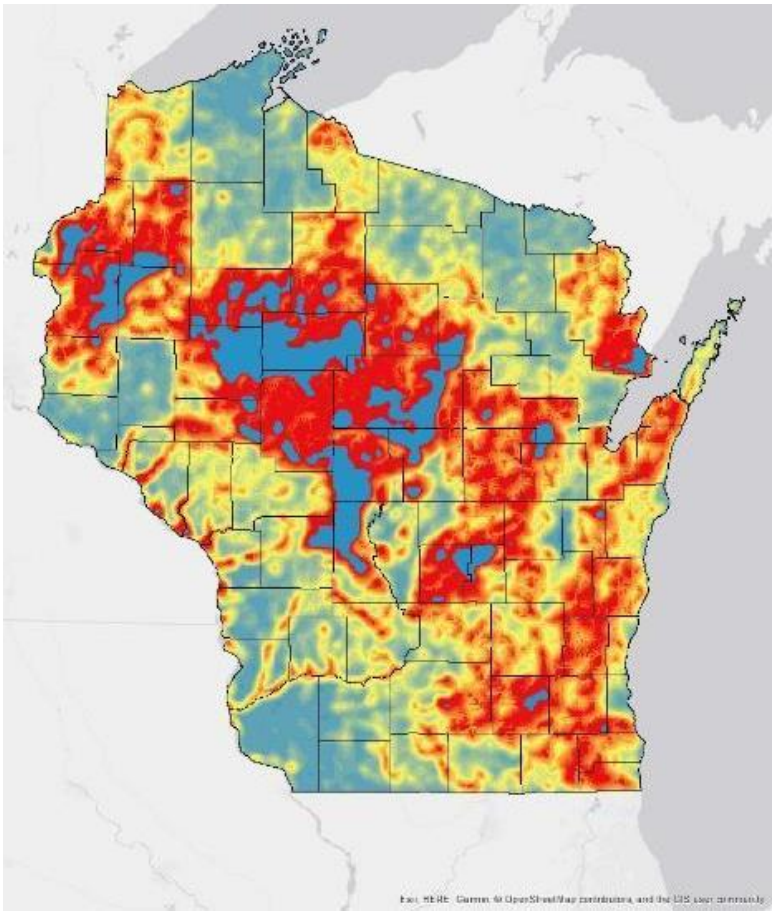


Figure 27. Raster image of theoretical distribution of potential expanding of waterfowl breeding habitats in Wisconsin. Areas in red depict greatest potential and blue the least based on potential ecological condition.

Methodology – We removed the core areas of the breeding habitat and density distribution layer to focus efforts on areas in proximity to quality breeding habitat that also had a high potential for restoration. To identify the density and distribution of areas with restoration potential, we converted the WDNR potentially restorable wetlands spatial layer into a raster surface analogous to the breeding habitat layer. We then intersected the two surfaces through a multiplicative fuzzy membership. The product of the two surfaces resulted in a new surface that identified areas outside of the most suitable breeding habitat but where both restoration and breeding habitat potential exist.

Spatial interpretation – Areas in red represent where breeding habitats could be expanded on landscapes that are potentially restorable (Figure 27). The goal with this layer is to depict areas of greatest need adjacent to existing breeding habitats.

Outputs / Products –

A. Map of area of high importance for expanding the breeding waterfowl habitat base in Wisconsin (Figure 27).

Wetland and Bird Enthusiasts as a Resource User

Layer Type – Social

Overview - We developed this layer to depict opportunities that might maximize outdoor recreation related to potential waterfowl habitat-conservation sites most associated with human populations (i.e., accessible considering travel time or distance). This layer is similar to the JV conservation support layer, but we modified and enhanced it by considering urban opportunities. We addressed this social objective by developing and combining a conservation recreational opportunity around and within urban areas.

Conservation objective - Maximize waterfowl viewer/recreationist retention and recruitment.

Weight applied in Conservation Opportunities layer - 0.33; ranked second out of three layers

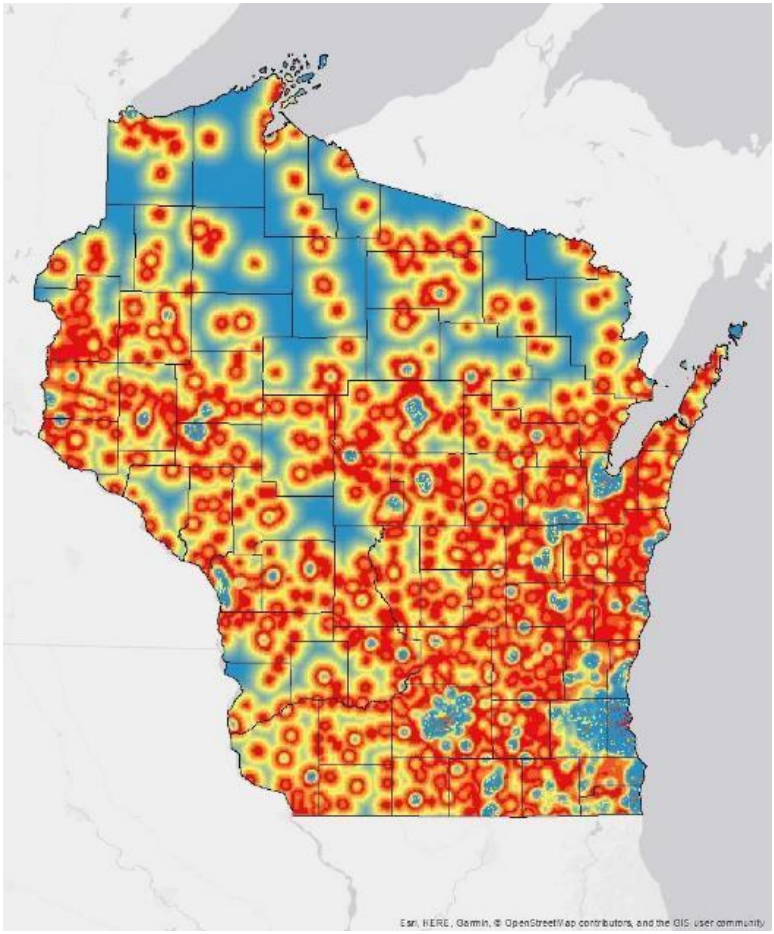


Figure 28. Raster image of distribution of human-populated areas expected to receive greatest use by Wetland and Bird Enthusiasts if accessible waterfowl habitats are available (red is highest, blue is lowest).

Data sources/inputs –

A. Spatial layer of potential outdoor recreation around urban areas
B. Spatial layer of potential conservation lands within urban areas

Methodology - To model potential outdoor recreation opportunities surrounding urban areas, we assumed locations with higher human populations have more potential recreationists (i.e., consumptive and non-consumptive users), but travel time or distance will limit use of conservation lands (Devers et al. 2017). We assumed outdoor recreationists will have the best retention and recruitment opportunities as they move away from busy urban areas towards more open sub-urban landscape. Once recreationists reach remote rural areas the opportunity to practice their recreation needs will diminish gradually as they continue to move away. To produce the spatial model, we obtained human abundance data per block (https://www.census.gov/data.html), and then converted block polygons to points, where each point inherited a "weight", that is the number of people in the original block. We used these points and their

weights in a weighted (kernel) density analysis to generate a model (1 km cell-size raster) for the density and distribution of human populations in Wisconsin. We reversed the cell values, where cells within city centers have low values then values gradually increase as distance increase away from cities, reaching to the highest values which were assigned to rural and remote areas. Finally, we assigned new values for rural and remote areas as distance increase away from sub-urban landscape (gradually decreasing values at an increment of 1 km).

To model conservation lands within urban centers, we assumed semi-developed sites (e.g., active and deserted golf courses, brown fields, cemeteries, and city parks) with ponds, lakes, and or various other potential habitats could provide greater value to waterfowl and people. For example, in addition to waterfowl habitat, urban conservation lands can provide city dwellers with green space, bird watching opportunity, pollinator gardens, and much more. To produce the spatial model, we re-used the raster for the density and distribution of human populations in Wisconsin. We assigned zero value to areas overlapping with original U.S. census blocks with >=1 resident (leaving only areas overlapping with blocks with zero residents). We also assigned zero value to remote lands outside urban and sub-urban areas. Finally, we transformed the values of each of the two resulting models (recreation around urban areas and conservation lands within urban areas) to 0-1 scale (using the Linear fuzzification algorithm of Fuzzy Membership tool in ArcGIS 10.6; ESRI 2011), then combined them with cumulative values to overlapping locations.

Spatial interpretation – Area in red represent the greatest wetland recreation opportunities relative to proximity to human populations. High impact opportunity areas exist around and within urban areas (Figure 28).

Outputs / Products –

A. Map of Conservation opportunities layer for Wisconsin relative to human population centers (Figure 28).

Ecological Goods and Services (*Potential*)
Layer Type – Social

Overview – We developed and used a separate ecological goods and services layer for wetlands than the UMGL JV and one that is specific to wetlands and landscapes in Wisconsin. In 2017, The Nature Conservancy and the WDNR produced a statewide dataset with an associated report (Miller et al. 2017) and decision support tool (www.WetlandsByDesign.org) called *Wetlands by Design: A Watershed Approach for Wisconsin* that assessed and ranked wetlands for their ecosystem service potential. These data serve as the basis for the "ecological goods and services" provided by existing wetlands. Since this layer is based on potentially restorable wetlands it represents opportunities for conservation.

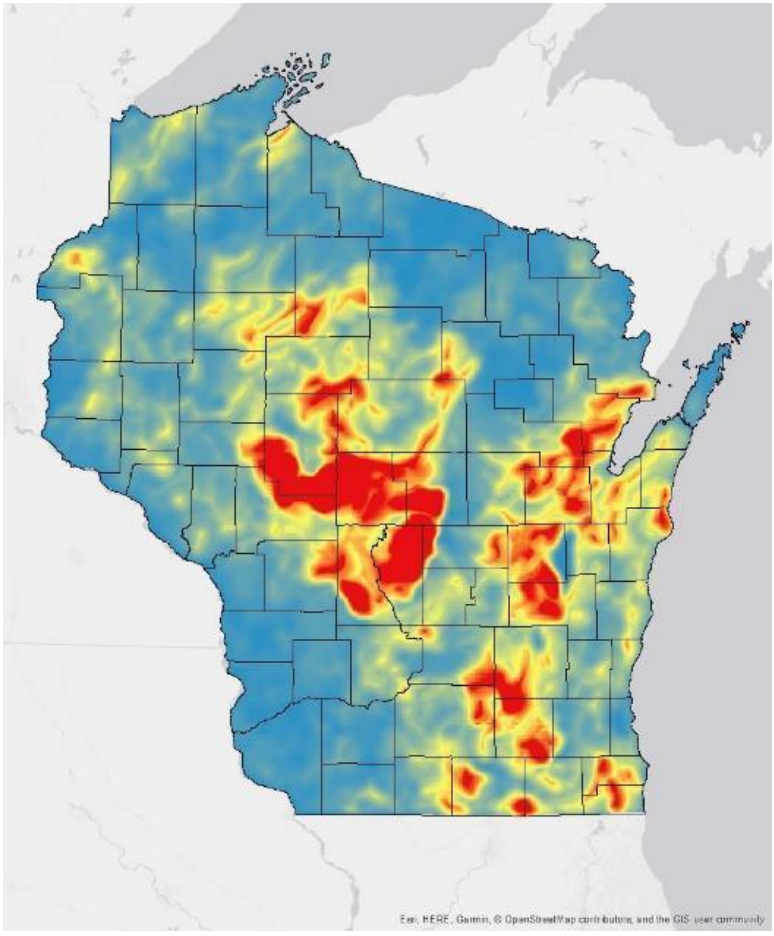


Figure 29. Raster image of levels of ecological services potentially provided by wetlands in Wisconsin (red is highest, blue is lowest), if wetlands were created or restored in this landscape

Conservation objective - Maximize flood abatement, sediment retention, surface water supply, and fish and aquatic habitat. Minimize nutrient transformation.

