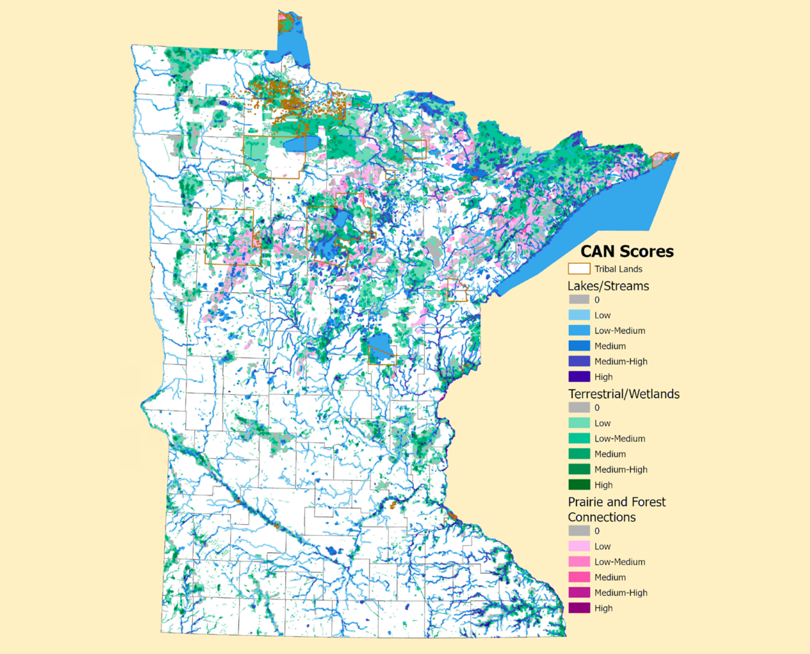
MINNESOTA'S WILDLIFE ACTION PLAN 2025-2035

CONSERVING HABITATS AND BIODIVERSITY

CONSERVATION ACTION NETWORK



DEPARTMENT OF NATURAL RESOURCES

NONGAME WILDLIFE PROGRAM

Acknowledgments

We would like to thank more than 300 people who contributed to the development of this State Wildlife Action Plan (SWAP) throughout our revision process over the past two years (see List of Plan Contributors). Everyone's varied perspectives and expertise has improved the plan and will carry on into the next ten years of conservation action for Minnesota's biodiversity and vulnerable wildlife. A specific thank-you to members of the Nongame Wildlife Program core team who facilitated teams, developed content, and pulled together this huge resource: Alison Cariveau (lead), TJ Boettcher, Daren Carlson, Mags Edwards, Julia Geschke, Benjamin Gieseke, Kristin Hall, Chris Jennelle, Tim Mitchell, Elizabeth Nault-Mauer, Jessica Ruthenberg, and Jim Wanstall. Special appreciation also to Lee Pfannmuller, Bridget Henning-Randa, Bob Dunlap, and April Rust who contributed so much to this revision. We thank numerous taxonomic experts and all the volunteers who participated in eleven revision teams; please see the full List of Plan Contributors.

Funding

The SWAP revision was funded through U.S. Fish and Wildlife Service State Wildlife Grants as well as matching funds from private donations to the Nongame Wildlife Fund and Reinvest in Minnesota funds. We also received funding from the Minnesota Environmental and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

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Cover Photos: Conservation Action Network (CAN), depicting terrestrial and wetland cores, lake and stream cores and connectivity for forests and prairies; Workshop participants looking at maps for planning purposes, Julia Geschke

How to cite this document: Minnesota Department of Natural Resources. (2026). Minnesota's Wildlife Action Plan 2025-2035: Conserving Habitats and Biodiversity. Ecological and Water Resources Division.

Chapter 6. Implementation - Conservation Action Network

Chapter 6 contains three sections, each of which are applied to guide our conservation work under this Plan. This section explains the Conservation Action Network, which represents biodiversity and high-quality habitat in our state spatially as a resource to prioritize conservation actions geographically. A second section describes Conservation Opportunity Areas, which identify locations for partners to focus on-the-ground conservation efforts that build and improve areas in and around the Conservation Action Network (see Chapter 6 Implementation – Conservation Opportunity Areas). Third, we provide foundational information regarding climate trends in Minnesota and strategies for climate adaptation that are broadly applicable throughout many types of conservation actions (see Chapter 6 Implementation – Climate Adaptation).

Of the more than 7,000 known plant and animal species in Minnesota, 1,142 have been identified as Species in Greatest Conservation Need (SGCN) following a rigorous conservation status assessment described in Chapter 2. Given the sheer number of SGCN, one of the main goals of the Plan is to prioritize and focus on conservation actions for habitats needed by SGCN (see Chapter 3: Habitats). This habitat approach can meet the needs of multiple species and emphasizes sustaining and enhancing terrestrial and aquatic habitats for SGCN in the context of both the local and larger landscape scale (including watersheds). Habitat loss and fragmentation affect biodiversity and ecosystem function, making habitat conservation and restoration central objectives in conservation planning. Evaluating landscape functional connectivity and mapping habitat networks are key steps and challenges for implementing effective actions to conserve SGCN (Duflot et al., 2018).

Goals to manage local habitat are more successful in the context of landscape-scale planning and management priorities, with the ultimate endpoint to maximize ecosystem resilience. Ecosystem resilience is an emerging concept which includes developing ways to assess functional groups (e.g., decomposers, producers, predators) and understanding the niche or redundancy of functional groups at multiple scales, while also identifying structural diversity, ecosystem services and human social/ecological connections. Resilience, as it applies to Minnesota's Wildlife Action Plan, is the capacity of an ecological system to absorb some level of disturbance and reorganize while still retaining essential functions, structures and feedbacks. Landscape prioritization provides focus for conservation actions to maintain or enhance ecosystem resilience. Examples of such actions include:

- Protecting large habitat areas from fragmentation.
- Restoring natural levels of connectivity while maintaining natural barriers.
- Reducing invasive species.
- Prioritizing habitats for biological and functional diversity (vs. single species needs).
- Minimizing pollution and impervious surfaces.
- Restoring watershed hydrology.
- Reintroducing disturbance when appropriate.

Building on the two Prior Plans

2005-2015 Tomorrow's Habitat for the Wild and Rare

Minnesota's original State Wildlife Action Plan, Tomorrow's Habitat for the Wild and Rare, identified significant loss and degradation of habitat as the principal management challenge for achieving its goal to stabilize and increase SGCN populations (DNR 2005). The principal strategy for addressing this management challenge was the need to identify key SGCN habitats and focus management efforts on them. Habitat descriptions were subsequently provided for 16 key habitats in profiles of all 25 ecological subsections in Minnesota (Ecological Classification System). Each subsection profile included a matrix of SGCN use for all habitats that occurred in the subsection along with an assessment of which habitats were the most important to the greatest number of SGCN. Conservation actions to maintain and enhance the key habitats in each subsection were delineated.

Minnesota's Wildlife Action Plan 2015-2025

Minnesota's Wildlife Action Plan 2015-2025 identified a three-pronged approach to ensuring the long-term health and viability of Minnesota's wildlife, the first and most comprehensive being the habitat approach (DNR 2015). In the 2015 Plan, the Wildlife Action Network (WAN) was developed as a tool for the implementation of a habitat-based conservation approach, resulting in a map illustrating the distribution of high-quality habitats for both terrestrial and aquatic SGCN and identifying potential movement corridors among the prioritized habitat cores. To prioritize areas for on-the-ground conservation efforts, sites within the WAN were assigned priority rankings based on five metrics, including SGCN population viability and species richness. These rankings were used in combination with a set of Conservation Focus Areas where resources, such as partners and/or funding, were available to address conservation needs through on the ground habitat restoration and management.

The 2025-2035 Plan maintains the same concept of the 2015 Wildlife Action Network (WAN), applying updated and new information to better identify and prioritize areas of high conservation value. With the addition of plants as SGCN and the availability of additional current landcover GIS layers reflecting habitat quality, the resulting WAN revision is more comprehensive and therefore called the Conservation Action Network (CAN).

The Conservation Action Network serves as the foundational prioritization tool to help accomplish the five habitat strategies laid out in Chapter 3: Habitats, which are to:

1. **Protect,** buffer and connect high quality habitats to optimize biodiversity, SGCN and landscape benefits.
2. **Restore,** enhance and maintain lands and waters to benefit SGCN, biodiversity and ecosystem resilience
3. **Collaborate** with conservation partners and landowners to enhance conservation delivery
4. **Monitor** SGCN**,** native plant communities, habitats and ecosystems for changes through time including responses to stressors, natural disturbances, conservation actions and climatic conditions.
5. **Connect** to develop**,** innovate, incentivize and disseminate evidence-based habitat management practices to benefit SGCN.

In practice the CAN is well suited to assist in large scale and multi-faceted conservation planning efforts. As climate change becomes more pronounced, its effects will be both direct and indirect. Effects from climate change in addition to those from other large-scale drivers will be synergistic; that is, multiple stressors will have an effect that is greater than what may be considered simply additive. Species are already moving in response to climate change, and it is expected that the ranges of plant and animal species will continue to shift, and habitats will change. The Conservation Action Network will facilitate planning for adaptation to these changes by identifying core areas large enough to contain a diversity of ecotones and habitats to allow for local shifts (e.g., dry to mesic prairie) and highlighting ecological corridors to allow for species movements and the flow of energy and materials. These conditions will support the biological diversity already present in the Conservation Action Network and make it more likely that ecosystem resilience can be maintained in response to climate change and other stressors, such as invasive species and other forms of habitat degradation. The CAN may be used to prioritize areas in which to maintain and increase native biological diversity, which has also been shown generally to decrease the ability of invasive plants to become established (Yan et al., 2015; Levine and D'Antonio, 1999; Hooper et al., 2005; Fridley et al,. 2007).

While corridors are necessary for connectivity, considerations of potential negative effects and local knowledge are also important to recognize and prevent unintended consequences, such as the novel transmission of pathogens and invasive species. However, one review found little strong evidence for negative consequences of landscape corridors (Haddad et al., 2014), and others have found strong evidence of positive effects, such as increased biological diversity (Gilbert-Norton et al., 2010). Still, knowing how dynamic a system is and what the potential effects of connectivity within that system could be is important. Corridors between naturally unconnected aquatic or wetland systems might be inappropriate, for instance.

Ultimately the CAN was developed with the aim of increasing the effectiveness and efficiency of conservation actions when resources and capacity are limited. A network focus will increase efficiency by facilitating coordination of management, prioritizing outreach efforts and targeting technical assistance. Coordination of management will also increase its effectiveness. For example, coordinating activities across multiple ownerships within the network can benefit species that require large areas of habitat in particular successional stages (i.e., time since disturbance).

In essence, the Conservation Action Network is an effort to identify the best places for SGCN and Minnesota's diverse plants, animals and many other organisms to persist and adapt to a changing climate as well as physical changes to the land, water and air. The CAN identifies and scores core areas of high biodiversity, important habitats, and healthy ecosystems as well as areas of potential connectivity between the cores. The CAN intends to guide conservation partners to maximize collective outcomes and will continue to build on the utility of the 2015 WAN (see Case Study about the Wildlife Action Network in action).

The Conservation Action Network is based on a rich set of species occurrence data and biodiversity rankings from several decades of intensive survey efforts by Minnesota Biological Survey staff; surveys and public reports collected by Nongame Wildlife Program, Scientific and Natural Areas and Parks and Trails staff; intensive sampling efforts by the Minnesota Pollution Control Agency for stream Indices of Biological Integrity; and other sources of information. The CAN does not capture potentially important areas lacking survey information. Over the next 10 years, the network should be further refined to include new information on additional rare species occurrences.

Case Study: Minnesota Land Trust's Use of the Wildlife Action Network

The Minnesota Land Trust (MLT) is a conservation non-profit organization that works with private landowners to conserve land through voluntary land conservation agreements. The Land Trust's mission is to protect and restore Minnesota's most vital natural lands to provide wildlife habitat, clean water, outdoor experiences and scenic beauty for generations to come. Since 1991, the Land Trust has partnered with hundreds of Minnesota landowners to permanently protect over 80,000 acres of natural land and 540 miles of fragile shoreline throughout the state. In addition, they have restored over 9,000 acres of critical habitat.

The MLT's conservation easement acquisition program works throughout Minnesota in a range of different "program areas" such as the Blufflands and the North Shore that largely corresponds with state grants they receive from the Outdoor Heritage Council. A main component of this work is partnering with private landowners to place permanent conservation easements on their property. MLT's focus is typically areas of high-quality natural habitat. MLT also has a restoration program to provide restoration assistance to landowners once the conservation easement is complete. All of MLT's program areas have slightly different goals and objectives, but use of the Wildlife Action Plan is consistent across all of them.

MLT uses the Wildlife Action Network from Minnesota's 2015 Wildlife Action Plan to help prioritize where our work will have the maximum conservation impact. To prioritize among a large volume of landowner applications across a given landscape, the Wildlife Action Network is a key data point in sorting through these potential parcels and identifying priorities for protection. In southeastern Minnesota, for example, MLT uses a ranking system that weighs the parcel's size, the quality of its natural resources/habitat, and its landscape context to come up with a composite ranking for prioritization. The Wildlife Action Network is an outstanding metric for use in the "natural resources/habitat" quality score because it synthesizes so many other data sets into one, easy-to-use metric.

Photo: Workshop participants looking at maps for planning purposes, Julia Geschke

Developing the Conservation Action Network

The Conservation Action Network (CAN) was developed through a careful review of multiple data layers, guidance from SWAP revision core staff, and input gathered during three conservation practitioner meetings held in 2024 and 2025. A total of 18 GIS data layers were used to assemble the CAN, including 16 layers to comprise the core areas, and two layers for connectivity (Table 6.1). Also see Appendix F for more details on CAN development.

Table 6.1. Geographical Information System (GIS) layers used to map habitat cores and corridors in the Conservation Action Network (CAN).