Data sources/inputs –
A. Potentially Restorable Wetlands layer
B. *Wetlands by Design* data scaled to the HUC 12 spatial scale

Weight applied in Conservation Opportunities layer - 0.19; ranked last out of three layers

Methodology- Detailed methods and further context are provided in the *Wetlands by Design* report (Miller et al. 2017). For purposes of this assessment, potentially restorable wetlands (PRWs) are former wetlands converted to upland through hydrologic alteration, as mapped by WDNR (dnr.wi.gov/topic/surfacewater/datasets/PRW/). All PRW polygons were assessed for their potential to

provide five ecosystem services: flood abatement, fish and aquatic habitat, sediment retention, nutrient transformation, and surface water supply (i.e., stream baseflow maintenance).

Sites were assessed for their ecosystem service potential using NWI-Plus, (Tiner 2003; Tiner 2005) an approach developed by the US Fish and Wildlife Service and modified for application in Wisconsin. Using this approach, GIS analyses were conducted to assign four categories of hydrogeomorphic modifiers to all current and restorable wetland sites: landscape position (the relation of a site to a waterbody), landform (the physical shape/location of the site), water flow path (e.g., inflow, outflow, or through-flow), and waterbody type (e.g., rivers, streams, or lakes). These factors were combined with WWI data (hydrologic regime, vegetation type, etc.) and additional modifiers (e.g., incision of associated streams, groundwater discharge index). Possible combinations of modifiers were then assigned to categories of ecosystem service potential, resulting in a rank (very high, high, moderate, and not applicable) for each ecosystem service at each site.

Site-level data for individual ecosystem services were aggregated within 12-digit HUC watersheds to consider the potential for sites to provide all services, combined, using the following formulae:

Restorable Services in each 12-digit HUC = flood abatement (sum of PRW acres assessed as very high or high) + fish & aquatic habitat (sum of PRW acres assessed as very high or high) + sediment retention (sum of PRW acres assessed as very high or high) + nutrient transformation (sum of PRW acres assessed as very high or high) + surface water supply (sum of PRW acres assessed as very high or high)

12-digit HUC watersheds were then ranked against all others in the state by dividing each watershed's score by the highest watershed score in the state for restorable services. The resulting dataset determines ecological goods and services potential.

Spatial interpretation – The map represents areas of Wisconsin where wetlands have the greatest potential to provide ecological goods and services (depicted in red), if they were restored (Figure 29).

Outputs / Products - **A.** Map of wetland ecological goods and services potential (Figure 29)

Conservation Opportunities Decision Support Layer

Interpretation - The CO layer is an amalgamation of one biological and two social data layers described in the sections above. It is most strongly influenced by expanding the core breeding habitat distributions (0.48 weight) and least influenced by ecological goods and services (potential) layer (0.19 weight). It displays the density of potential waterfowl habitat resources on the landscape with red indicating the greatest potential and blue the least (Figure 30).

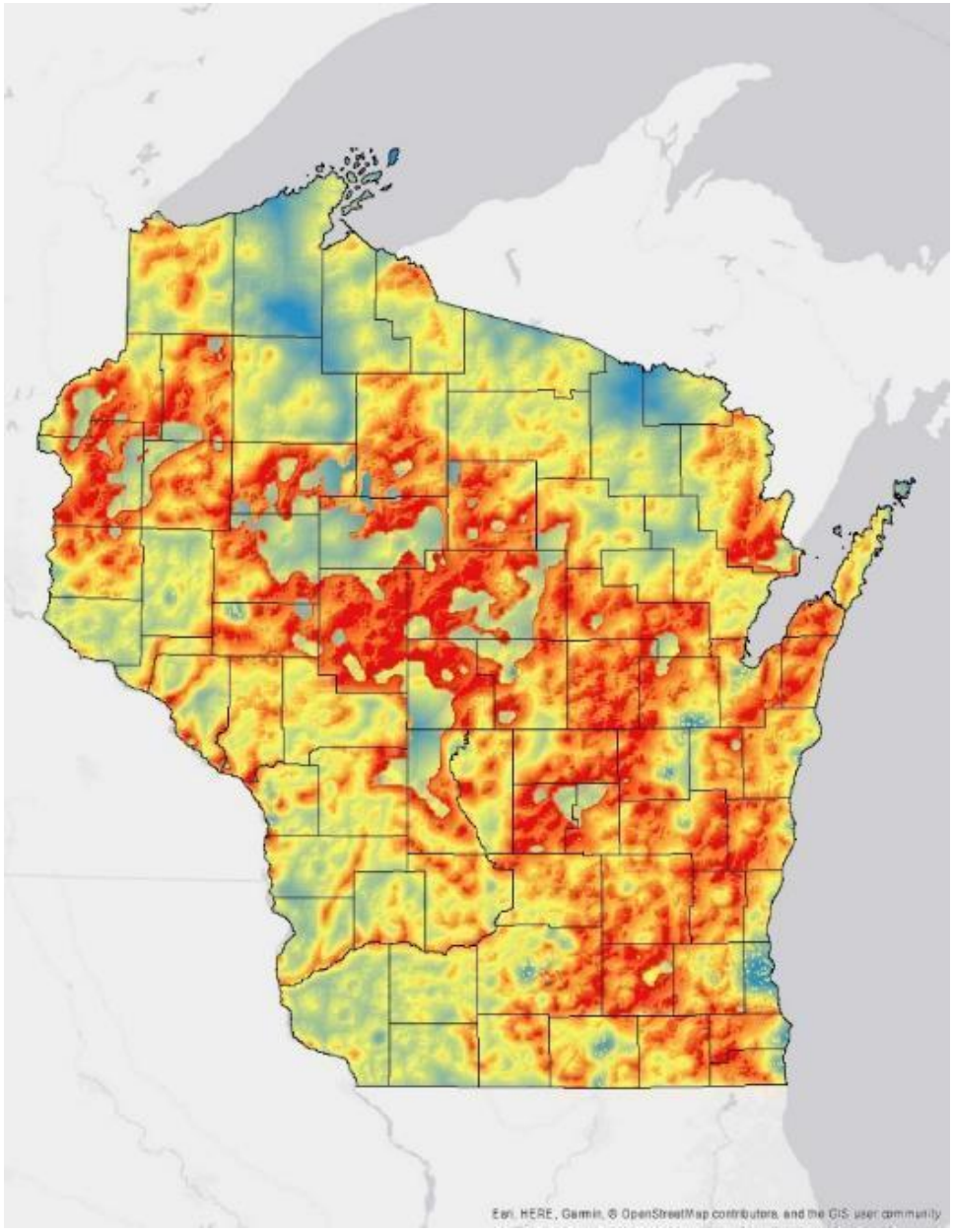


Figure 30. Raster image of cumulative Conservation Opportunities layers in Wisconsin. Models include the layers of expanding the core breeding habitats, wetland enthusiasts as a resource user, and ecological services potentially provided by wetlands (red is highest, blue is lowest).

Translating to Ecological Landscapes - To meet our objective of guiding "… conservation activities in the most geographically relevant areas in Wisconsin by creating priority landscapes" we overlaid the boundary of all 17 ELs onto the CO layer. This layer was a continuous surface of 1-km raster cells ranging in value from 0 (dark blue) to 1 (red). As each cell contained its own value, we ranked each EL relative to each other by calculating the average of all raster cells within each respective EL. Therefore, each landscape then had one CO score to represent the average of its respective region. Finally, we categorized all landscapes into quantiles. The resultant map ranks landscapes from greatest (red) to least (blue) regarding the average CO scores within a respective region (Figure 31).

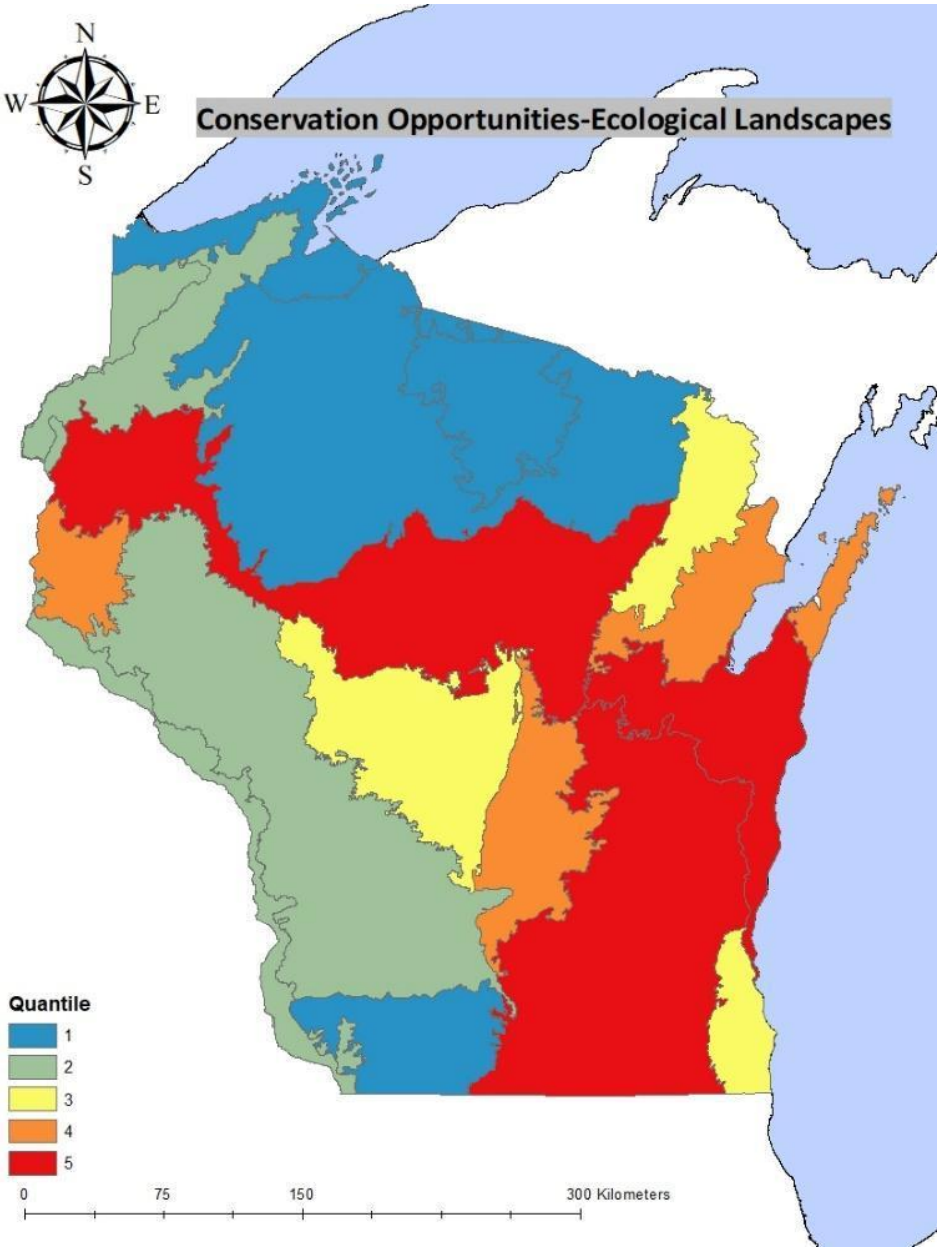


Figure 31. Ecological Landscapes of Wisconsin ranked (5 greatest priority, 1 least priority) by their cumulative Conservation Opportunities within each Ecological Landscape.