GIS layer	Scale	Description	Used in 2015 WAN?
Species in Greatest Conservation Need (SGCN) Richness Hotspots	Species	Clusters of SGCN species summed in 2 km square hexagons. See Hotspots section for more detail.	Yes – updated in 2025
Mapped Endangered and Threatened Animal Populations	Species	Populations of State and Federal Endangered and Threatened Animals mapped in 2015 for the previous Wildlife Action Plan.	Yes – not updated
High Quality Element Occurrences of Endangered and Threatened Plants	Species	From Biotics Rare Natural Features maintained in The Natural Heritage Information System, DNR - Division of Ecological Resources (NatureServe, DNR Natural Heritage Information System).	No
Federal Critical Habitat designations	Species	Current Federal Critical Habitat designations for Dakota skipper, piping plover, poweshiek skipperling, and topeka shiner.	Yes
Bat maternity roost and hibernacula restriction buffers	Species	Selected all forest classes within buffers around known hibernacula entrances and occupied maternity roost trees that are used by northern long-eared bat (*Myotis septentrionalis*), little brown myotis (*Myotis lucifugus*), and tricolored bat (*Perimyotis subflavus*) (Lakes States Forest Management Bat Habitat Conservation Plan).	No
Rare Native Plant Communities	Habitat	Native Plant communities mapped by staff within the Minnesota Biological Survey (DNR) that have a state conservation rank of S1 or S2 (Minnesota's Native Plant Communities).	No
High Quality Wetland Native Plant Communities	Habitat	Wetland Native Plant communities mapped by staff within the Minnesota Biological Survey (Minnesota DNR) that have a condition rank of A, B or C (Minnesota's Native Plant Communities).	No

GIS layer	Scale	Description	Used in 2015 WAN?
Forest Management Opportunity Areas	Habitat	State forest land with management emphasis to improve forest habitat for wildlife species. The following types were included: Landscape (LAND), Old Forest Management Complexes (OFMC), White Pine/ Conifer Management Area (WPMA), Owl Management Area (OWMA), Large Block/Moose, Management Area (MMA), Open Landscape Management Area (OLMA), Forest Patch (PATCH), Deer Management Area (DMA), INT, Pilot INT MOA and Pilot UPLD MOA (Forest Resource Management Planning).	No
DNR Forest Inventory Old Growth and old growth Special Management Zones (SMZ)	Habitat	Currently designated or candidate old growth forest stands and old growth Special Management Zones (SMZ) - a 330-foot buffer around the Old Growth stand on lands administered by the MN Department of Natural Resources (DNR) (Old growth forests).	No
Forest Representative Sample Areas (RSAs)	Habitat	Ecologically viable representative samples of forest types on lands administered by the DNR designated to serve one or more of three purposes: 1) To establish and/or maintain an ecological reference condition; or 2) To create or maintain an under-represented ecological condition; or 3) To serve as a set of protected areas or refugia for species, communities and community types otherwise not captured.	No
High Conservation Value Forests (HCVF)	Habitat	Forest areas administered by the DNR selected by Interdisciplinary Regional Teams from a subset of sites of Biodiversity Significance identified by the Minnesota Biological Survey (MBS) that was recommended for consideration by Division of Ecological and Water Resources biologists (High conservation value forests).	Yes
Lakes with high Lake Health scores in the Watershed Health Assessment Framework (WHAF)	Habitat	Lakes with an overall WHAF lake health score of 75 or greater and lakes with a lower overall health score but had a biology component score of 70 or greater. (Watershed Health Assessment Framework: Lakes).	No

GIS layer	Scale	Description	Used in 2015 WAN?
Lakes with high bird rankings identified in the Lakes of Biological Significance layer.	Habitat	Added lakes not selected from the WHAF health scores above which ranked high or outstanding from the Lakes of Biological Significance layer with a bird rank of 1 (Outstanding) or 2 (High) (Lakes of Biological Significance).	Yes
High Quality Stream Reaches	Habitat	This layer includes stream reaches (WIDS) that met Exceptional Use criteria for fish and/or aquatic invertebrates based on Indices of Biological Integrity (IBI) developed and surveyed by the Minnesota Pollution Control Agency (MPCA). Adjacent reaches that met General Use criteria and all streams with an order size of 5 to 9 were also added to maintain connectivity. (MPCA Index of biological integrity).	Yes – updated since 2015
Sites of Biodiversity Significance	Landscape	A biodiversity significance rank is assigned by staff within the Minnesota Biological Survey (DNR) on the basis of the number of rare species, the quality of the native plant communities, and areas' size and context within the landscape (MBS Site Biodiversity Significance Ranks). Here we include those with ranks of High and Outstanding.	Yes – updated since 2015.
Minnesota Prairie Conservation Plan Core Areas	Landscape	Represents landscapes with concentrations of native prairie, grasslands and other habitats identified using DNR Biological Survey, USFWS and land cover data. Where appropriate, these boundaries were adjusted to reflect watershed divides and ownership/field boundaries (Minnesota Prairie Conservation Plan).	Yes –updated in 2017
TNC forest connectivity	Connectivity	Areas of high diffuse and concentrated flows selected from the forest wall-to-wall Circuitscape model developed by ecologists at The Nature Conservancy's North America Science team.	No
TNC prairie connectivity	Connectivity	Areas of high diffuse and concentrated flows selected from the prairie wall-to-wall Circuitscape model developed by ecologists at The Nature Conservancy's North America Science team.	No

Core Areas

Layers representing core areas were chosen to represent three different scales: species, habitats/communities, and landscapes. Ensuring representation of these scales has been identified as important for landscape planning under climate change (Schmitz et al., 2015). Aquatic and terrestrial cores represent areas with high concentrations of SGCN species, high-quality or rare habitats, or healthy ecosystems. Core areas of habitat are depicted in Figure 6.1.

The species scale was split into two categories: all SGCN and Endangered and Threatened species (federal and state). Five GIS data layers were used to represent the species scale, one for all SGCN species (Richness hotspots) with the other four brought together to focus on endangered and threatened species (High Quality Element Occurrences of Endangered and Threatened Plants, Mapped Endangered and Threatened Animal Populations, Federal Critical Habitat designations, and Bat maternity roost and hibernacula restriction buffers). Habitat from each of these layers was included in the CAN.

High quality and rare habitats were determined for five habitat categories: prairies, wetlands, forests, lakes and rivers/streams, based on a set of nine layers.

Healthy landscape cores were represented by two data layers: Sites of Biodiversity Significance and core areas from the Minnesota Prairie Conservation Plan.

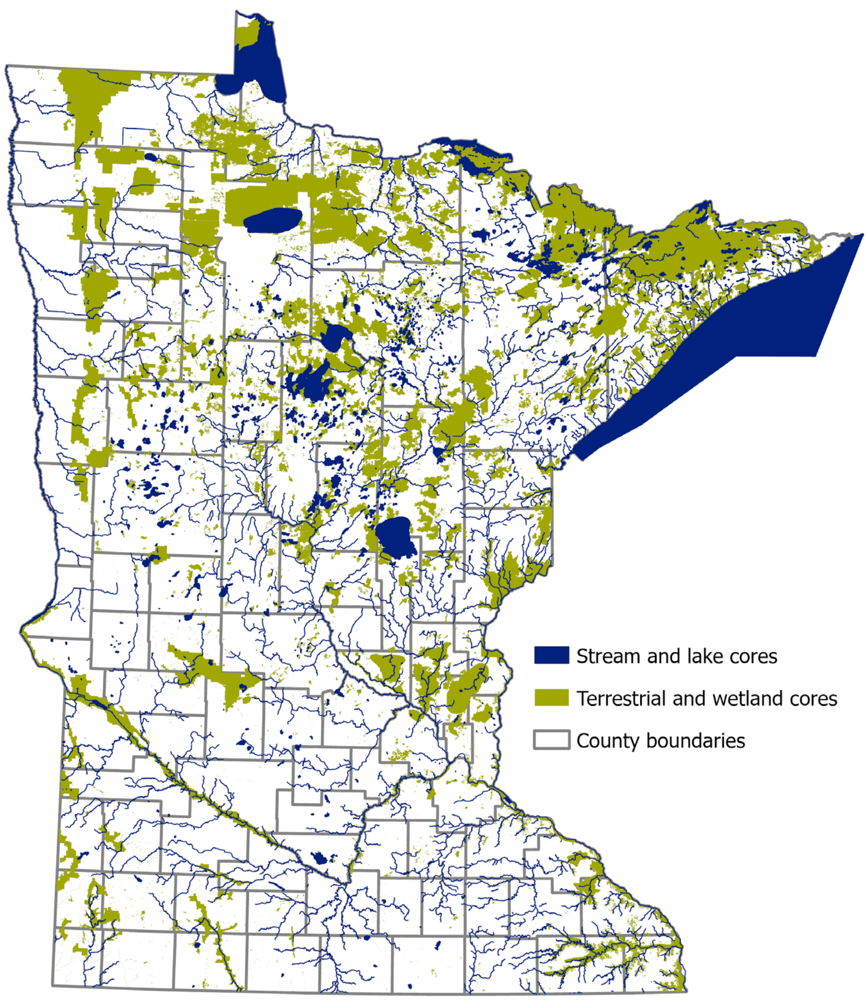

Figure 6.1. Core areas of the CAN depicting streams and lakes (blue) and terrestrial habitat and wetlands (gold).

Connectivity

To address connectivity, we utilized separate prairie and forest connectivity maps recently created for Minnesota's, and adjacent states and provinces, landscapes by ecologists in The Nature Conservancy's North America Science team who employed a wall-to-wall Circuitscape model (Pelletier et al., 2014). These structural connectivity maps describe relative differences in how the spatial pattern of prairies and forests may support or constrain generalized animal movement and ecological processes. The methods used to create these maps follow methods described in previous work by TNC for the entire U.S. (Anderson et al. 2023), however in that work all ecosystem types were combined in a "naturalness" measure.

Circuitscape models use the mathematics of electrical circuit theory to describe how heterogeneity in land use and other factors can influence where movement is most likely, and where movement is constrained (McRae et al. 2008). The model is applied to a resistance surface comprised of landscape features, with each feature weighted by its relative resistance to movement (Dickson et al., 2019; Shah & McRae, 2008). Rather than tracking electrons, the model tracks paths of "random walkers" traveling across this resistance surface, producing a cumulative "current flow" output. In a uniform landscape, current flow spreads out evenly, but in heterogeneous landscapes this even flow pattern is disrupted as the walkers avoid areas of higher resistance and concentrate in contiguous areas with lower resistances. This pattern of variation in amount of flow in each pixel, and in diffusion and concentration, can then be used to help understand how conditions on the landscape impact species movement and the flow of ecological processes.

To update the resistance surfaces described in Anderson et al. (2023), the TNC team integrated the most up to date landcover data from the National Land Cover Database (NLCD), and then developed separate resistance weighting schemes for prairies and forest systems. Both schemes retain the same weights for roads and development, but treat either forests or prairies as lowest resistance depending on the focal system, and then reflect expert user input on how other land cover types should be weighted relative to the focal system (Table 6.2).

When the Circuitscape model is run, each cell receives a quantitative score reflecting the amount of "current" accumulated in the cell as a function of its location, context, resistance, and direction of flow. The wall-to-wall continuous grid output from Circuitscape was classified into three main flow types. Diffuse flow represents areas that are extremely intact and consequently facilitate high levels of dispersed flow that spreads out to follow many different and alternative pathways. Concentrated flow represents areas where large quantities of flow are concentrated through a narrow area. Constrained flow represents areas where little flow gets through and is consequently deflected around these features. To describe important connectivity areas at the state level, we focus on two patterns that can be categorized from the continuous current flow outputs. Areas that had high flow and a high standard deviation across neighboring pixels represent "concentrated flow", a pattern that highlights places where movement potential is predicted to be especially high due to constraints in nearby locations. Our maps also highlight areas with high to moderate flow and low standard deviations. These "diffuse" areas indicate the most intact regions, where movement processes are well supported (multiple potential movement pathways).

For both forest and prairie connectivity, areas of high diffuse or high concentrated flow were included in the CAN (Figure 6.2). The forest and prairie connectivity maps indicate areas likely to facilitate the movement of plants and animals in response to a changing climate and other stressors.

Table 6.2. Resistance values used for connectivity runs using Circuitscape for the forest and grassland models. Lower values correspond to lower resistance.

Landuse	Resistance Value in Forest Model	Resistance Value in Grassland Model
Forests	1	Not included
Woody wetlands	1.5	5
Natural Barrens	3	3
Herbaceous wetlands	6	2
Shrub/Scrub	5	5
Undisturbed prairie/grasslands	Not included	1
Grassland/Herbaceous	6	2
Pasture/Hay	8	2
Cultivated Crop	9	7
Low and Medium Density Development	10	10
Residential Roads	10	10
High Density Development	20	20
Primary and Secondary Roads	20	20

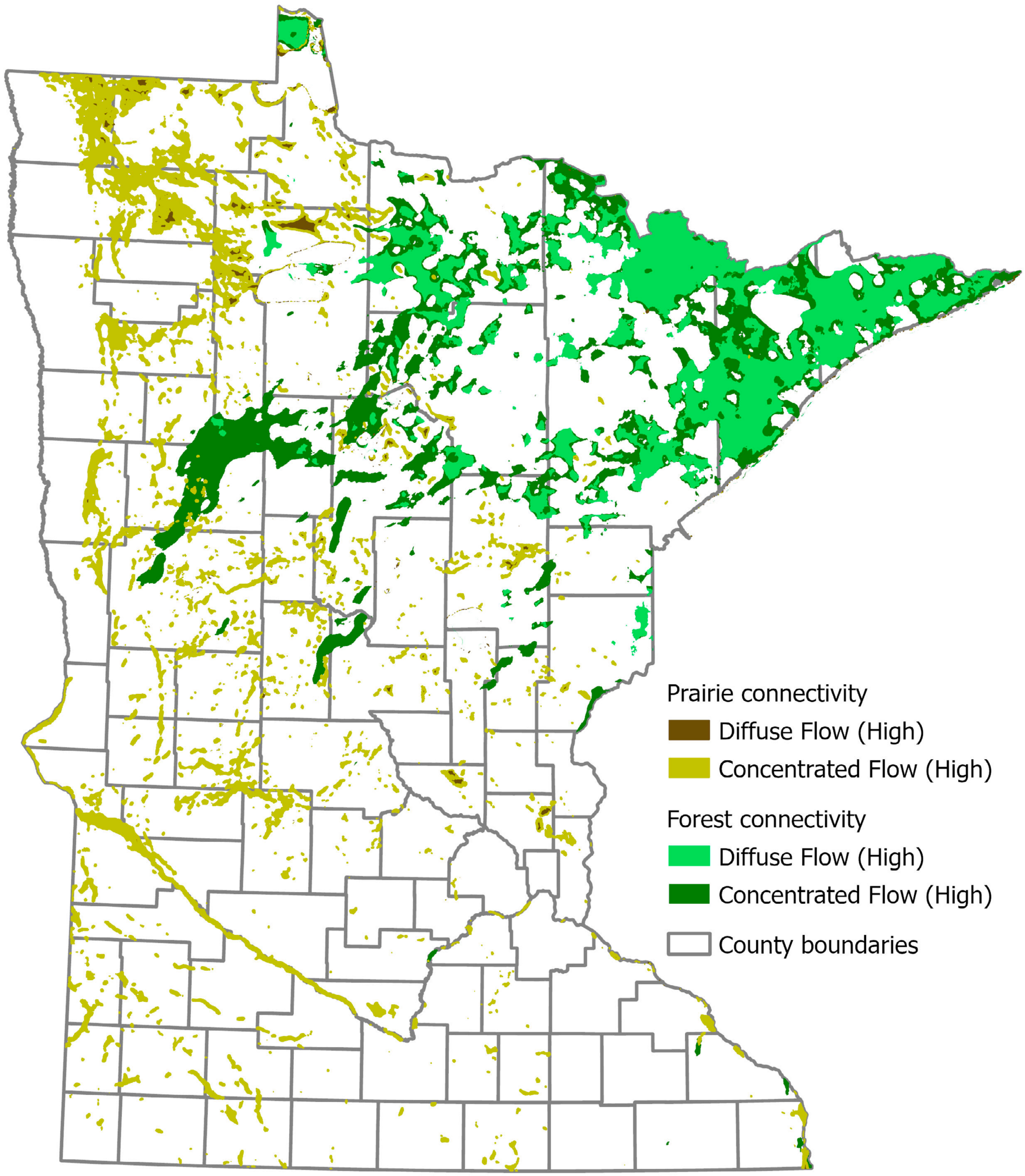

Figure 6.2. Prairie or open habitat (gold/brown) and forest (green) areas of connectivity.

Scoring the Conservation Action Network

The final step scored the core and connectivity layers to provide greater prioritization within the network. Scoring employed five layers, selected for balance across the scales and types of habitats: 1) SGCN richness; 2) Endangered and Threatened species richness (and including species with s-ranks of S1 and S2); 3) Lake health or biological significance; 4) Stream Indices of Biotic Integrity; and 5) Sites of Biodiversity Significance (Table 6.3 and Figures 6.3-6.7).

We used Jenks natural breaks to classify the number of species into five categories for the SGCN richness and Endangered and Threatened species richness layers. The Jenks natural breaks classification method is a data clustering method designed to determine the best arrangement of values into different classes. This is done by seeking to minimize each class's average deviation from the class mean, while maximizing each class's deviation from the means of the other classes. In other words, the method seeks to reduce the variance within classes and maximize the variance between classes (Jenks, 1967).

These five scoring layers were combined into a single scoring layer where the individual layer scores were first summed together and then normalized so the overall score ranged between 0 and 1. This combined scoring layer was then used to separately score 1) the terrestrial habitats (including wetlands), 2) the aquatic habitats (lakes and streams), 3) the prairie connectivity layer and 4) the forest connectivity layer. These scored layers were overlayed to create the final scored Conservation Action Network (Figure 6.8).

Table 6.3. GIS layers used to score habitat cores and connectivity in the Conservation Action Network.

Layer	Scoring Parameters
Species in Greatest Conservation Need (SGCN) Richness Grids	Number of SGCN species using Jenks natural breaks: 0 = 0, 1-2 =.1, 3-7 = .3, 8-14 = .6, 15-24 = .8, 25-48 = 1
Endangered, Threatened Species (and including species with s-ranks of S1 and S2) Richness Grids	Number of species using Jenks natural breaks: 0=0, 1-2 =.1, 3-5 =.3, 6-10 =.6, 11-16 =.8, 17-21 =1
Lakes a. WHAF Lake Health Score (LHS) b. Lakes of Biological Significance	Combine a. & b. below, using b. where a. was not available. a. Lake Health Score/100 (minimum value 0.45); b. Lakes of biological significance where Outstanding = 0.8, High = 0.6
Stream Indices of Biological Integrity (IBI)	[Max WID Fish IBI or Invert IBI score]/100
Sites of Biodiversity Significance	Outstanding = 0.8, High = 0.6, Medium = 0.4

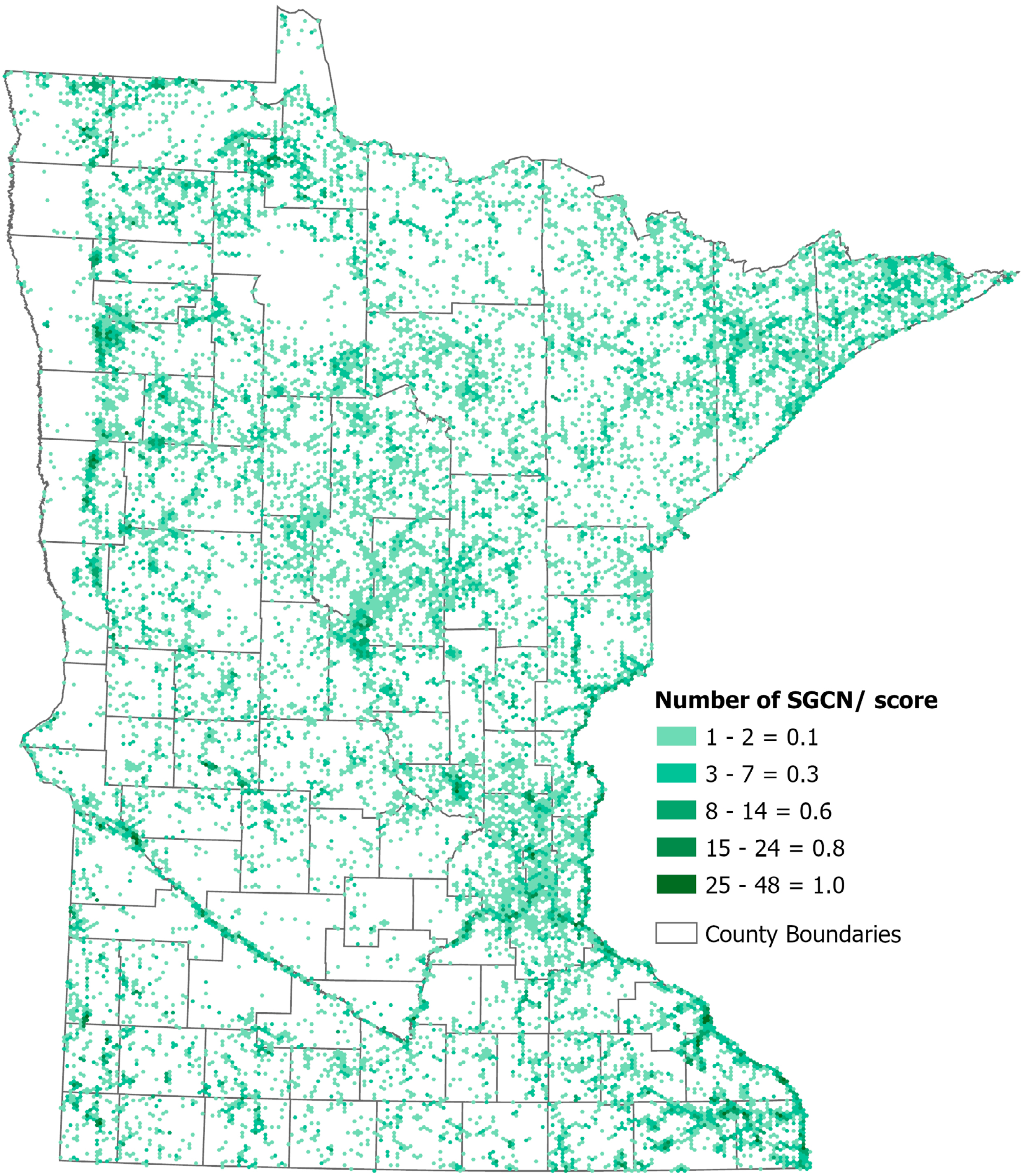

Figure 6.3. Number of all SGCN records summed within 2 km^2 hexagons and scored using Jenks natural breaks.

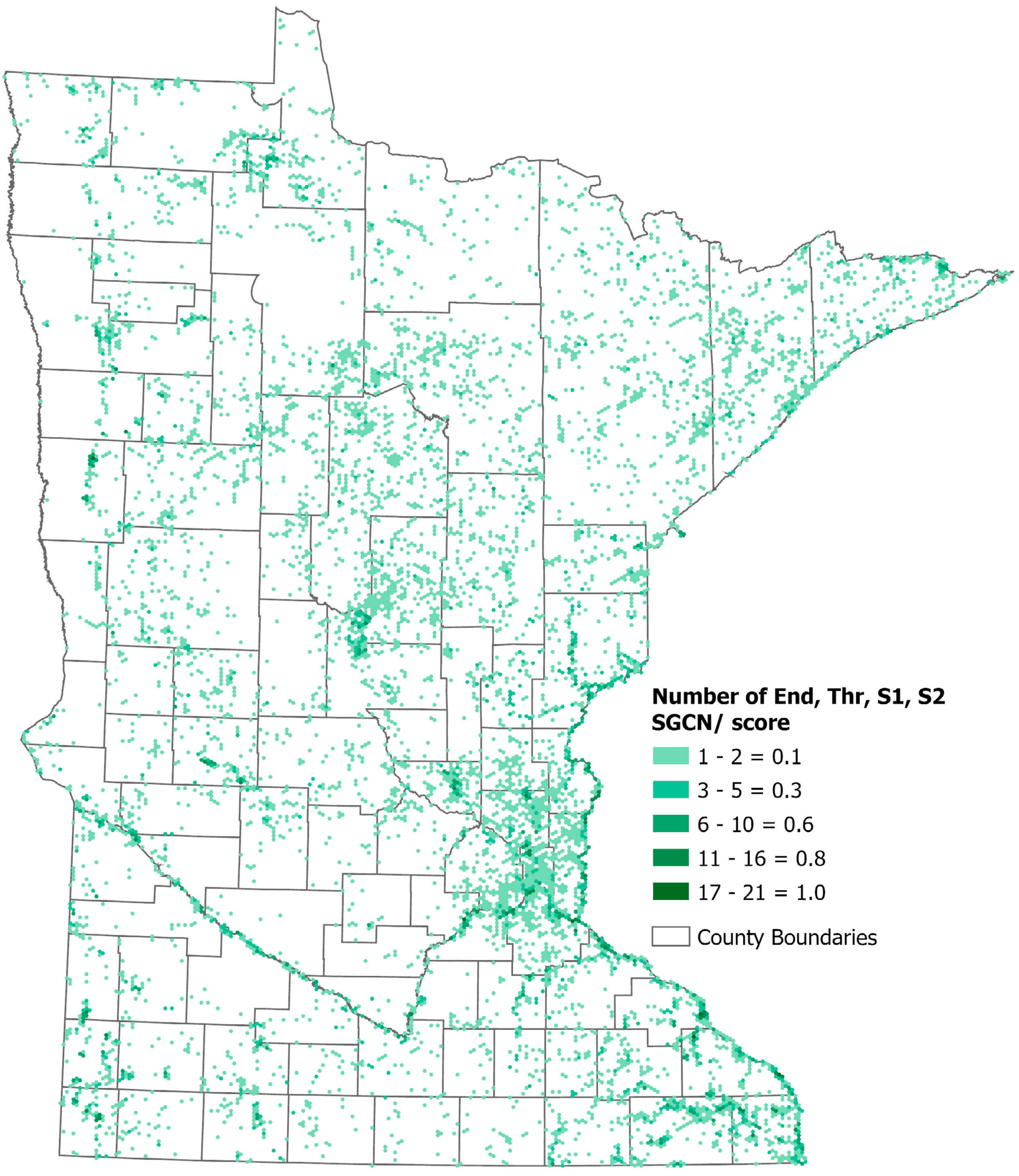

Figure 6.4. Number of Endangered and Threatened SGCN records (and including species with s-ranks of S1 and S2) summed within 2 km^2 hexagons and scored using Jenks natural breaks.

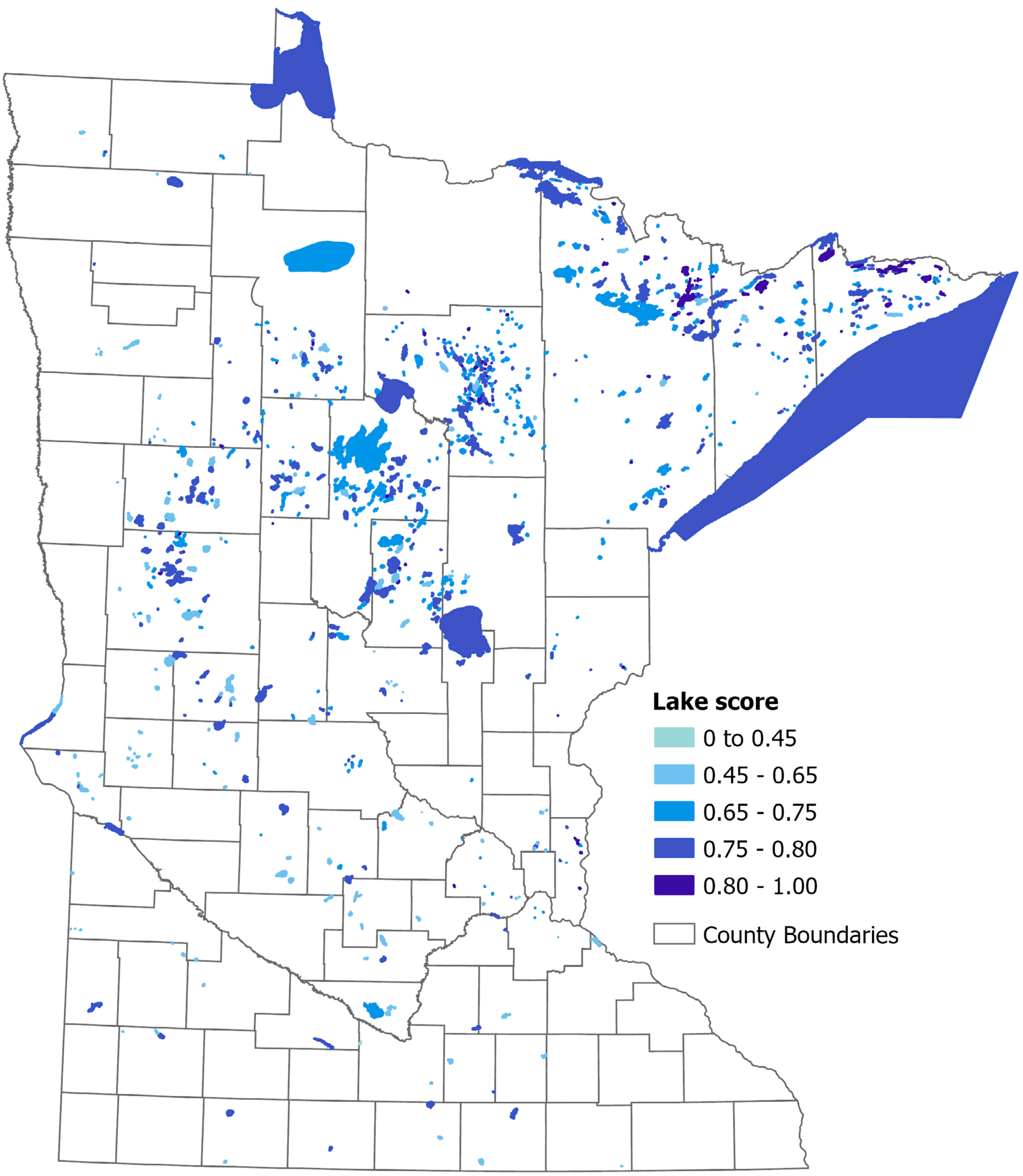

Figure 6.5. Lake scores based on Watershed Health Assessment Framework (WHAF) Lake Health Scores and Lakes of Biological Significance rankings where Lake Health Scores were not available. The area in NE Minnesota delineating part of Lake Superior represents Minnesota's managed portion of the lake.