Translating to watersheds To meet our objective of guiding "… practitioners to the most impactful HUC 12 watersheds" we overlaid the boundary of all HUC 12 watersheds onto the CO layer. Within each landscape, we calculated the average CO score as an aggregate of all the cells in a watershed. Each watershed then had one composite CO score to represent the average of its respective watershed. The decision to calculate scores for watersheds within landscapes is important and noteworthy. For example, the Southwest Savanna was a low priority EL but it still has high priority watersheds. Essentially, this approach ensured that each landscape had both high and low priority watersheds. This means low priory landscapes have high priority watersheds. The decision to go with this approach was encouraged by our team of core collaborators who wanted to identify important watersheds in all landscapes in Wisconsin. Finally, we categorized all watersheds, within their respective landscapes into quartiles. The resultant map ranks watersheds from greatest (red) to least (blue) regarding the average CO scores within a respective watershed (Figure 32).

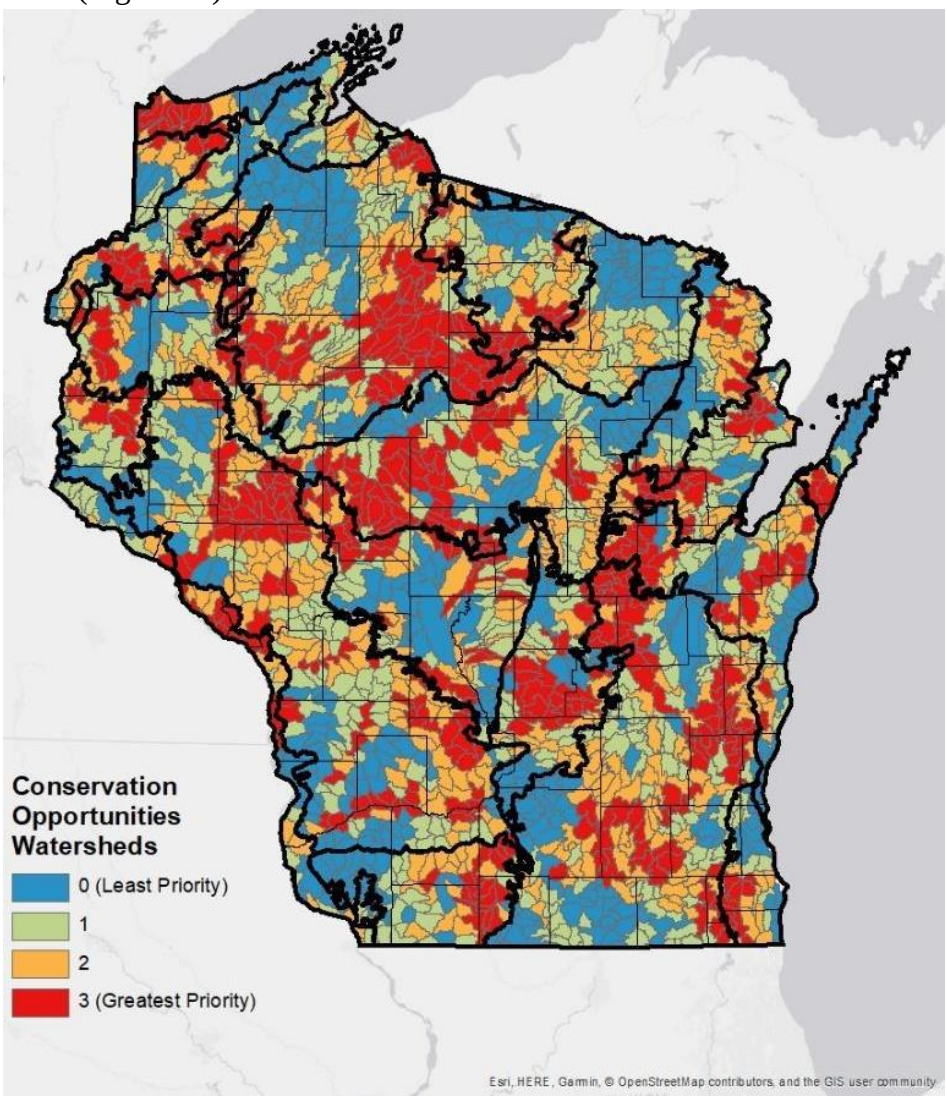
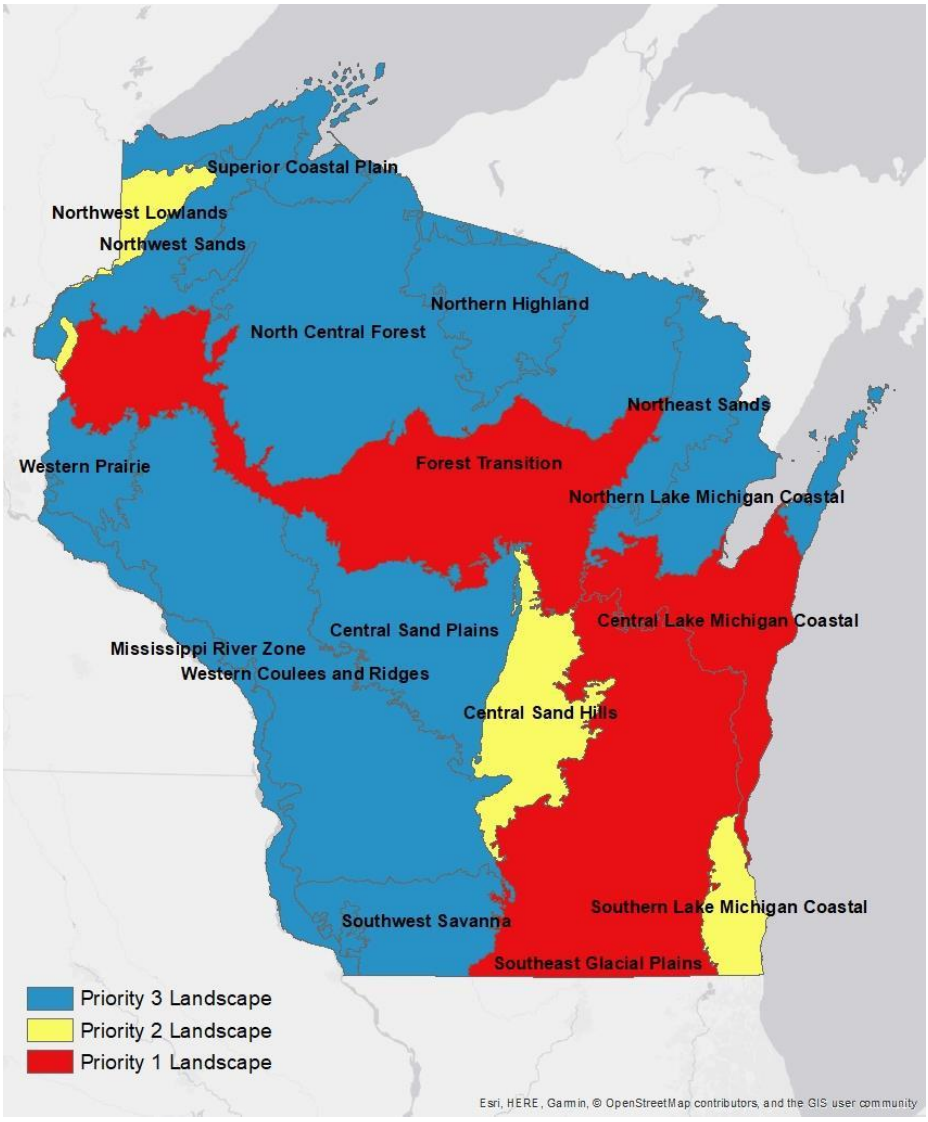


Figure 32. Priority 3 (greatest) through 0 (least) Hydrologic Unit Code 12 watersheds in Wisconsin ranked independently within each Ecological Landscape (black boundaries) for Conservation Opportunities.

Decision Making and Potential Scenarios to apply Conservation Opportunity data layers – The CO watershed ranking layer can be applied in decision making processes that are specific to restoring or creating waterfowl habitat, including wetlands and associated upland nesting areas. For example, the USFWS Partners for Fish and Wildlife Program strategically targets its limited federal resources to aid habitat restoration efforts on private lands. Although the UMGL JV defines priority landscapes, this finer resolution provides private lands biologists the ability to dial into voluntary wetland and upland restoration projects within these high priority CO watersheds. This in-turn provides conservation delivery programs the ability to demonstrate where accomplishments occur in a landscape and how science-based decisions are used when allocating congressionally appropriated and other funds.

Aggregate Wisconsin Waterfowl Habitat Decision Support Layers

Background - The aggregate decision support layer identifies both high priority landscapes and watersheds in Wisconsin for waterfowl habitat conservation and is guided by principles and practices of the 2012 NAWMP and the 2017 UMGL JV Waterfowl Habitat Conservation Strategy. Specifically, it combines the CO and CC landscapes and watershed layers and uses a series of eight spatial data layers that were developed, weighted and vetted by managers, biologists, and planners in Wisconsin (*see Development below*). We produced a layer of cumulative ecological landscapes ranked by three-tiered approach (greatest to least priority; Figure 33). The cumulative ecological landscapes map identifies the following Priority Landscapes as:



Priority 1-Southeast Glacial Plains, Central Lake Michigan Coastal, and Forest Transition

Priority 2-Central Sand Hills, Southern Lake Michigan Coastal, and Northwest Lowlands

Priority 3-Southwest Savanna, Western Coulees and Ridges, Mississippi River Zone, Central Sand Plains, Western Prairie, North Central Forest, Northern Highland, Northeast Sands, Northwest Sands, Northern Lake Michigan Coastal, and Superior Coastal Plain

Figure 33. Ecological Landscapes of Wisconsin ranked from greatest (Priority 1 Landscape) aggregate waterfowl conservation need to least (Priority 3 Landscape).

We also produced an aggregate priority watershed layer ranked from 9 (greatest) to 1 (least; Figure 34). left). The aggregate ecological landscapes and watershed layers are the result of combining a series of other layers. Specifically, we combined the scores for each watershed from the 1) EL layer (Figure 33), the 2) CC Watersheds (Figure 26) and 3) CO Watersheds (Figure 32). We created a flowchart (Figure 36) to aid the understanding of this process and we followed the steps in Table 5.

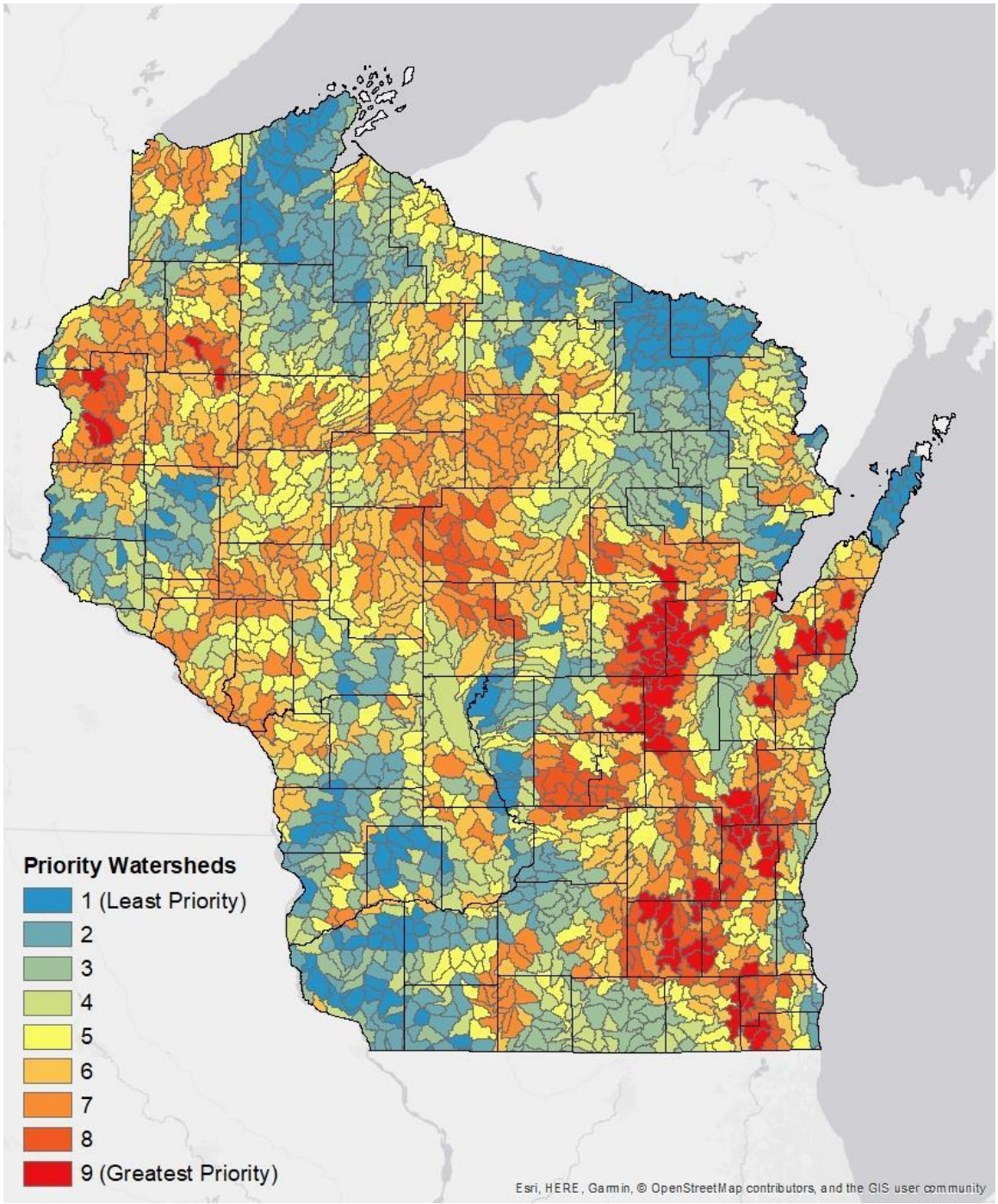


Figure 34. Hydrologic unit Code 12 watersheds of Wisconsin ranked from greatest (red; 9) aggregate waterfowl conservation need to least (blue;1).

Table 5. Steps involved in building the Wisconsin Waterfowl Habitat Decision Support Layer for Hydrologic unit Code 12 watersheds ranked from greatest (9 points) to least (0 points) priority.

Step 1.	Take the Conservation Capital (CC) and Conservation Opportunities (CO) raster and overlay the Ecological Landscapes (ELs) of Wisconsin.
Step 2.	For CC and CO separately, calculate the average conservation value within each EL and then categorize each EL into five quantiles (20%) based on that value.
Step 3.	For CC and CO separately, assign a score of one (bottom quantile) through five (top quantile) for all ELs.
Step 4.	Combine scores from CC and CO (Step 3) ELs such that each EL now has a value that ranges from 2 (min) to 10 (max).
Step 5.	Re-classify ELs as Priority 1 if the combined score from Step 4 is 9 or 10, Priority 2 if the combined score from Step 4 is 7 or 8, and Priority 3 if the combined score from Step 4 is <7.
Step 6.	Assign 3 points to all Priority 1 Els, 2 points to all Priority 2 Els, and 1 Point to all Priority 3 ELs.
Step 7.	For CC and CO separately (Step 2), within each EL, categorize HUC 12 watersheds into quartiles (25%) based on their average conservation value within each watershed.
Step 8.	For CC and CO separately, assign 3 points to all top ranked quartile watersheds, assign 2 points for the second greatest quartiles, assign 1 point for the third greatest quartiles, and assign 0 points to the bottom ranking quartiles.
Step 9.	For each unique watershed in Wisconsin, combine the points from whichever Priority landscape they reside in with the points from CC Watersheds and the CO Watersheds (Step 8).
Step 10.	Depict all watersheds on a map of Wisconsin showing their ranking from a final value of 1 (least priority) to 9 (greatest priority).

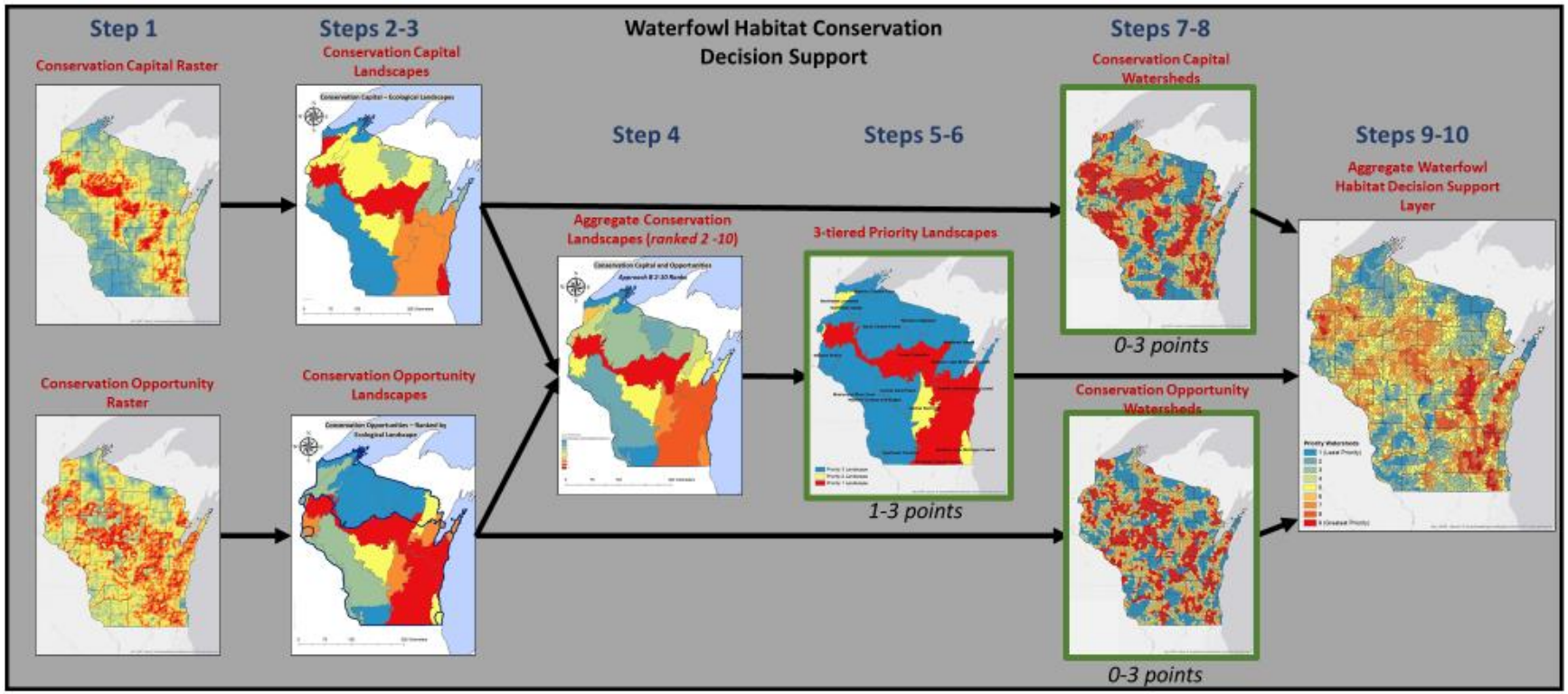


Figure 35. Steps and processes involved in building the Wisconsin Waterfowl Habitat Conservation Decision Support Layers. Points from maps with green borders were used in building the aggregate waterfowl habitat decision support layer.

Interpretation - The 3-tiered Priority Landscapes map divides all ELs into Priority 1 (best), Priority 2 (moderate) and Priority 3 (least) regions. The aggregate priority watersheds layer scores all Wisconsin HUC 12 Watersheds on a 1 to 9 scale. A HUC 12 watershed with a score of 9 indicates the watershed was within a Priority 1 Landscape (3 pts) and was identified as the top quartile (25%) within its respective ecological landscape for both CO (3 pts.) and CC (3 pts.). Conservation delivery in a HUC 12 watershed with a conservation score of 9 would give you the greatest "bang for your buck" regarding hitting all the objectives of the Wisconsin Waterfowl Habitat Conservation Strategy. Theoretically, it would deliver much needed local-scale results while also being embedded in a Priority Landscape. A HUC 12 watershed with a score of 1 indicates it was within a Priority 3 Landscape (1 point) and was identified as the bottom quartile (25%) within its respective ecological landscape for both CO (0 pts.) and CC (0 pts.).

Scenarios and Applications. - The map of cumulative ecological landscapes could be used to identity important region-wide initiatives, while the watershed map could be used to direct conservation habitat delivery at a finer spatial resolution. Below is an example of HUC 12 watersheds ranked by the aggregate waterfowl habitat decision support layer within the Southeastern Glacial Plains EL (Figure 36). This level of spatial resolution allows biologists and planners to prioritize conservation delivery at the watershed scale. Overall, this analysis with associated maps can provide users the flexibility to decide which application will meet their needs.

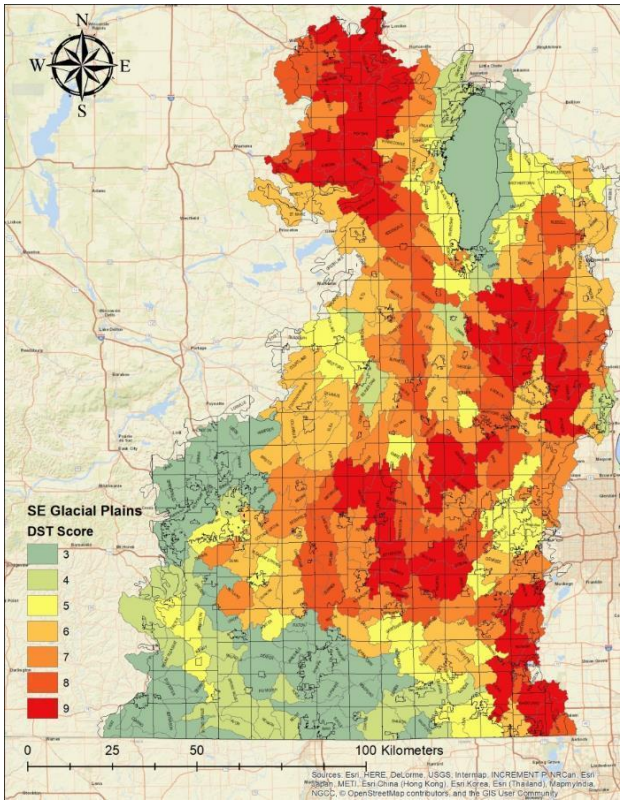


Figure 36. Hydrologic unit Code 12 watersheds ranked from greatest (9) aggregate waterfowl conservation need to least (1) for the Southeastern Glacial Plains Ecological Landscape.