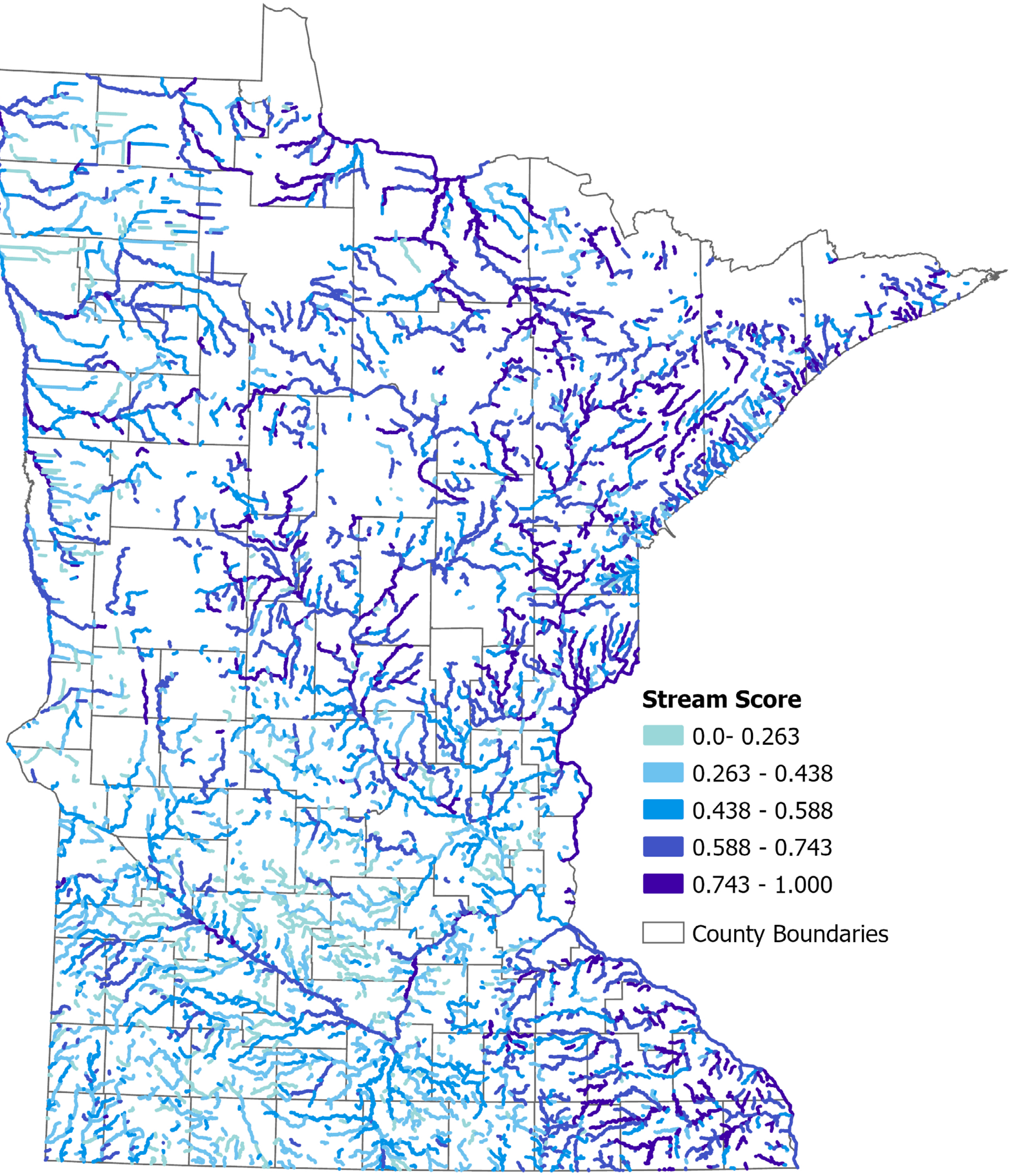

Figure 6.6. Stream score from the maximum fish or invertebrate IBI value by stream segment (WID) normalized to a range between 0 and 1.

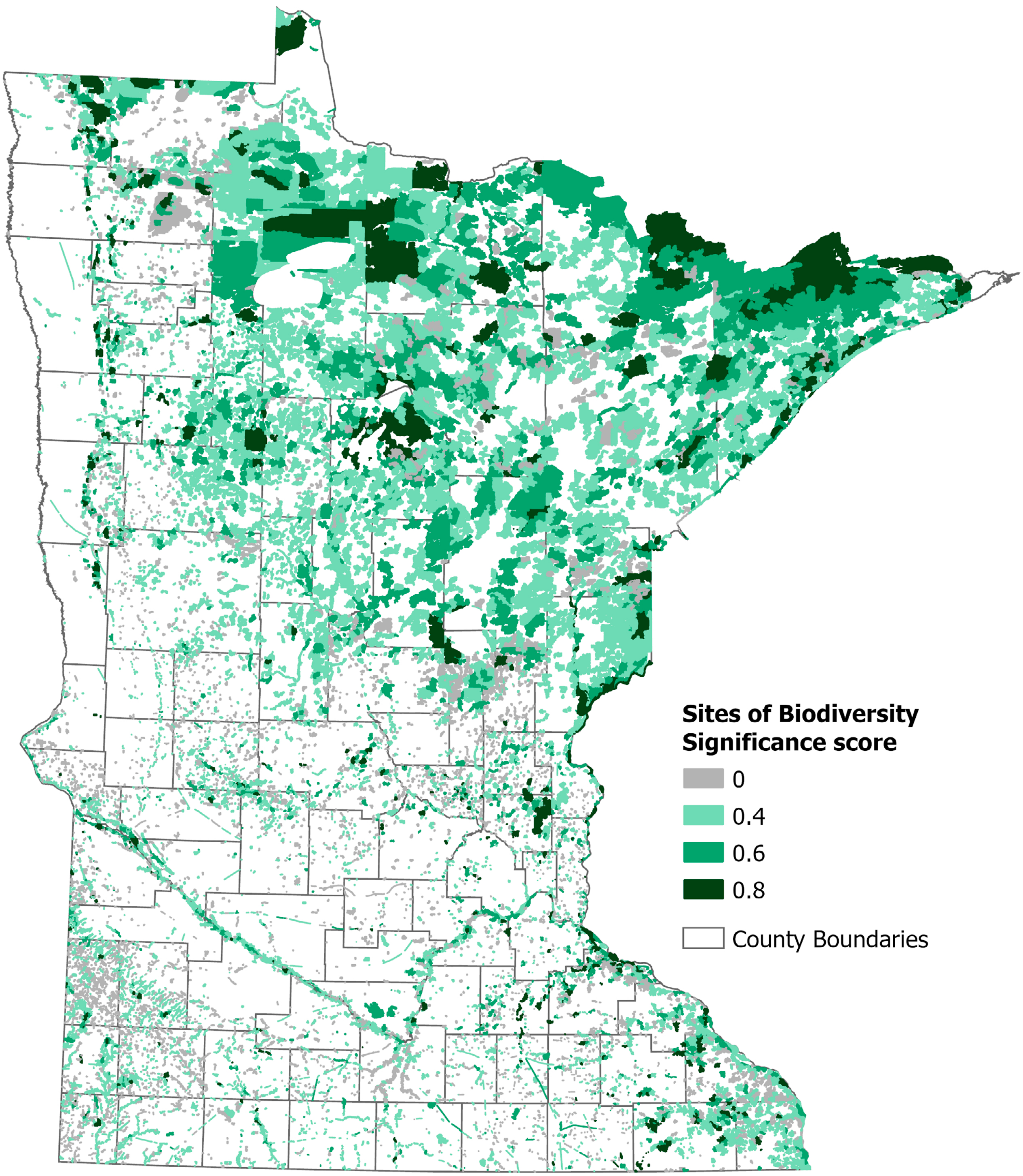

Figure 6.7. Sites of Biodiversity Significance scoring layer, with Below (gray) = 0, Medium (mint green) = 0.4, High (green) = 0.6, and Outstanding (dark green) = 0.8.

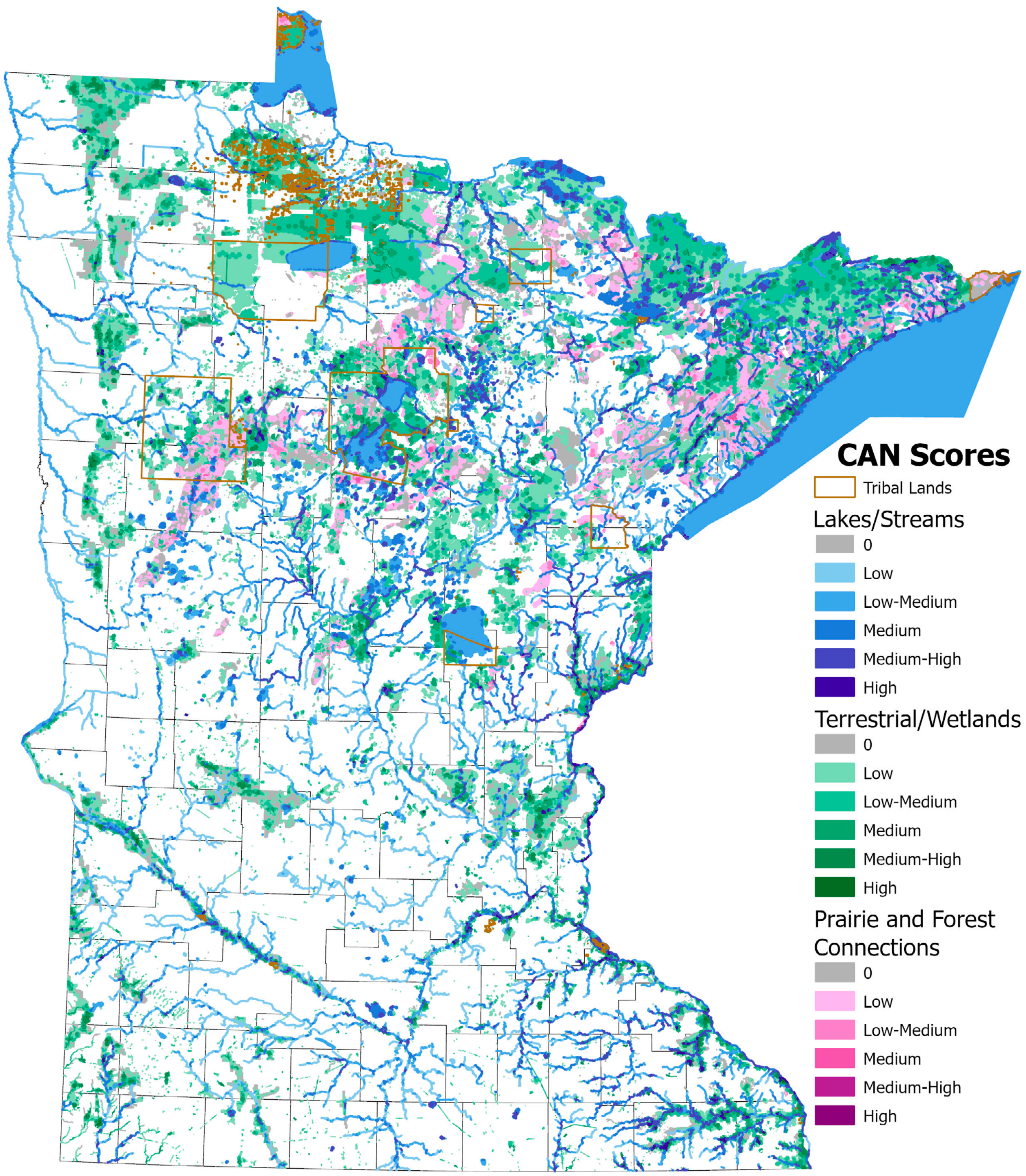

Figure 6.8. The scored Conservation Action Network (CAN), depicting terrestrial and wetland cores, lake and stream cores and connectivity for forests and prairies. Scores were applied using 5 factors.

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Supplemental Material - Additional Detailed Methods for Developing the Conservation Action Network

GIS data layers used for the CAN cores

Species scale

Five GIS data layers were used to represent the species scale, one focused on all SGCN species (Richness hotspots) with the other four focused on the state and federal endangered and threatened species (High Quality Element Occurrences of Endangered and Threatened Plants, Mapped Endangered and Threatened Animal Populations, Federal Critical Habitat designations, and Bat maternity roost and hibernacula restriction buffers). Habitat from each of these layers was included in the CAN.