Research, Monitoring and Planning Improvements and Priorities

Critical Needs for Waterfowl Habitat Planning in Wisconsin

We believe the Wisconsin Waterfowl Habitat Conservation Decision Support Layers will advance the abilities of partners to make informed decisions regarding where to implement conservation delivery. Yet through the process of developing the decision support framework we have identified existing needs that should be pursued in the future that would enhance the practical effectiveness of the conservation strategy. In the following, we lay out existing needs we believe should form the basis for future extensions of our work.

- Determine how habitat restoration objectives will be met in the next 15 years, including who will do the work, what delivery tactics will be used, and where. Our Decision Support Framework layers can assist in the 'where' by targeting areas of greatest conservation need, but partners need to decide how they can cohesively and consistently use the information provided in this plan.
- The UMGL JV objectives for waterfowl habitat retention in Wisconsin (1.27 million acres) undoubtedly includes acreage that already is protected, but
    a. partners must evaluate where these habitats are distributed (i.e., productive sites in BCR 23 vs. less productive sites in BCR 12).
    b. do they represent quality habitats that support waterfowl?
    c. what is their distribution among private and public land? and
    d. to what extent these areas are stable (i.e., easement perpetuity vs. short term conservation contracts)?
- Procedures for reporting habitat accomplishments should be improved and streamlined. Quality control measures and outreach methods that are agreed upon, user friendly, aligns with JV report accomplishments, and can collate information from traditional and non-traditional partners would more accurately reflect the true habitat accomplishments for Wisconsin.
- Procedures for monitoring and evaluating the quality of waterfowl habitats are needed (see (Schultz et al. 2019 *in review* and Straub et al. 2019). Scientists, managers, and planners should think about ways to monitor and evaluate the quality of wetland and upland habitats, especially as they relate to enhancing key vital rates for breeding waterfowl in Wisconsin. Adaptive management should then be applied to address deficiencies in habitat quality through feasible means.
- State and Federal staffing levels have generally declined since the release of the Original Plan. This has a negative effect on both quantity and quality of waterfowl habitat across Wisconsin. The retention and addition of dedicated habitat restoration and management staff is needed to accomplish objectives.
- Increase funding levels to carry out habitat restoration, enhancement, and retention activities.
- Advocate for and support policies that will help achieve the goals and objectives in this strategy.
- Research projects are needed that are designed to validate and inform spatial models of the Decision Support Framework layers.

Challenges moving forward

- How do planners and managers achieve large-scale gains in wetland area and quality given the current model of mostly small scale-projects?
- How can ecological response to restoration be best tracked? Can this process be standardized among partners? Do partners have the capacity, time, and expertise to monitor and track ecological responses?
- Despite progress made to gain quality habitat through decades of partnerships in Wisconsin, net gains likely will be less in the future, considering ongoing losses of habitat elsewhere throughout the state. What policies and programs can be implemented to slow the loss of waterfowl habitat? Can habitat losses be effectively documented and tracked?
- How are opportunities for waterfowl habitat conservation identified and then implemented in landscapes with highly fragmented land ownership and competing land use practices?
- How do we best manage external influences that degrade the quality of existing waterfowl habitat (e.g., nutrient loading and runoff from other properties, invasive species invasions, stressors related to climate change, reduced funding for habitat management, etc.)?
- How will outreach and education personnel communicate general conservation principles and elements that affect this plan to waterfowl habitat constituents and the general public.

Strategy Implementation

This strategy will be implemented primarily through the partnerships within the Wisconsin JV Steering Committee and other conservation agencies and organizations at local levels. At the committee level, partners will discuss programs and assets that they have to bring to the table and discuss strategic approaches to efficiently implement conservation work and programs cooperatively or independently to target the goals and objectives of the strategy. Partners will continue to create new landscape-based conservation initiatives that will be guided by the strategy to focus efforts of waterfowl habitat conservation in the best places within Wisconsin (e.g., the formation of the Glacial Habitat Restoration Area). This should also guide WRE, PFW, State Waterfowl Stamp, and new NAWCA initiative boundaries focused on newly revised habitat priority regions. This plan should also guide and inform decision makers on where to invest in waterfowl-specific management and infrastructure.

Throughout the 15-year cycle of the strategy, committee partners will regularly provide feedback that will evaluate the effectiveness and validity of the decision support framework and the model weights within them. The strategy shall be treated as a living document, with the potential for multiple versions within the 15-year timeframe. Updates to the strategy also may be considered if significant changes are made to NAWMP or JV plans, or new policies that would influence habitat conservation at the state-level. Partners shall consider offering the various services associated with writing plan updates, modeling and analysis from staff associated with their agencies or organizations and provide resources and services where they are needed. Alternatively, partners can consider contracting these services, provided support and resources are obtained for them.

Our Habitat Decision Support Layers are well suited for integration into a web-based decision support tool like the American Black Duck Decision Support Tool or the Wetlands by Design interactive web-mapper. Users can identify very specific habitat projects at the sub-watershed level and ultimately provide precision required to more effectively adhere to the plan's intent.

Literature Cited

Al-Saffar, M. and A. Sidie-Slettedahl. 2018. Upper Mississippi River and Great Lakes Region Joint Venture bird habitat conservation accomplishments (2007 – 2017). Upper Mississippi Great Lakes Joint Venture Report, 7p., accessed December 16, 2019 at https://umgljv.org/docs/JV-habitat-accomplishments-report-2007-2017.pdf.

Anonymous. 1977. Standard operating procedures for aerial waterfowl breeding ground population and habitat surveys. U.S. Department of the Interior, U.S. Fish and Wildlife Service & Department of Environment, Canadian Wildlife Service. 78p.

Bird Studies Canada and NABCI. 2014. Bird Conservation Regions. Bird Studies Canada on behalf of the North American Bird Conservation Initiative, accessed December 16, 2019 at https://www.birdscanada.org/research/gislab/index.jsp?targetpg=bcr&targetpg=bcr.

Blake-Bradshaw, A.G. 2018. Wetland suitability for waterbirds in Illinois. Thesis, University of Illinois at Urbana-Champaign, Champaign, IL.

Devers, P.K., A.J. Roberts, A. Knoche, P.I. Padding and R. Raftovich. 2017. Incorporating human dimensions objectives into waterfowl habitat planning and delivery. Wildlife Society Bulletin 41(3):405–415.

[ESRI] Environmental Systems Research Institute 2011. ArcGIS Desktop: Release 10. Redlands, CA.

Fleming, K.K., M.G. Brasher, D.D. Humburg, M.J. Petrie and G.J. Soulliere. 2017. Derivation of regional, non-breeding duck population abundance objectives to inform conservation planning. North American Waterfowl Management Plan Science Support Team Technical Report 2017–01. 31p.

Finger T. and T. Rohrer. 2019 (*unpublished report*). Wisconsin Waterfowl Management Plan 2020–2030. Wisconsin Department of Natural Resources, Madison, WI.

Green, A.J. and J. Elmberg. 2014. Ecosystem services provided by waterbirds. Biological Reviews 89(1):105–122.

Halvorsen, H. 2004. Waterfowl use of restored wetlands in CRP in Southeastern Wisconsin. The Passenger Pigeon 66(3):211–221.

Hellerstein, D.M. 2017. The US Conservation Reserve Program: The evolution of an enrollment mechanism. Land Use Policy 63:601–610.

Hepler, E. 2019. Warren Knowles-Gaylord Nelson Stewardship Program. Wisconsin Legislative Fiscal Bureau, 45p., Madison, WI, accessed December 16, 2019 at https://docs.legis.wisconsin.gov/misc/lfb/informational_papers/january_2019/0061_warren_knowles_gaylord_nelson_stewardship_program_informational_paper_61.pdf

Jenkins, W.A., B.C., Murray, R.A. Kramer and S.P. Faulkner. 2010. Valuing ecosystem services from wetlands restoration in the Mississippi Alluvial Valley. Ecological Economics 69(5):1051–1061.

Jones, M., K. Luke, J.M. Coluccy and P.K. Devers. 2016. Development of a decision support tool to inform black duck habitat delivery goals considering current and future landscape conditions. Final performance report submitted to Chesapeake Bay Trust, 33p., accessed December 16, 2019 at https://acjv.org/ABDU/abdu_cbt_finalreport_15dec2016_v5.pdf.

Kahler, B.M., R.L. Pierce and G.J. Soulliere. 2014. State x BCR Assessment: Wisconsin 23 – Prairie Hardwood Transition. Upper Mississippi River and Great Lakes Region Joint Venture, U.S. Fish and Wildlife Service, Bloomington, MN, 10p., accessed December 16, 2019 at https://umgljv.org/StateXBCRs/WI-BCR23.pdf.

Kahler, B.M. 2015. Upper Mississippi River and Great Lakes Region Joint Venture bird habitat conservation accomplishments. Final report (unpublished) to U.S. Fish and Wildlife Service, Bloomington, MN.

Krainyk A., J.E. Lyons, M.G. Brasher, D.D. Humburg, G.J. Soulliere, J.M. Coluccy, M.J. Petrie, D.W. Howerter, S.M. Slattery, M.B. Rice and J.C. Fuller. 2019. Spatial integration of biological and social objectives to identify priority landscapes for waterfowl habitat conservation. U.S. Geological Survey Open-File Report 2019–1029, 41 p., https://doi.org/10.3133/ofr20191029.

March, J., G.F. Martz and R.A. Hunt. 1973. Breeding duck populations and habitat in Wisconsin. Technical Bulletin. No. 68. Wisconsin Department of Natural Resources, Madison, WI, 37p.

Miller, N., J. Kline, T. Bernthal, J. Wagner, C. Smith, M. Axler, M. Matrise, M. Kille, M. Silveira, P. Moran, S. Gallagher Jarosz, and J. Brown. 2017. Wetlands by design: A watershed approach for Wisconsin. Wisconsin Department of Natural Resources and The Nature Conservancy. Madison, WI 61p., accessed December 16, 2019 at https://maps.freshwaternetwork.org/wisconsin/plugins/wetlands-watershed-explorer/assets/WetlandsByDesign_FinalReport.pdf.

[NAWMP] North American Waterfowl Management Plan. 1986. North American waterfowl management plan: a strategy for cooperation. U.S. Department of Interior – Fish and Wildlife Service and Environment Canada – Canadian Wildlife Service.

[NAWMP] North American Waterfowl Management Plan. 1994. Update to North American waterfowl management plan: expanding the commitment. U.S. Department of Interior – Fish and Wildlife Service, SEDESOL – Mexico, and Environment Canada – Canadian Wildlife Service.

[NAWMP] North American Waterfowl Management Plan. 1998. Expanding the vision: 1998 update, North American Waterfowl Management Plan. U.S. Department of Interior, Fish and Wildlife Service, SEMARNAP Mexico, and Environment Canada, Canadian Wildlife Service.

[NAWMP] North American Waterfowl Management Plan. 2004. North American waterfowl management plan 2004. Implementation Framework: Strengthening the Biological Foundation. Canadian Wildlife Service, U.S. Fish and Wildlife Service, and Secrataria de Medio Ambiente y Recursos Naturales.

[NAWMP] North American Waterfowl Management Plan. 2012. North American Waterfowl Management Plan 2012: People conserving waterfowl and wetlands. Canadian Wildlife Service, United States Fish and Wildlife Service, Secrataria de Medio Ambiente y Recursos Naturales.