Species in Greatest Conservation Need (SGCN) Richness Hotspots

The SGCN richness hotspot analysis is a revision of the 2015 layer using new and additional data with three modifications:

1. We used a grid of 2 km^2 hexagons to sum the number of Species in Greatest Conservation Need (SGCN). The 2015 analysis used a grid of 2.5-km-by-2.5 km (6.25 km^2) square blocks.
2. We changed the hotspot selection rules to have smaller cut-off values to account for the smaller area of the 2 km^2 hexagons.
3. The number of SGCN increased to 1142 species in the 2025 SWAP, compared to 346 in 2015.

The first step in the process was to create a grid of 2 km2 hexagons across the entire state of Minnesota, followed by intersecting the SGCN observation points with the hexagon grid. SGCN observation data were from multiple data sources (Table 6.4) and comprised 85,782 records having a maximum locational uncertainty of 0.62 miles (1000 meters). These records represented 888 (or 75%) of the 1142 SGCN species. SGCN species not represented were mostly because locational uncertainty was not available or exceeded the 0.062 mi cut-off (generally species with very few, older records). Following the intersection of hexagons with SGCN observation records, the number of species were summed within each hexagon and then the 2025 selection rules were applied to identify SGCN richness hotspots (Figure 6.9).

2025 hotspot selection rules using 1.24 mi^2 (2 $kilometer^2$) hexagons:

1. A single hexagon comprising 10 or more species, or
2. A cluster of at least four contiguous hexagons each comprising four or more species, or
3. A cluster of at least six contiguous hexagons each comprising two or more species; cluster must contain hotspot already defined in 1 or 2 above

The SGCN richness hotspots were intersected with the Minnesota’s 2025-2035 Wildlife Action Plan Habitat Layer (see Chapter 3, Habitat Map Methods) to remove non-habitat areas (development and agriculture) within the hexagons (Figure 6.10). This resulted in some areas, especially within the Twin Cities metropolitan area, with little natural habitat represented in the hotspots (Figure 6.11). Some observation records dated back to 1979 and habitat in these locations may have since been converted to agriculture or developed. Also, some SGCN records are in residential areas (such as rusty patched bumblebee). While residential habitat can be important for certain SGCN species, it was not mapped as a habitat given our inability to discern locations of suitable residential habitat (e.g. native plantings) from the landcover map.

Table 6.4. Datasets used for SGCN observation records to identify richness hotspots and to score the CAN.

Dataset	Description
Natural Heritage Information System	Records of current federal and state listed species, and 2015 non-listed SGCN.
DNR releve database	Plant species occurrence data from 11,555 vegetation plots collected by the Minnesota Biological Survey Minnesota Department of Natural Resources throughout the State of Minnesota between 1986 and 2025.
Bell Museum Herbarium	Records of over 160,000 plant specimens collected throughout Minnesota's history.
MBS Aquatic Plants	Database containing aquatic plant records from approximately 2,000 of Minnesota's lakes.
Mayfly (Ephemeroptera) data	Minnesota mayfly records collected/curated by Luke Jacobus from Indiana University.
Stonefly (Plecoptera) data	Minnesota mayfly records collected/curated by Ed Dewalt from the University of Illinois.

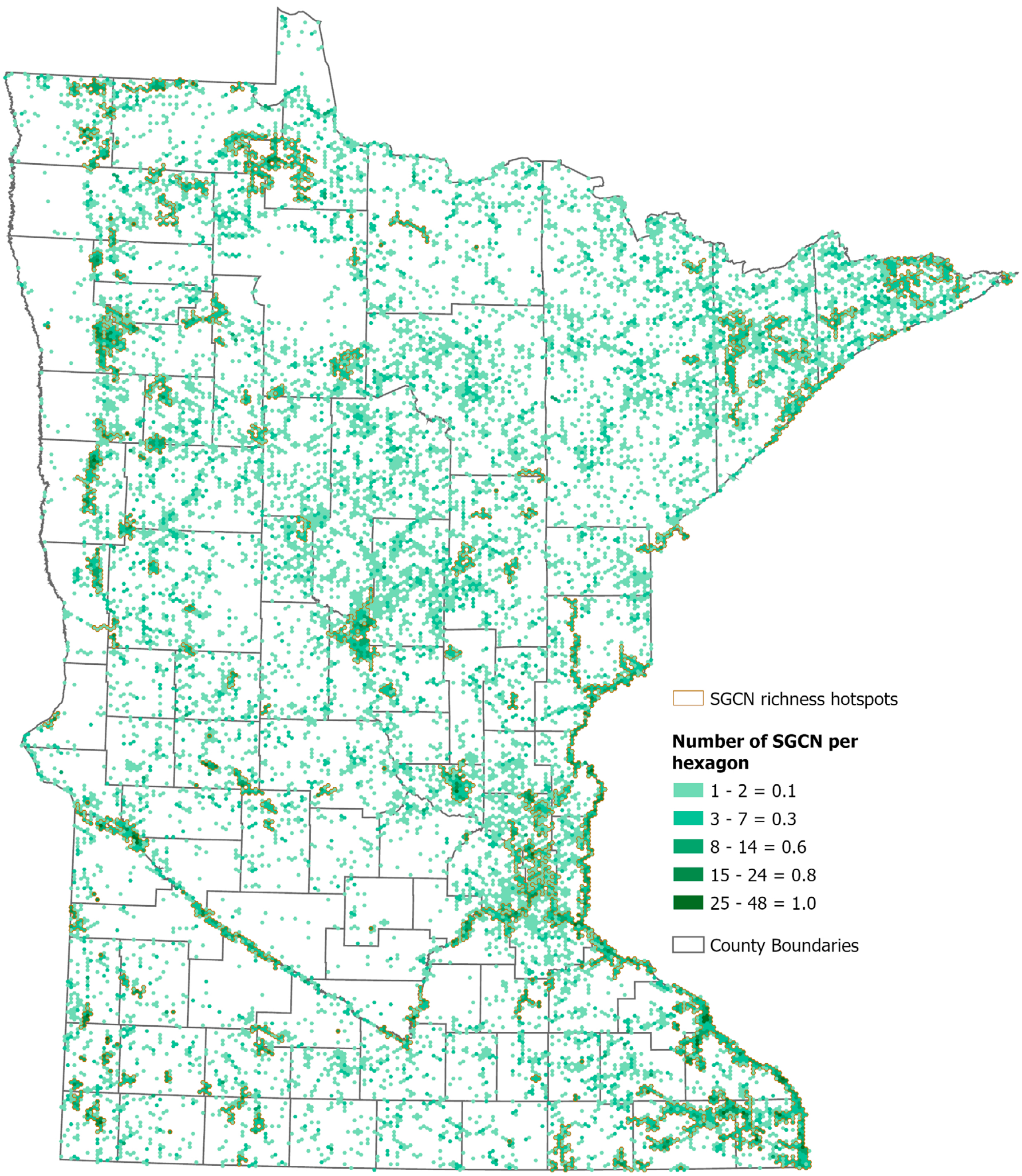

Figure 6.9. Distribution of Species of Greatest Conservation Need (SGCN) across Minnesota, shown by number of species per hexagon. Richness ranges from 1–2 species (light green) to 25–48 species (dark green). Outlined areas highlight SGCN richness hotspots.

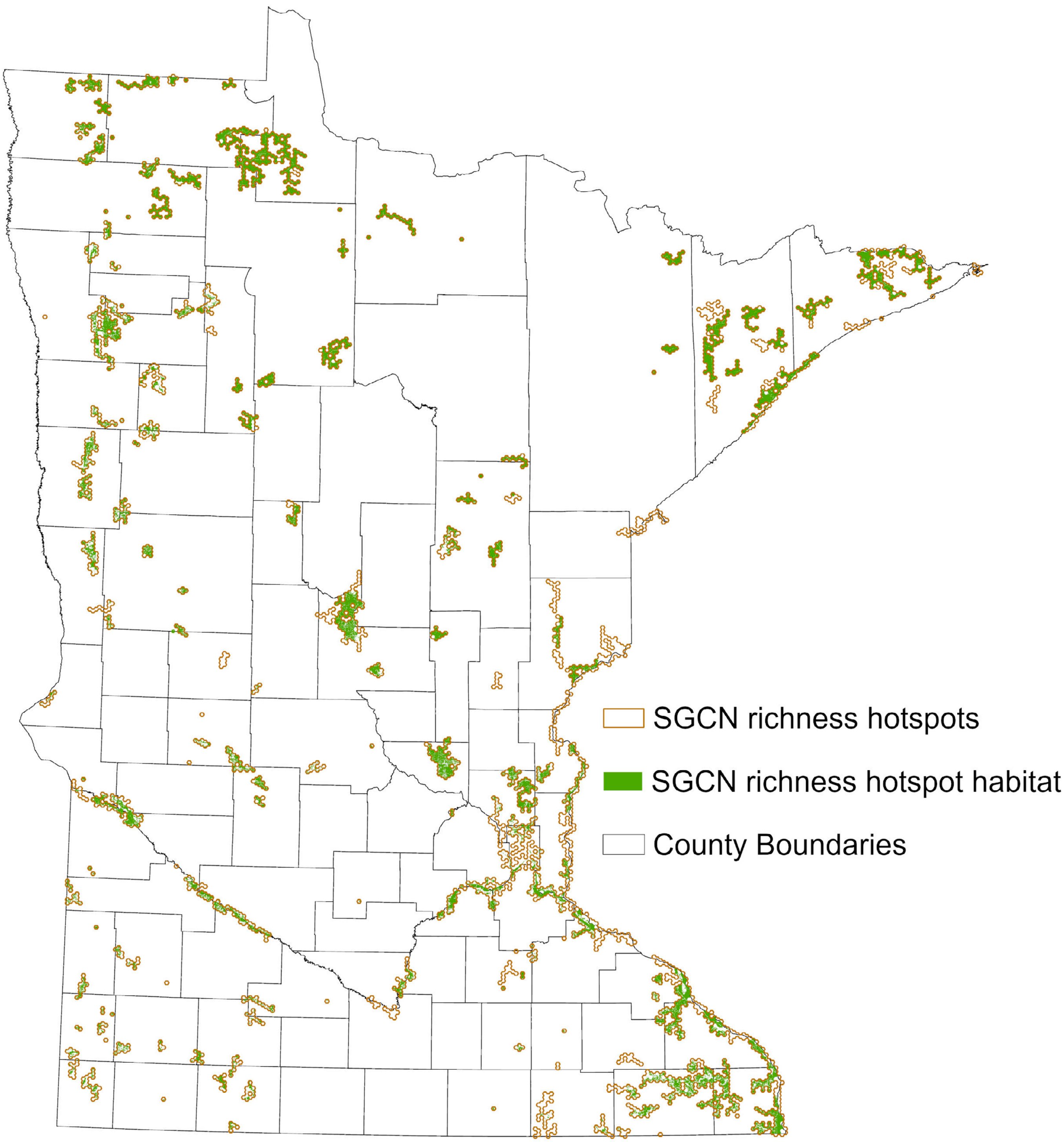

Figure 6.10. Distribution of SGCN richness hotspots across Minnesota. Outlined areas indicate hotspots, and green areas show the habitat within those hotspots.

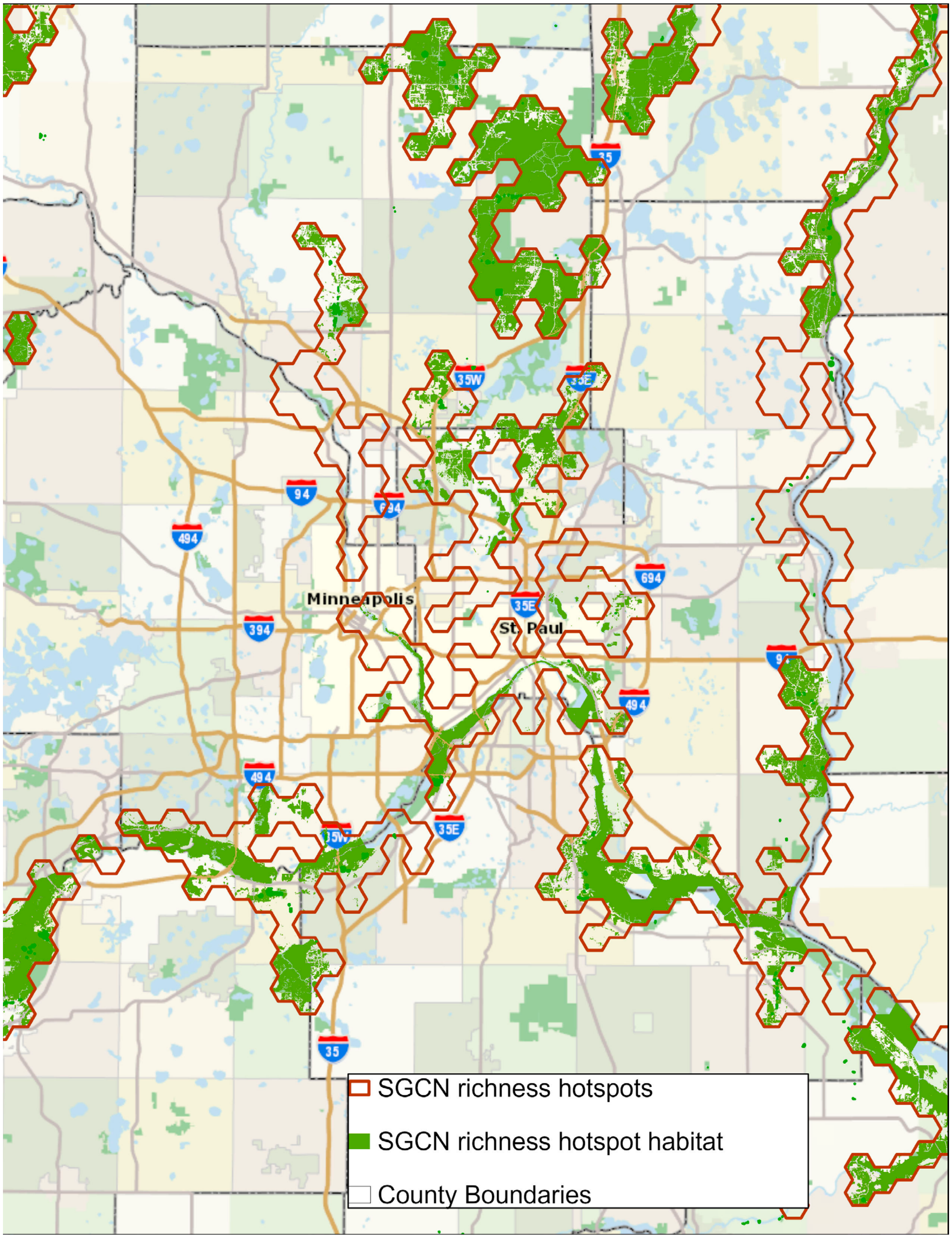

Figure 6.11. Hotspot hexagons (brown boundaries) in the Twin Cities Metropolitan area, showing remaining potential habitat (green polygons) within the mapped areas. Hotspot areas with no green habitat indicate that SGCN had been recorded there sometime in the past and are now developed or row crop agriculture. Some of this is due to records in residential areas (such as rusty patched bumblebee) and, while residential habitat is important for many species, it was not mapped as a CAN core habitat.

High Quality Element Occurrences of Endangered and Threatened Plants

Element occurrences (EOs) of federal or state endangered and threatened plants typically represent populations that, if conserved, can contribute to the survival or persistence of the element. Rankings represent the viability of the population where an A rank = excellent viability, B rank = good viability, C rank = fair viability, and D rank = poor viability. Plant species with an A, B, or C rank were selected from the NHIS dataset resulting in 1,134 plant EOs for use in the CAN core (Figure 6.12, NatureServe, DNR Natural Heritage Information System).

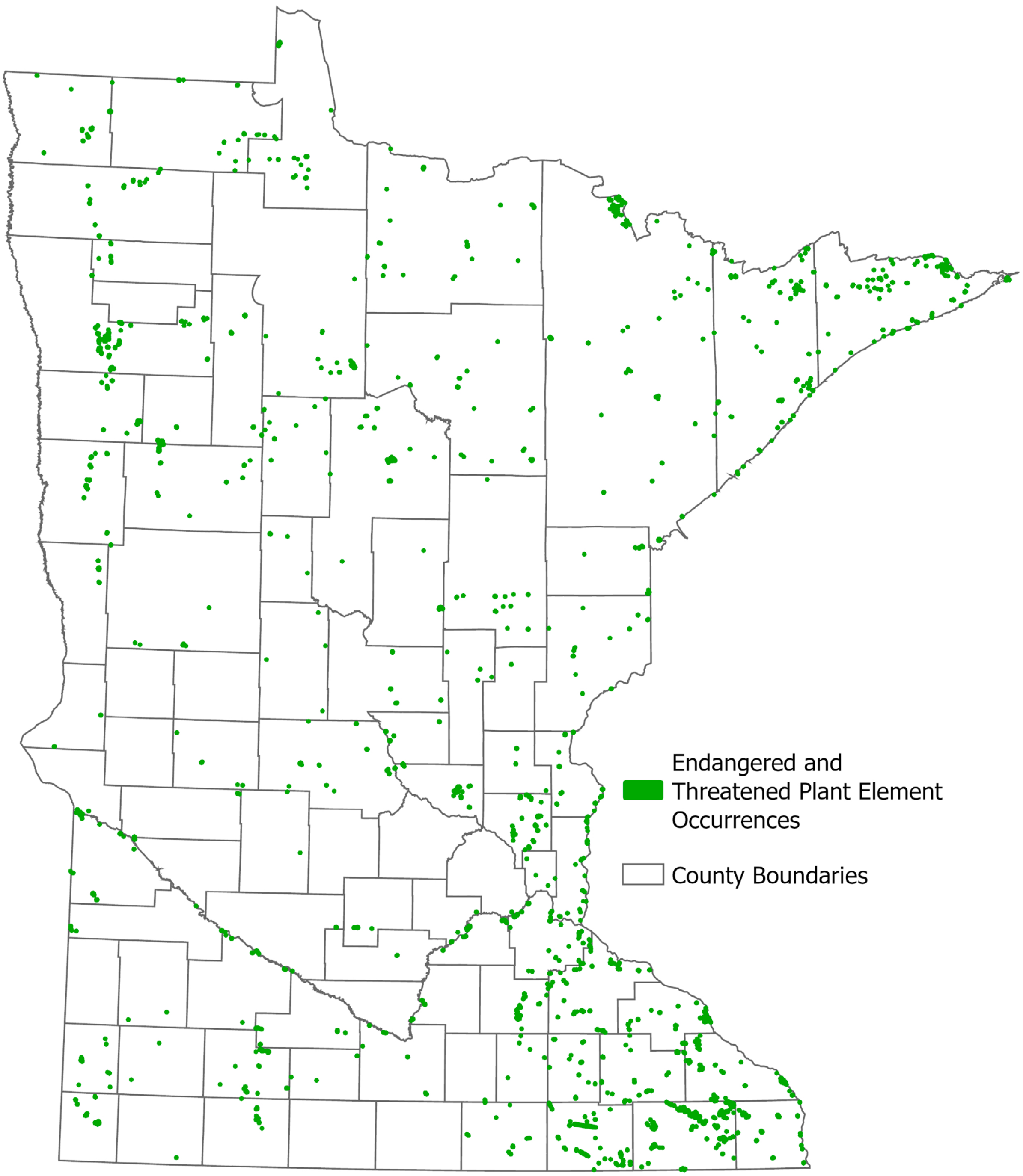

Figure 6.12. Federal or state endangered and threatened plant element occurrences (EO) with a rank of A, B, or C.

Mapped Endangered and Threatened Animal Populations

The mapped populations of federal and state endangered and threatened animal species were developed for the 2015 MNWAP using a series of taxa expert workshops (See Appendix E in the 2015 MNWAP). This was a time intensive effort which we were not able to replicate for the 2025 revision, and efforts to automate the process were unsatisfactory.

We determined that the mapped populations of endangered and threatened species remained relevant for the 2025 revision and included them as cores (Figure 6.13). Mapped populations of other SGCN, aka the 2015 Composite Population maps, were not used as there were numerous realized or potential changes since the 2015 version. These areas are largely represented by other layers used in the CAN.

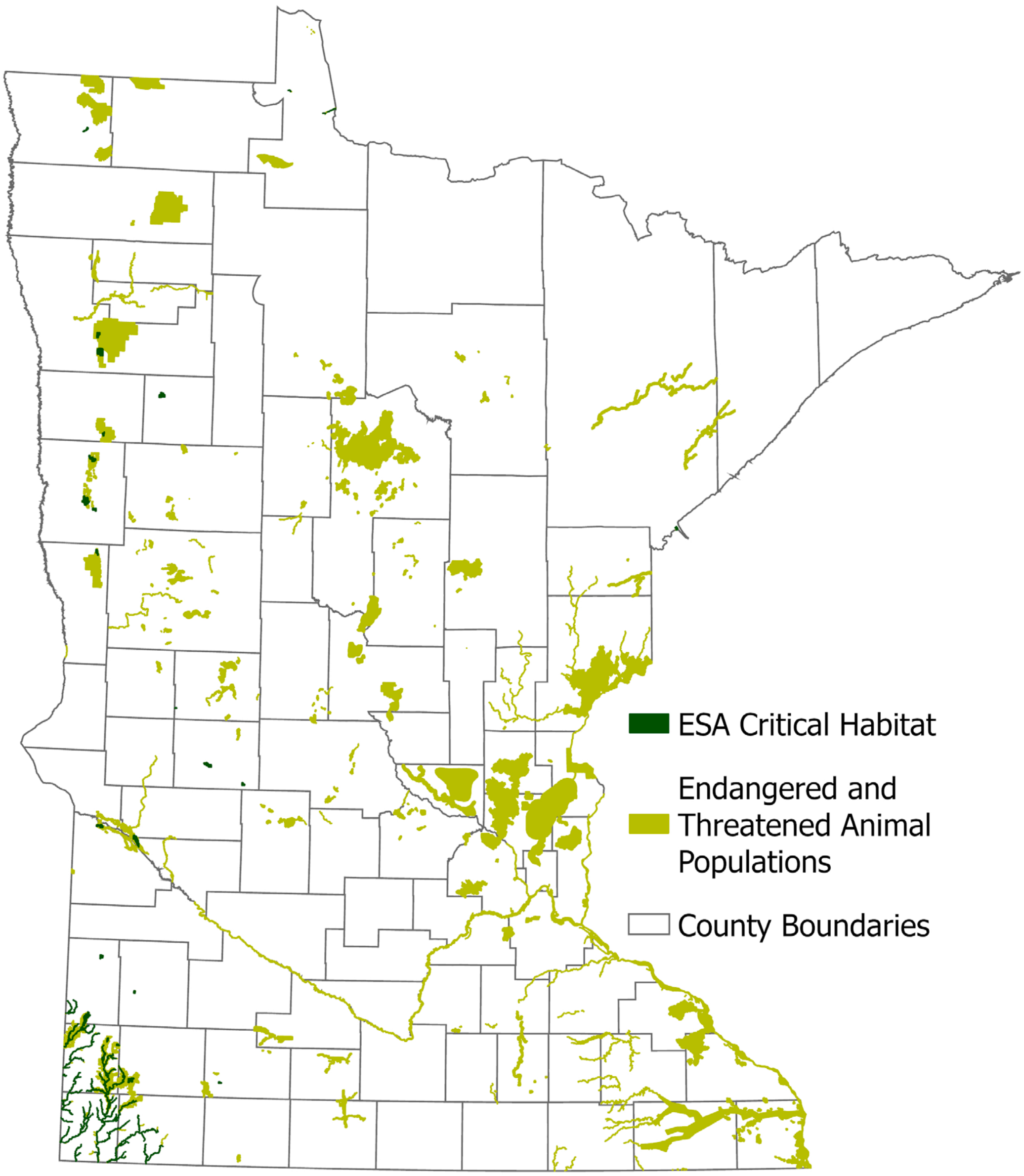

Figure 6.13. Federal or state endangered and threatened 2015 animal population map in orange and current ESA critical habitat designations in red. Critical habitat does not include Canada lynx or gray wolf as areas are too general for the prioritization mapping intent of the Conservation Action Network (CAN).

Federal Critical Habitat designations

We also included the current Federal Critical Habitat Designations for Dakota skipper (*Hesperia dacotae*), piping plover (*Charadrius melodus*), poweshiek skipperling (*Oarisma Poweshiek*) and topeka shiner (*Notropis topeka*) which have been updated since 2015 (Figure 6.13). We did not include critical habitat designations for Canada lynx (*Lynx canadensis)* or gray wolf (*Canis lupus*) as the areas designated are too general for the prioritization mapping intent of the CAN. We also chose to not include the range maps for Northern Long-Eared Bat (*Myotis septentrionalis*) and the tricolored bat (*Perimyotis subflavus*) for the same reason. Finally, proposed critical habitats for rusty patched bumble bee (*Bombus affinis*), salamander mussel (*Simpsonaias ambigua*), spectaclecase mussel (*Cumberlandia monodonta*), snuffbox mussel (Epioblasma triquetra) and sheepnose mussel (*Plethobasus cyphyus)* were delayed for inclusion until after critical habitat statuses are finalized.

Bat maternity roost and hibernacula restriction buffers

The MN DNR maintains an internal database of known hibernacula entrances and occupied maternity roost trees that are used by northern long-eared bat (Myotis septentrionalis), little brown bat (Myotis lucifugus) and tricolored bat (Perimyotis subflavus) with specified protection buffer distances of 150 feet for maternity roost trees, and 0.25 miles for hibernaculum restricting or limiting tree removal, road and trail maintenance and prescribed burns. There is an additional 2.5 miles buffer around hibernaculum with certain limitations for road and trail maintenance and development. For this mapping exercise, we chose the 150 ft and 2.5 mi. buffers for roost trees and hibernaculum. These data are used to implement the **Lakes States Forest Management Bat Habitat Conservation Plan**. Within these buffered areas, all forest habitat mapped in the Minnesota's 2025-2035 Wildlife Action Plan Habitat Layer were selected for inclusion in the CAN core. Map is not provided due to the sensitive nature of the data.

Habitat scale

Rare Native Plant Communities

All rare native plant communities, representing rare assemblages of plants in Minnesota (S1 and S2) regardless of condition rank, were included in the CAN core (Figure 6.14). Native plant communities are mapped by staff within the Minnesota Biological Survey (Minnesota DNR) using a combination of remote sensing and field verification. This layer includes prairies, wetlands, forests (Minnesota's Native Plant Communities).

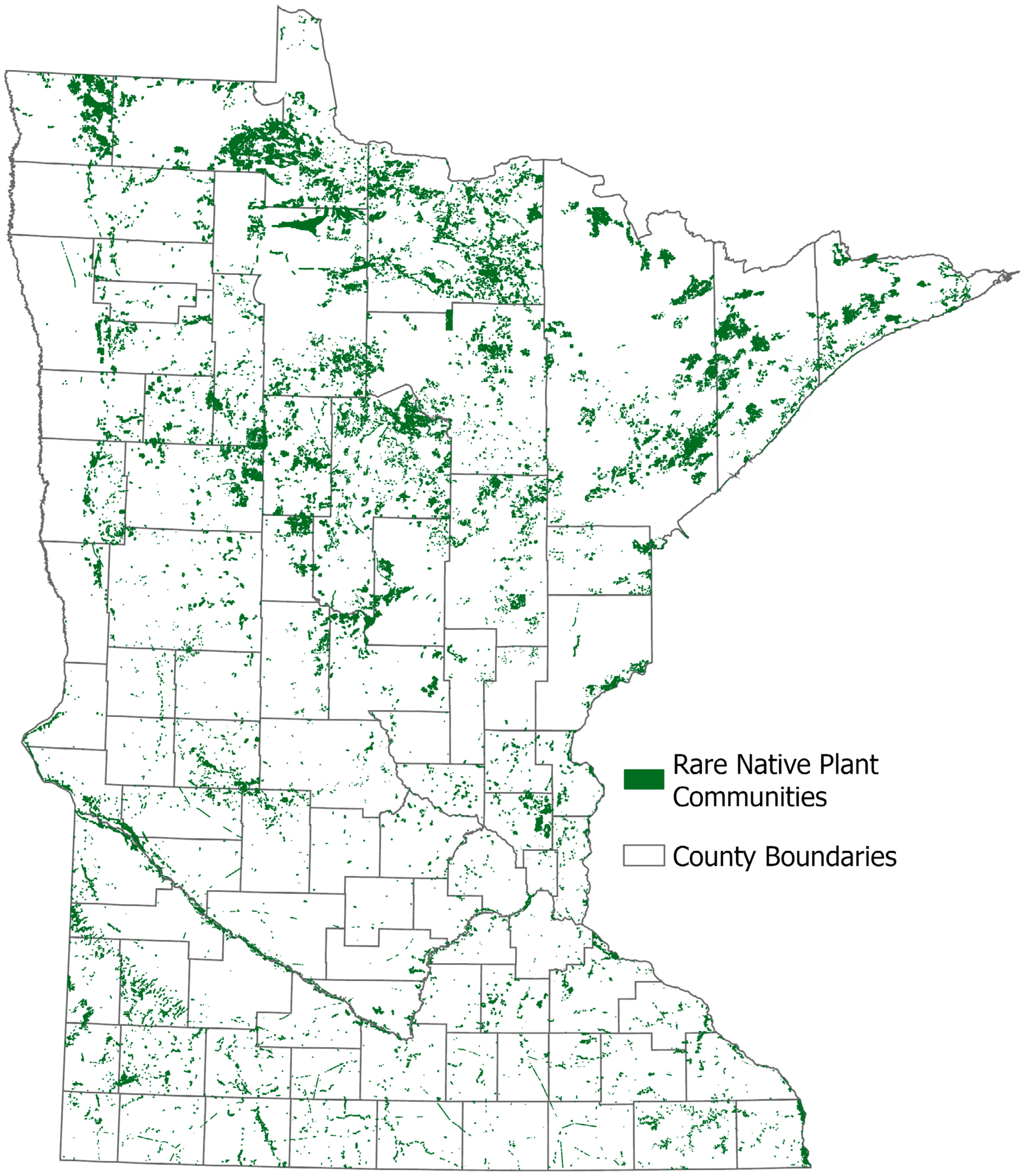

Figure 6.14. Rare Native Plant Communities defined as having a state conservation rank of S1 or S2.