[NAWMP] North American Waterfowl Management Plan. 2018. North American Waterfowl Management Plan (NAWMP) Update: Connecting People, Waterfowl, and Wetlands. Canadian Wildlife Service, United States Fish and Wildlife Service, Secrataria de Medio Ambiente y Recursos Naturales.

Pierce, R.L., B.M. Kahler, and G.J. Soulliere. 2014. State x BCR Assessment: Wisconsin 12 – Boreal Hardwood Transition. Upper Mississippi River and Great Lakes Region Joint Venture, U.S. Fish and Wildlife Service, Bloomington, MN, 12p., accessed December 16, 2019 at https://umgljv.org/StateXBCRs/WI-BCR12.pdf

Reynolds R.E., T.L. Shaffer, R.W. Renner, W.E. Newton and B. Batt. 2001. Impact of the Conservation Reserve Program on duck recruitment in the U.S. Prairie Pothole Region. The Journal of Wildlife Management 65(4):765–780.

Roy, C.L., C.M. Herwig and P.F. Doherty. 2013. Mortality and refuge use by young ring-necked ducks before and during hunting season in north-central Minnesota. The Journal of Wildlife Management 77(5):947–956.

Roy, C.L., J.B. Berdeen and M. Clark. 2019. A Demographic model for ring-necked ducks breeding in Minnesota. The Journal of Wildlife Management 83(8):1720–1734.

Schaub, M. and M. Kéry. 2012. Combining information in hierarchical models improves inferences in population ecology and demographic population analyses. Animal Conservation 15(2):125–126.

Schultz, R.E., J.N. Straub, M. Kaminski and A. Ebert. 2019 (*in review*) Floristic and macroinvertebrate responses to different wetland restoration techniques in southeastern Wisconsin. Wetlands

Soulliere, G.J., B.A. Potter, J.M. Coluccy, R.C. Gatti., C.L. Roy, D.R. Luukkonen, P.W. Brown, and M.W. Eichholz. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Waterfowl Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, MN, 121p., accessed December 16, 2019 at https://www.fwspubs.org/doi/suppl/10.3996/062012-JFWM-054/suppl_file/10.3996_062012-jfwm-054.s10.pdf.

Soulliere, G.J., M.A. Al-Saffar, J.M. Coluccy, R.J. Gates, H.M. Hagy, J.W. Simpson, J.N. Straub, R.L. Pierce, M.W. Eichholz, and D.R. Luukkonen. 2017. Upper Mississippi River and Great Lakes Region Joint Venture Waterfowl Habitat Conservation Strategy – 2017 Revision. U.S. Fish and Wildlife Service, Bloomington, MN, 170p., accessed December 16, 2019 at http://umgljv.org/docs/2017JVWaterfowlStrategy.pdf.

Soulliere, G.J. and M.A. Al-Saffar. 2017. Targeting conservation for waterfowl and people in the Upper Mississippi River and Great Lakes Joint Venture Region. Upper Mississippi Great Lakes Region Joint Venture, Technical Report No. 2017–1, 16 p.

Sterner, R.W., P. Ostrom, N.E. Ostrom, J.V. Klump, A.D. Steinman, E.A. Dreelin, M.J. Vander Zanden and A.T. Fisk. 2017. Grand challenges for research in the Laurentian Great Lakes. Limnology and Oceanography 62(6):2510–2523.

Straub, J.N., R.E. Schultz, J. Fleener, B. Glenzinski, G. Kidd, K. Waterstradt and S. Hygnstrom. 2019. Effectiveness of wetland conservation programs in the Glacial Habitat Restoration Area of Wisconsin. Final report F17AC00937 submitted to Wisconsin Department of Natural Resources 34p.

Thompson, S.J., T.W. Arnold and S.Vacek. 2012. Impact of encroaching woody vegetation on nest success of upland nesting waterfowl. The Journal of Wildlife Management 76(8):1635–1642.

Tiner, R.W. 2003. Correlating enhanced National Wetlands Inventory data with wetland functions for watershed assessments: A rationale for Northeastern U.S. Wetlands. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Region 5, Hadley, MA, 26p., accessed December 16, 2019 at https://www.fws.gov/northeast/ecologicalservices/pdf/wetlands/CorrelatingEnhancedNWIDataWetlandFunctionsWatershedAssessments.pdf.

Tiner, R.W. 2005. Assessing cumulative loss of wetland functions in the Nanticoke River watershed using enhanced National Wetlands Inventory data. Wetlands 25(2):405-419.

U.S. Department of Agriculture. 2018. Summary Report: 2015 National Resources Inventory. Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa, 210p., accessed December 16, 2019 at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcseprd1422028.pdf.

[USFWS] U.S. Fish and Wildlife Service. 1990. Upper Mississippi River and Great Lakes Region Joint Venture – concept plan. U.S. Fish and Wildlife Service, Twin Cities, MN.

[USFWS] U.S. Fish and Wildlife Service. 1993. Upper Mississippi River and Great Lakes Region Joint Venture – implementation plan. U.S. Fish and Wildlife Service, Twin Cities, MN. 36pp.

[USFWS] U.S. Fish and Wildlife Service. 2017. Partners for Fish & Wildlife Program: Midwest Region Strategic Work Plan 2017-2021. U.S. Fish and Wildlife Service, 14p., accessed December 16, 2019 at https://www.fws.gov/uploadedFiles/17-21%20Midwest%20Strategic%20plan.pdf.

[WDNR] Wisconsin Department of Natural Resources. 1992. Upper Mississippi River and Great Lakes Region Joint Venture – Wisconsin Plan. Wisconsin Plan. Bureau of Wildlife Management, Madison, WI.

[WDNR] Wisconsin Department of Natural Resources. 2014. Wetland Activities in Wisconsin, 2006-2013 Gains, Losses and Acre-Neutral Activities. Wisconsin Department of Natural Resources, report submitted by Bureau of Water Quality, Division of Water, Madison, WI, 30p., accessed December 16, 2019 at https://dnr.wi.gov/topic/Wetlands/documents/WetlandTrackingReport2006-2013.pdf.

[WDNR] Wisconsin Department of Natural Resources. 2015. The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management. Wisconsin Department of Natural Resources, PUB-SS-1131, Madison, WI, accessed December 16, 2019 at https://dnr.wi.gov/topic/landscapes/documents/1805cover.pdf.

[WISCLAND] Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data. 2016. Wiscland 2 Land Cover User Guide (2016), accessed December 16, 2019 at https://www.arcgis.com/home/item.html?id=b6cff8bd00304b73bb1d32f7678ecf34.

Appendix A

Timeline of UMGL JV Conservation Delivery Action Definitions

Pre 2009

- No formal definitions of protection, retention, restoration, enhancement, or management.

2009 - 2014

- Protection = bird habitat area placed under ownership of a conservation organization or private lands with perpetual conservation easement.

- Restoration = converting an existing low-value habitat cover type (i.e., annual crop or other human influenced zone) to a perennial native-plant community which has high value for target bird species or guilds.

- Enhancement = improving quality of an existing habitat area over an extended period (>10 years) for a target bird species or guilds (e.g., set back succession, suppress invasive plants, improve water quality, or provide a missing element to an otherwise suitable landscape).

2015 - 2016

- Protection = protecting an area of relatively high value to target bird species or guilds (i.e., JV focal species or guilds) through fee acquisition by a conservation organization or through private-land perpetual conservation easements.

- Restoration = reverting an altered site with low-value cover (i.e., annual row crop, agricultural/drained wetland) to a perennial native-plant community with restored ecological functions and high value for focal bird species or guilds.

- Enhancement = increasing ecological functions and improving quality of degraded bird habitat with practices lasting for extended periods (>10 years). Work might include setting-back succession, controlling invasive plants, improving water quality resulting in increased forage, or other techniques that increase focal species recruitment or survival.

2017 - present

- Retention = protecting habitat of relatively high value to target species (i.e., JV focal species or guilds) through fee acquisition, perpetual conservation easement, or regulation. Retention typically involves the purchase of existing bird habitats on private lands that are vulnerable to future degradation or development and transfer of ownership to a conservation agency or organization, assuring permanent protection.

- Restoration = returning or replacing a lost ecosystem that once provided habitat, thus reverting altered sites where ecological function and bird habitat have been compromised to a system with restored ecological functions and high value for focal species or guilds.

A common example of habitat restoration is converting an agricultural field with hydric soils to an emergent wetland (e.g., hemi-marsh, wet meadow) and grassland complex.

- Enhancement = improving ecological function and quality of degraded bird habitat with practices lasting for extended periods (>10 years), such as eradicating monoculture stands of invasive plants and replacement with desirable species, cleaning or re-contouring sediment-filled basins, or improving water quality to increase biodiversity. Enhancement significantly increases long-term carrying capacity for focal species or guilds (i.e., increasing occurrence, recruitment, or survival) but does not reduce biodiversity, ecological functions, and or habitat values for other species of conservation concern.

- Operational Management* = periodic or annual manipulation of areas under a persistent management regime to achieve desired outcomes for focal species or guilds. Management includes actions considered routine for the location to retain quality bird habitat for the breeding period (e.g., burning grassland to reduce brush) or non-breeding period (e.g., impoundment drawdown for moist soil management or marsh successional setback).

- Operational Maintenance* = repair or replacement of infrastructure and or special equipment with limited life expectancy (e.g., dike, pump, water control structure) but necessary to conduct bird habitat management at this location. Closely related to operational management, this type of work typically occurs at areas intensively managed due to altered hydrology and surrounding human-influenced landscapes. Reporting may simply include costs to complete maintenance rather than acres affected.

*defined for clarification, reporting for this category unneeded

Appendix B

UMGL JV Habitat Definitions

Circa 2007-2017

Category	Cover type	Definition
Marsh	Wet meadow with open water	Seasonal wetlands with herbaceous vegetation (sedge, rush, grass) mixed with pockets of semi-permanent shallow open water
	Shallow semi-permanent marsh, hemi-marsh	Marsh <3 feet deep with herbaceous cover and persistent standing water most years; typically a mosaic of emergent vegetation and open water
	Deep water marsh	Open water 2-5 feet deep mixed with small areas and borders of emergent vegetation; submergent vegetation common
Mudflat / shallows	Dry mudflat	Non-forested wetland in prolonged dry condition (e.g., draw down) with limited or short vegetation
	Wet mudflat / moist soil plants	Non-forested wetland with dynamic hydrology and areas of exposed mudflat; summer growth of annual seed-producing plants (moist-soil species), typically is flooded in fall and spring
	Shallow or moderate water	Non-forested wetland with <8 inches of water depth; vegetation typically sparse
Open water	Extensive open water	Open water areas of the Great Lakes, large rivers, and inland lakes with water depth 1-9 m (3-30 feet)
*	Islands with limited vegetation	Islands with periodic disturbance or a foundation that inhibits vegetation growth (<40% coverage); typically on the Great Lakes; may include lighthouse structures, confined disposal facilities (CDFs), and other human-made structures
*	Beach	Sandy shorelines maintained by wave action; may contain pebbles or cobble but little vegetation
Grassland	Grassland or mixed openland	Areas dominated by herbaceous plants (grasses and forbs) and with few trees; includes pasture or haylands or Savanna-like areas in combination with sparse trees or oak openings
	Shrubland	Areas dominated by woody vegetation <20 feet tall; includes shruby wetlands
Woodland	Deciduous forest	Areas dominated by trees where >75% of the species shed foliage simultaneously in response to seasonal change; includes deciduous forested wetlands
	Evergreen forest	Areas dominated by trees where >75% of the species maintain their leaves all year; canopy is never without green foliage; includes evergreen forested wetlands