High Quality Wetland Native Plant Communities

In addition to the rare wetlands selected in the previous data layer, this layer contains all wetland native plant communities (NPC) with a condition rank of A, B, or C (Figure 6.15). This included all NPCs in the Acid Peatland, Marsh, Open Rich Peatland, Wet Meadow/Carr, and Wetland Prairie systems of the MN DNR Native Plant Community Classification (Minnesota's Native Plant Communities).

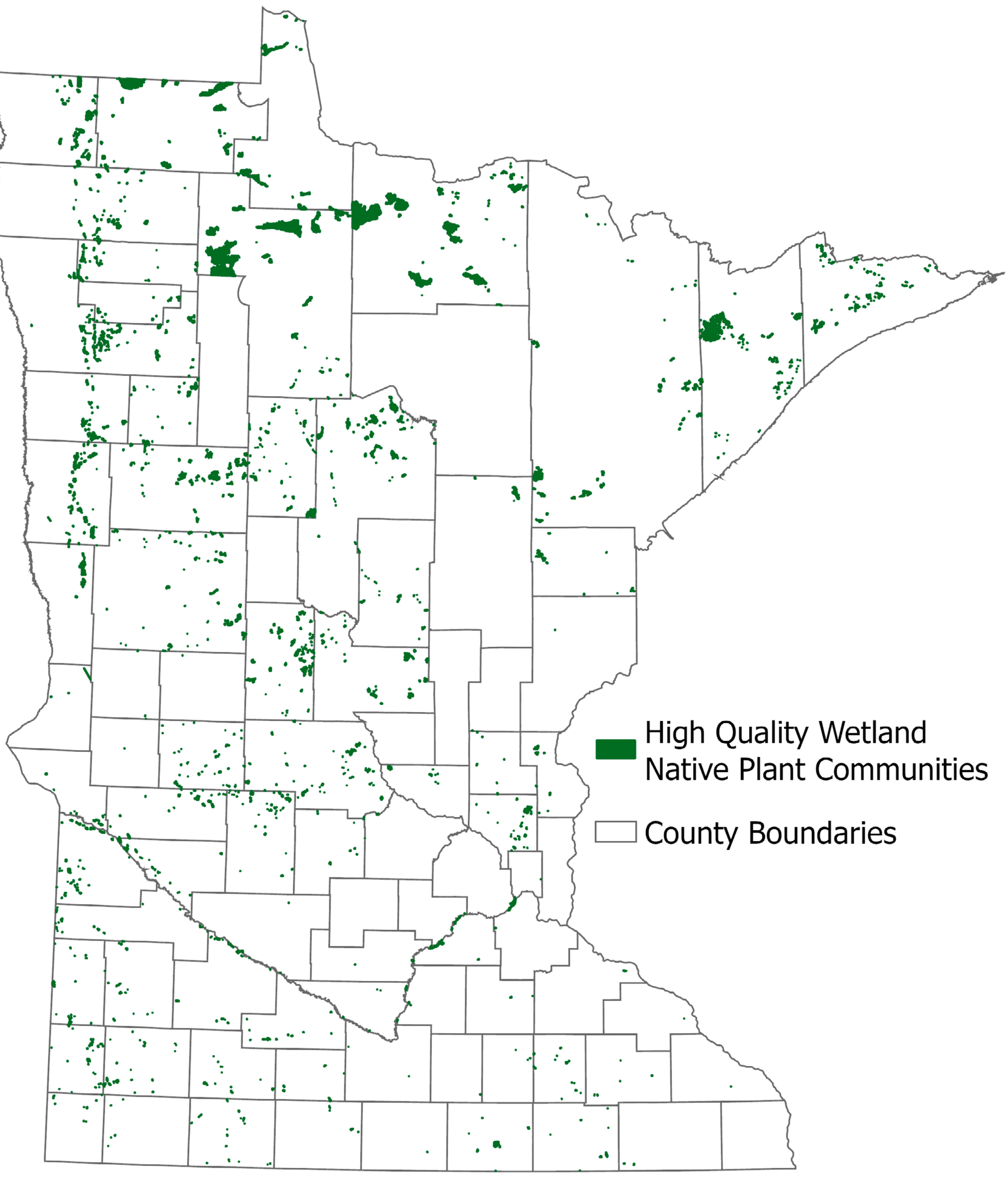

Figure 6.15. High Quality Wetland Native Plant Communities (NPCs), defined as having an NPC quality rank of A, B, or C.

Forest Management Opportunity Areas

Forest management opportunity areas are state forest lands with management emphasis to improve forest habitat for wildlife species. The following types were included: Landscape (LAND), Old Forest Management Complexes (OFMC), White Pine/Conifer Management Area (WPMA), Owl Management Area (OWMA), Large Block/Moose, Management Area (MMA), Open Landscape Management Area (OLMA), Forest Patch (PATCH), Deer Management Area (DMA), INT, Rotating older forest within the landscape Management Area (Pilot INT MOA), and Older upland forest adjacent to younger forest for Boreal owl habitat Management Area (Pilot UPLD MOA, Figure 6.16, [Forest Resource Management Planning]).

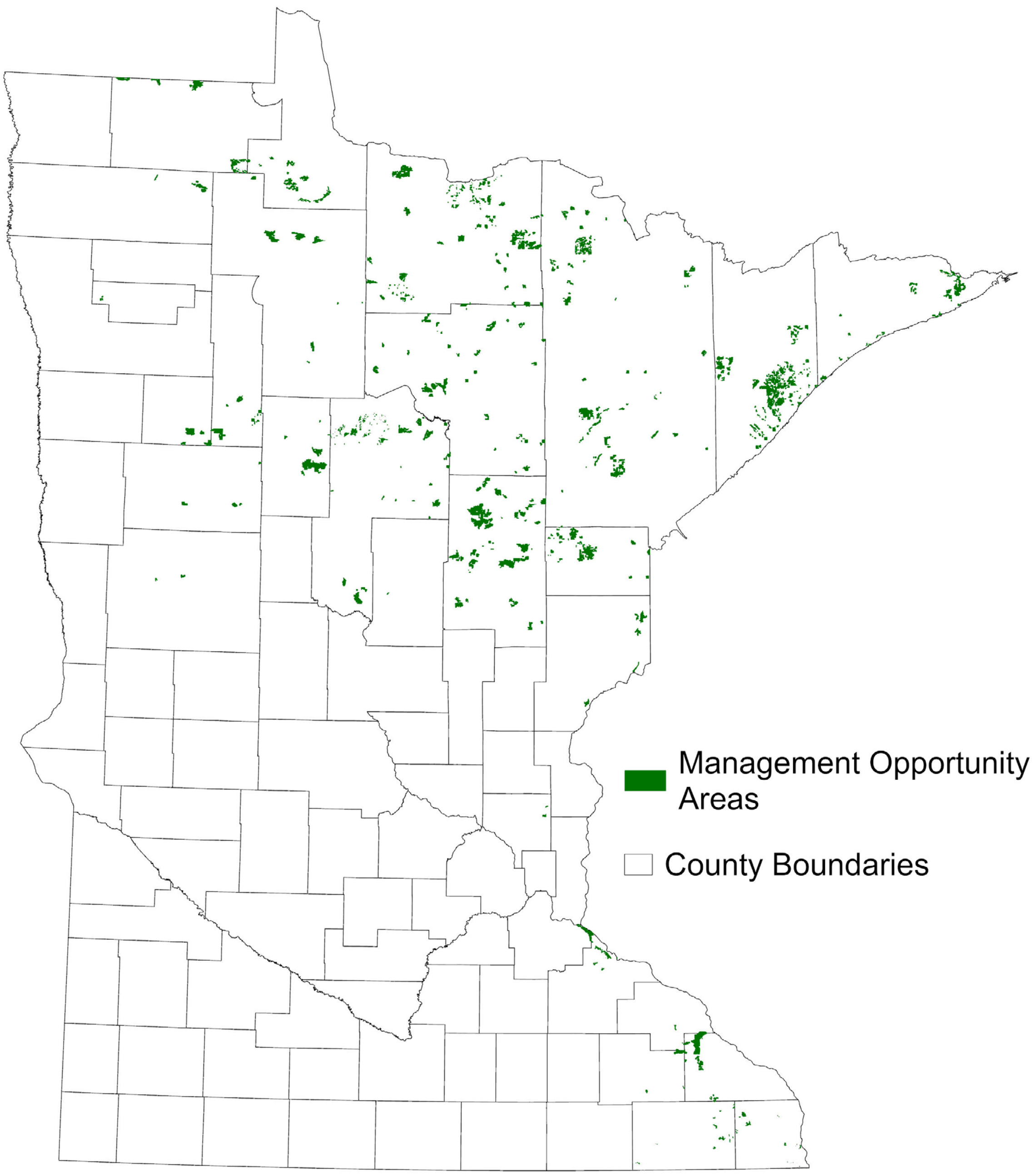

Figure 6.16. DNR forest management opportunity areas.

Significant Forests

Three data layers are included in this group as described below. These layers represent Minnesota DNR forest land that have a focus on unique, rare, or representative characteristics that can provide habitat for certain SGCN (Figure 6.17). The layers are:

1. DNR Forest Inventory Old Growth (currently designated or candidate old growth forest stands) and Old Growth Special Management Zone (SMZ) - a 330-foot buffer around the Old Growth stand on lands administered by the DNR (Old growth forests).

2. Forest Representative Sample Areas (RSAs) are ecologically viable representative samples of forest types on lands administered by the DNR designated to serve one or more of three purposes: to establish and/or maintain an ecological reference condition; or to create or maintain an under-represented ecological condition; or to serve as a set of protected areas or refugia for species, communities and community types not captured in other criteria of this Standard.

3. High Conservation Value Forests (HCVF) are Forest areas administered by the DNR having outstanding biological or cultural significance as defined by The Forest Stewardship Council® (FSC, High conservation value forests). As part of maintaining FSC forest certification, the FSC states: "Management activities in high conservation value forests shall maintain or enhance the attributes which define such forests. Decisions regarding high conservation value forests shall always be considered in the context of a precautionary approach."

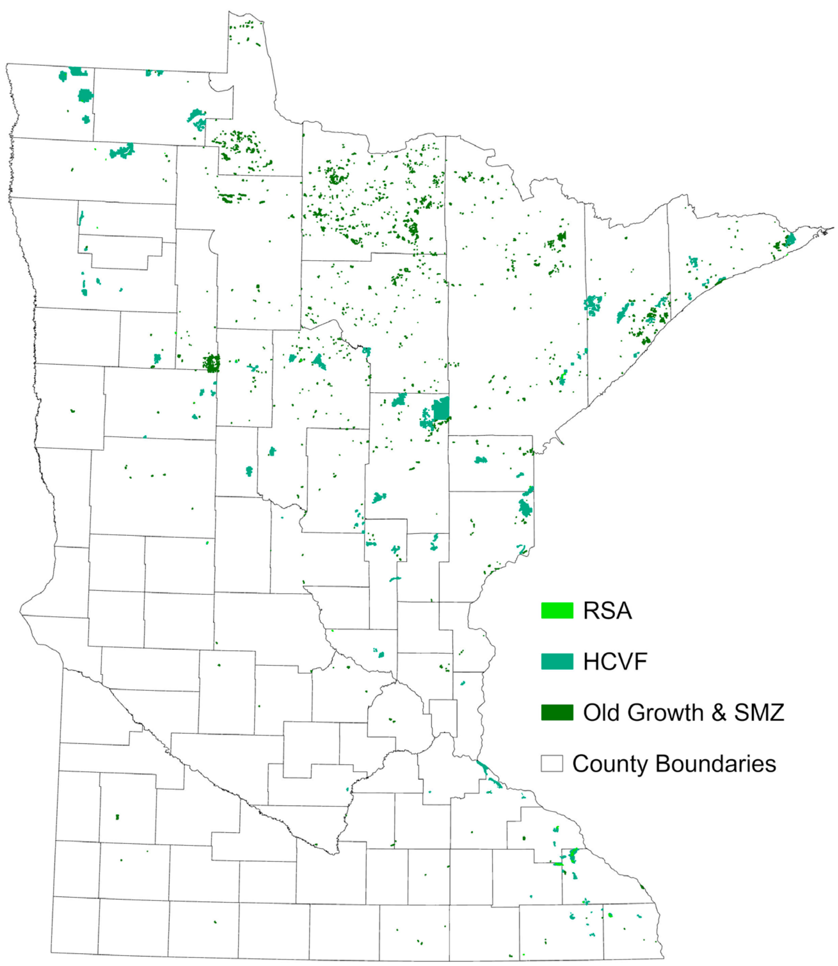

Figure 6.17. Significant Forests, including Minnesota DNR Forest Representative Sample Areas (RSA), High Conservation Value Forests (HCVF) and forest old growth and special management zones (SMZ).