***** Indicates no habitat category existed but partners were encouraged to report the cover type in a notes section of the form

Appendix B (*cont.*)

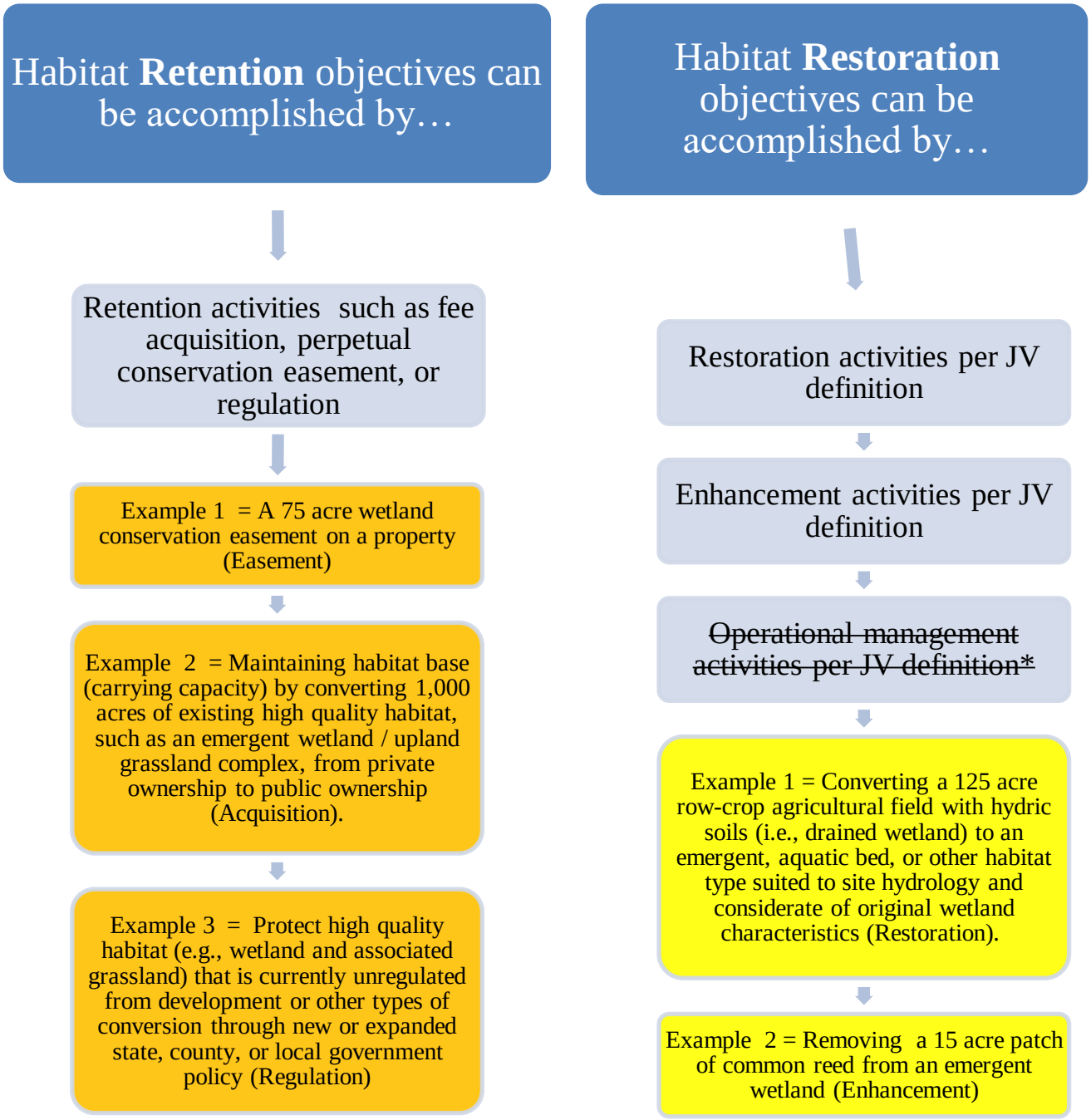
Circa 2018 - present

Recording categories	Bird habitat common names (examples)	Common habitat descriptions
Emergent wetland	Shallow marsh, hemi-marsh	Semi-permanent marsh <3 feet deep with emergent herbaceous plants and persistent water most years; often a mosaic of emergent vegetation with deeper open water / aquatic bed.
	Wet meadow with open water	Seasonal wetlands with emergent herbaceous vegetation (sedge, rush, grass) often mixed with pockets of semi-permanent shallow open water.
	Wet mudflat / moist soil management	Non-forested wetland with dynamic hydrology and areas of exposed mudflat; summer growth of annual seed-producing plants (non-persistent moist-soil species) typically is flooded in fall and spring.
Forested wetland	Swamp	Wetlands dominated by deciduous woody vegetation >20 feet tall and having persistent water (spring to fall) most years.
	Shrub-scrub swamp	Wetlands dominated by deciduous woody vegetation <20 feet tall and having persistent water (spring to fall) most years.
Aquatic bed wetland	Deep water marsh	Semi-permanent open-water basin typically <6 feet deep and dominated by submerged (at or below water surface) aquatic vegetation.
	Shallow lakes, impoundments, and bays	Open-water wetland 3-20 feet deep with bottom dominated by submerged aquatic vegetation.
Unconsolidated bottom / shore wetland	Extensive open water	Open-water areas of the Great Lakes, large rivers, and inland lakes with depth 3-30 feet, subject to waves and or currents, and having limited vegetation.
	Lakes and large rivers with beaches, bars, and flats	Open, un-vegetated shore areas influenced by erosion and deposition from waves and or water currents.
*	Islands with limited vegetation	Islands with periodic disturbance or a foundation that inhibits vegetation growth (<40% coverage); typically on the Great Lakes; may include lighthouse structures, confined disposal facilities (CDFs), and other human-made structures.
Grassland	Grassland or mixed openland	Areas dominated by herbaceous plants (grasses and forbs) and with few trees; can include pasture, haylands, and savanna.
Woodland	Shrubland	Areas dominated by woody vegetation <20 feet tall on predominately dry soils.
	Deciduous forest	Areas dominated by tree species where >75% of foliage is shed in response to season change and on predominately dry soils.
	Evergreen forest	Areas dominated by tree species where >75% of foliage is maintained all year; canopy is never without green foliage; includes evergreen forested wetlands.

***** Indicates no habitat category existed but partners were encouraged to report the cover type in a notes section of the form

Appendix C

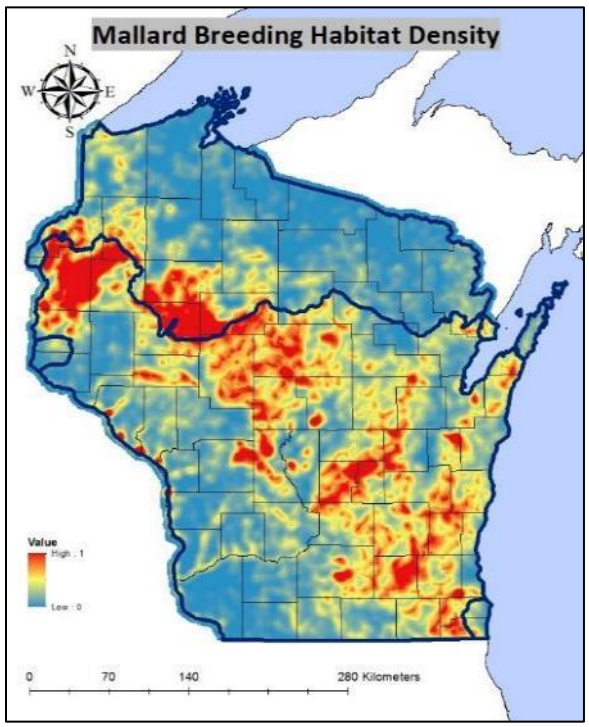
Examples of how partners can accomplish habitat retention and restoration objectives as defined by the UMGL JV Waterfowl Habitat Conservation Strategy (Soulliere et al. 2017).

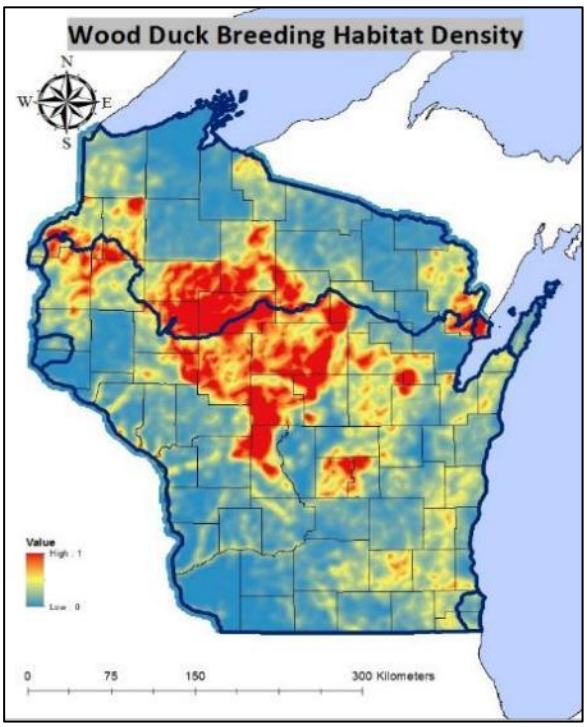


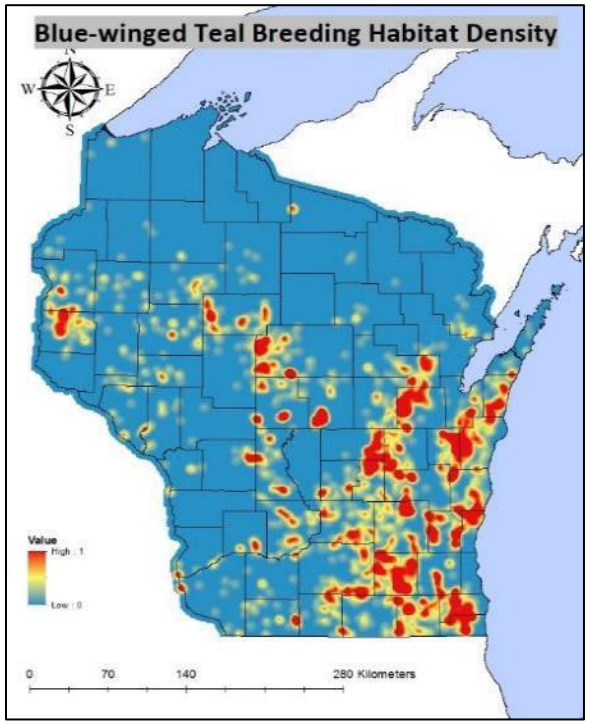
*****Crossed out actions are important activities identified by the JV but don't count toward meeting restoration objectives.

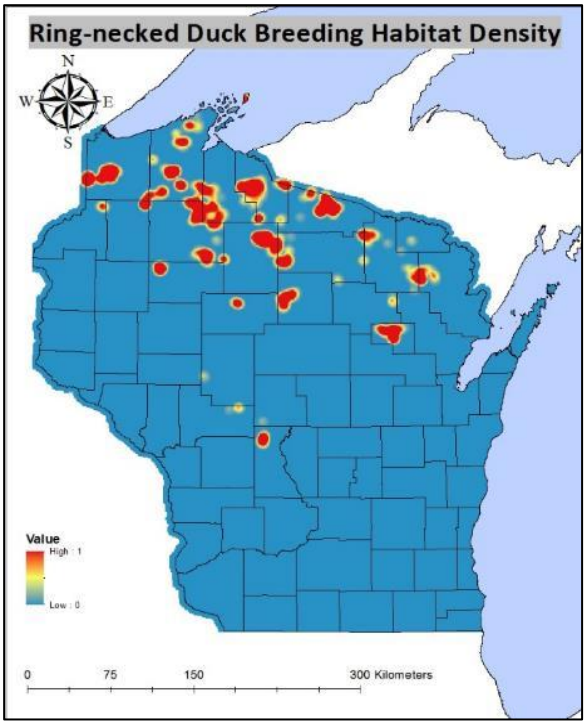
Appendix D

Distribution maps of species-specific breeding season habitat in Wisconsin.









Appendix E

Landscape Suitability Indices and National Wetlands Inventory habitat definitions used for breeding waterfowl habitat models in Wisconsin.

	National Wetlands Inventory Data						WISCLAND 2.0 Data							
Species	System	Sub-system	Class	Subclass	Water Regime	Exclusions	Wetland Area (ha)	Land Cover1	Land Cover Area (ha)	Land Cover2	Land Cover Area (ha)	Land Cover3	Land Cover Area (ha)	Distance of Wetland to LandCover (km)	Weight
Mallard	Any	Any	AB, EM, Split/UB	Any	C,F,G,H	NA	> 0.5	Grasslands/ Herbaceous	Any	NA	NA	NA	NA	≥0.0 to ≤ 0.5 from LC1	100
	Any	Any	AB, EM, Split/UB	Any	C,F,G,H	NA	> 0.5	Grasslands/ Herbaceous	Any	NA	NA	NA	NA	≥0.0 to ≤ 0.5 from LC1	80
Wood Duck	Any	Any	AB, EM, SS, FO	1, 3, 5, 6 (SS and FO only)	AB or EM: F,G,H -- SS or FO: A,C,E,F,G,H	Any SS or FO split subclass containing 2, 4	>5	Deciduous Forest	>0.5	NA	NA	NA	NA	< 0.5 from LC1	100
	Any	Any	AB, EM, SS, FO	1, 3, 5, 6 (SS and FO only)	AB or EM: F,G,H -- SS or FO: A,C,E,F,G,H	Any SS or FO split subclass containing 2, 4	≥0.5 to ≤ 5	Deciduous Forest	>0.5	NA	NA	NA	NA	< 0.5 from LC1	80
Blue-winged Teal	Any	Any	AB(Dominant Split Only), EM,US,UB	Any	F,G,H --US : A,C,J	L and R	> 10	Grassland/ Herbaceous	Any	Forest	>2.0	Develope	Any	<0.5 from LC1, and >0.3 from LC2 and LC3	100
	Any	Any	AB(Dominant Split Only), EM,US,UB	Any	F,G,H --US : A,C,J	L and R	≥0.5 to ≤ 10	Grassland/ Herbaceous	Any	Forest	>2.0	Develope	Any	<0.5 from LC1, and >0.3 from LC2 and LC3	80
Ring-necked Duck	Any	Any	AB, EM, UB Splits with SS or FO Dominant EM splits with SS or FO	Any	Any	NA	>4	L2P-EM and	Any	Developed	Any	Cultivatec	Any	<0.2 from LC1, and >5 from LC2 and LC3	100
	Any	Any	UB, US, AB, EM, SS	SS:3 -- Any for all others	EM: F,G,H-- US : A,C,E, J -- AB, UB, SS : Any	NA	≥0.5 to ≤ 4	L2P-EM and	Any	Developed	Any	Cultivatec	Any	<0.2 from LC1, and >5 from LC2 and LC3	80

Appendix F

Landscape Suitability Indices and National Wetlands Inventory habitat definitions used for fall-migrating waterfowl habitat models in Wisconsin.

	National Wetlands Inventory Data							WISCLAND 2.0 Data			
Species	System	Sub-system	Class	Sub-class	Water Regime	Exclusions	Legacy	Wetland Area (ha)	Land Cover1	Land Cover Area (ha)	Distance of Wetland to LandCover (km)	Weight
Mallard	Any	Any	SS, FO, AB, EM,UB, US	1, 3, 5, 6 (SS and FO only)	F,G,H	Any SS or FO split subclass containing 2, 4	Pf	> 2	na	na	na	Area of the wetland (ha)
Wood Duck	Any	Any	AB, EM, SS, FO	1, 3, 5, 6 (SS and FO only)	F,G,H	Any SS or FO split subclass containing 2, 4 -- All L	na	>2	na	na	na	Area of the wetland (ha)
Blue-winged Teal	Any	Any	AB, EM, UB	Any	F, G, H	na	na	>2	Developed	Any	>1 from LC1	Area of the wetland (ha)
Ring-necked Duck	Any	Any	AB,UB, EM	EM:3	Any	na	na	>2	Developed	Any	>1 from LC1	Area of the wetland (ha)

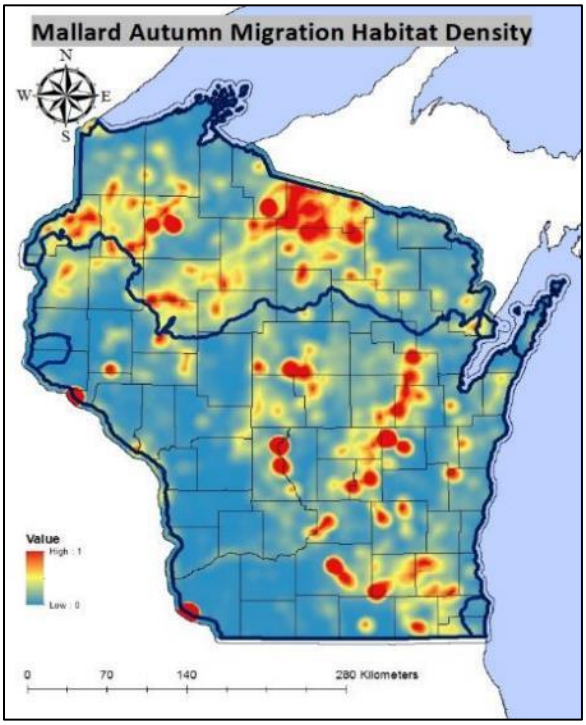
Appendix G

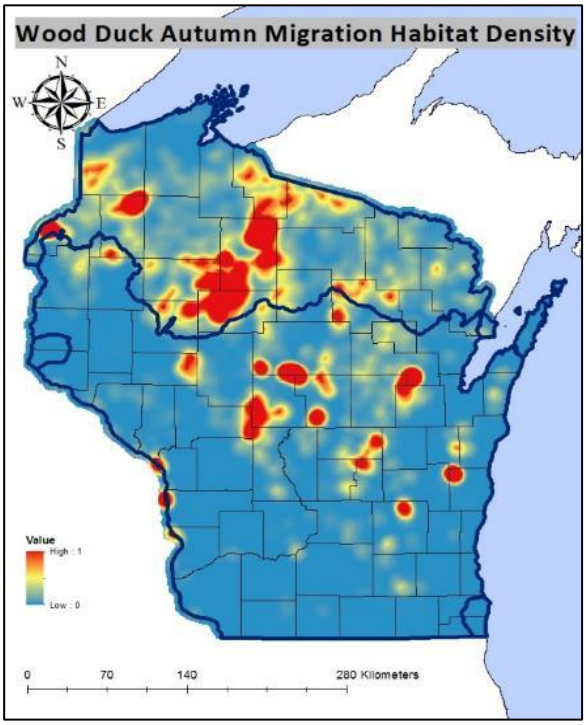
Landscape Suitability Indices and National Wetlands Inventory habitat definitions used for spring-migrating waterfowl habitat models in Wisconsin.

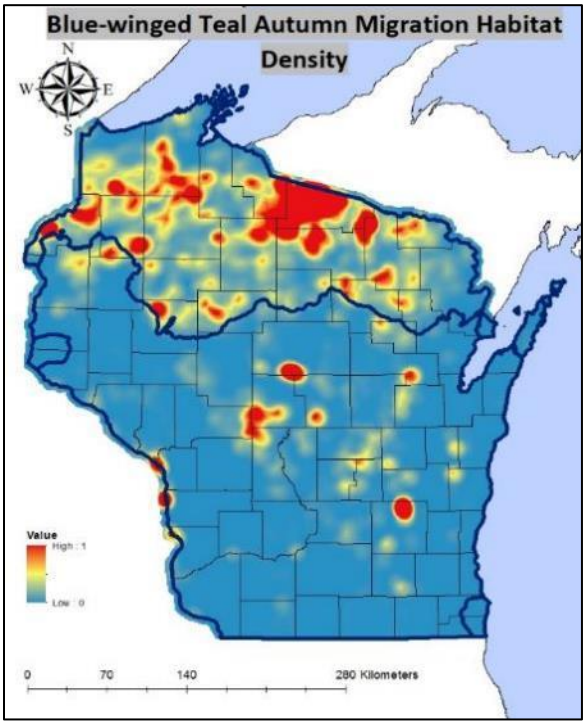
	National Wetlands Inventory Data								
Species	System	Sub-system	Class	Subclass	Water Regime	Exclusions	Legacy	Wetland Area (ha)	Weight
Mallard	Any	Any	SS, FO, AB, EM, UB, US	1, 3, 5, 6 (SS and FO only)	not (B, D)	Any SS or FO split subclass containing 2, 4	Pf	Any	100
Wood Duck	Any	Any	AB, EM, SS, FO	1, 3, 5, 6 (SS and FO only)	not (B, D)	Any SS or FO split subclass containing 2, 4 -- All L	na	Any	100
Blue-winged Teal	Any	Any	AB, EM, US, UB	Any	EM, US: A, C, E, J -- AB, UB: Any	na	Pf	Any	100
	Any	Any	AB, EM, US, UB	Any	EM: F, G, H-- US : A,C,E, J -- AB, UB : Any	na	Pf	Any	80
Ring-necked Duck	Any	Any	AB, UB, EM	EM:2	Any	na	na	Any	100

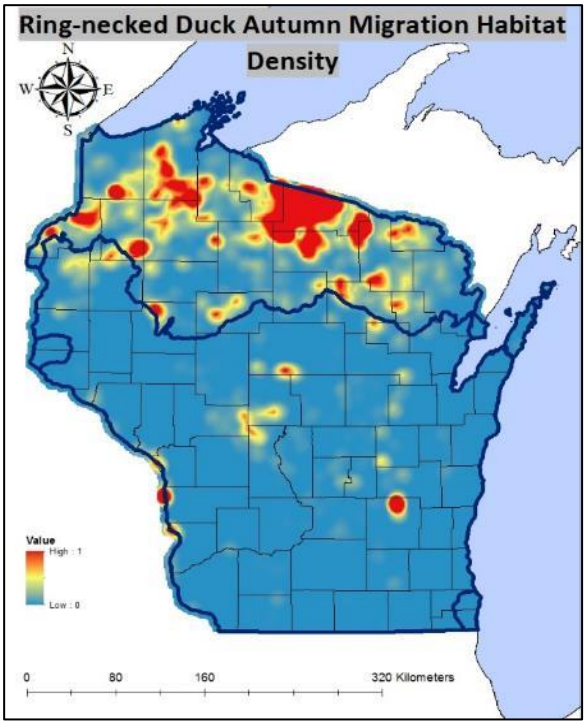
Appendix H

Distribution maps of species-specific fall migration habitat in Wisconsin.









Appendix I

Distribution maps of species-specific spring migration habitat in Wisconsin.