Significant Lakes

Lakes were selected with high Lake Health scores in the Watershed Health Assessment Framework (WHAF) and Lakes with high bird rankings identified in the Lakes of Biological Significance layer. First, we utilized lake health scores developed as part of the Watershed Health Assessment Framework (WHAF, [Watershed Health Assessment Framework: Lakes]). Lakes were selected that met either an overall lake health score of 75 or greater or lakes with a biology component score of 70 or greater. The lake health score was made up of 3 component scores: water quality, biology and hydrology to come up with an overall score ranging from 0 to 100. Given the biodiversity focus of the CAN, we included lakes with high biology scores even though they were below the 75 overall health score threshold.

Another lake evaluation layer, Lakes of Biological Significance, was used to identify additional lakes having significant SGCN bird populations given that the WHAF Lake Health Score biology component score did not include bird communities ([Lakes of Biological Significance]). Lakes selected from these two assessments were combined for inclusion into the CAN core (Figure 6.18).

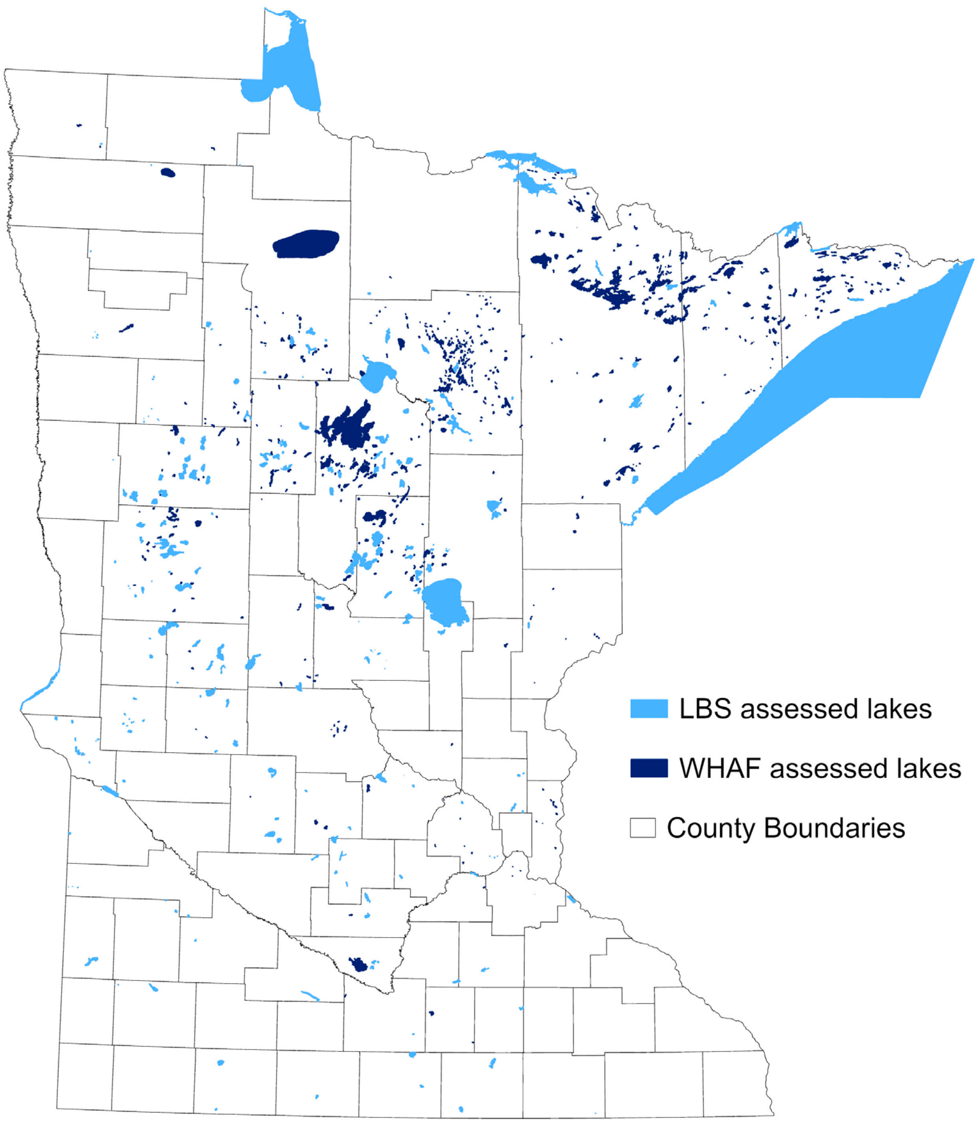

Figure 6.18. Significant Lakes selected from the Watershed Health Assessment Framework (WHAF) Lake Health assessment having overall scores of 75 or greater or biology scores of 70 or greater ("WHAF assessed lakes", dark blue) and lakes with high bird rankings from the Lakes Biological Significance (LBS) assessment ("LBS assessed lakes", light blue).

Significant Streams

This layer includes stream reaches (WIDS) that met Exceptional Use criteria for fish and/or aquatic invertebrates based on Indices of Biological Integrity (IBI) developed and surveyed by the Minnesota Pollution Control Agency (MPCA, [MPCA Index of biological integrity](#)). To depict connectivity of streams on the map, adjacent reaches that met General Use criteria and all streams with order sizes of 5 to 9 were also added (Figure 6.19). While this approach over-represents streams by including those of lower quality, it maintains connectivity between high quality reaches. The scoring step (see below) identifies stream reaches with high IBI scores.

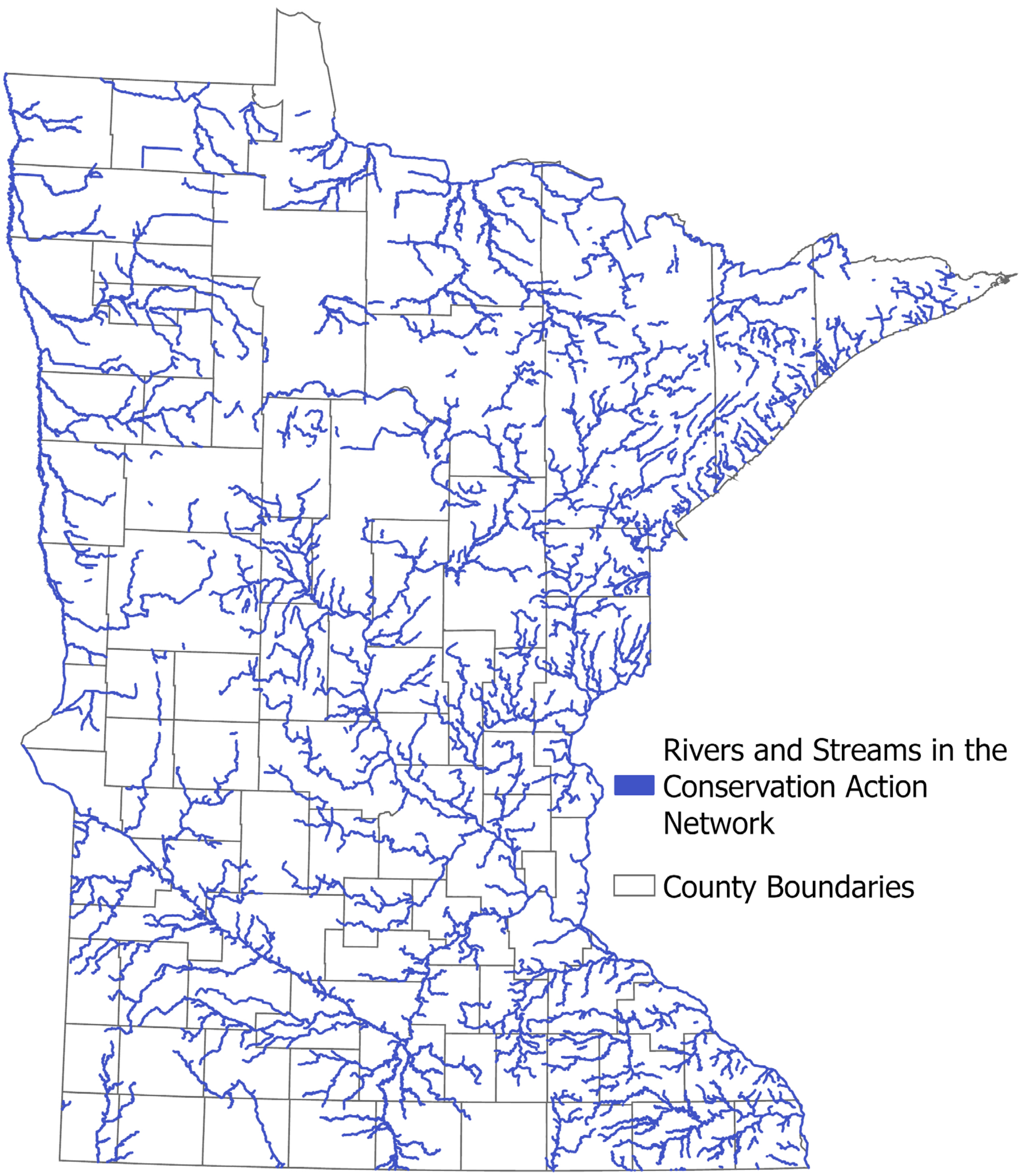

Figure 6.19. Rivers and streams included in the Conservation Action Network. Not all stream reaches depicted are of high quality, as lower quality reaches are included for connectivity. See the scoring layer (Figure 6.6) to identify higher quality streams.

Ecosystem/Landscape Scale

Sites of Biodiversity Significance

Sites of biodiversity significance are defined by the presence of high-quality and diverse native plant communities, along with populations of rare plant and animal species, and represent the largest and most intact natural areas within a regional context (MBS Site Biodiversity Significance Ranks). Sites were identified and delineated by staff within the Minnesota Biological Survey (Minnesota DNR) and assigned one of four ranks: poor, medium, high, and outstanding. All high and outstanding sites of biodiversity significance were selected for inclusion in the CAN core (Figure 6.20).

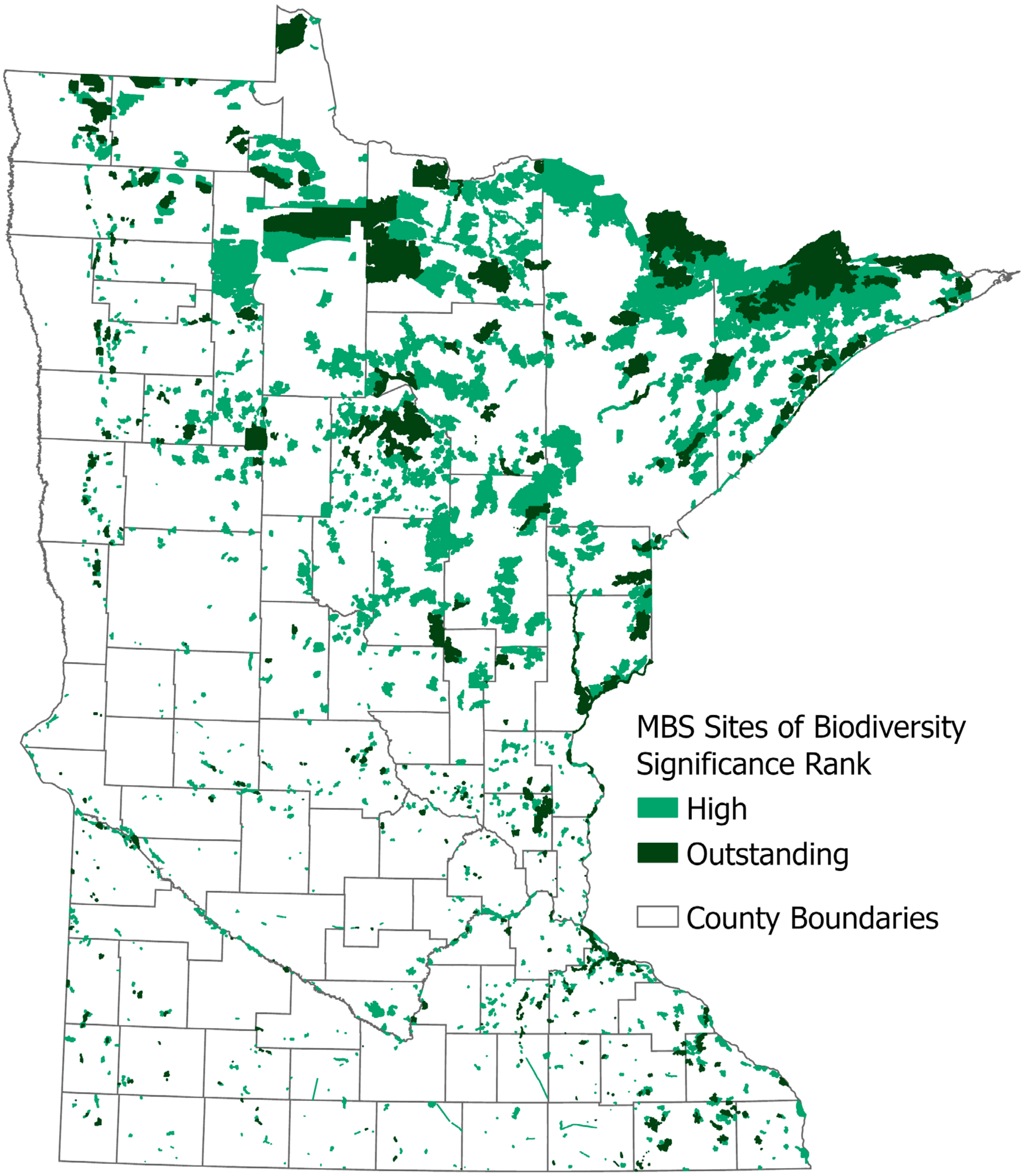

Figure 6.20. Minnesota Biological Survey Sites of Biodiversity Significance ranked high and outstanding and included as a CAN core.

Minnesota Prairie Conservation Plan Core Areas

Minnesota Prairie Conservation Plan Core Areas represent landscapes with concentrations of native prairie, grasslands and other habitats (Figure 6.21, Minnesota Prairie Conservation Plan). The Minnesota Prairie Conservation Plans corridors and complexes were not included in the CAN, as new connectivity maps developed by TNC and partners were used instead.

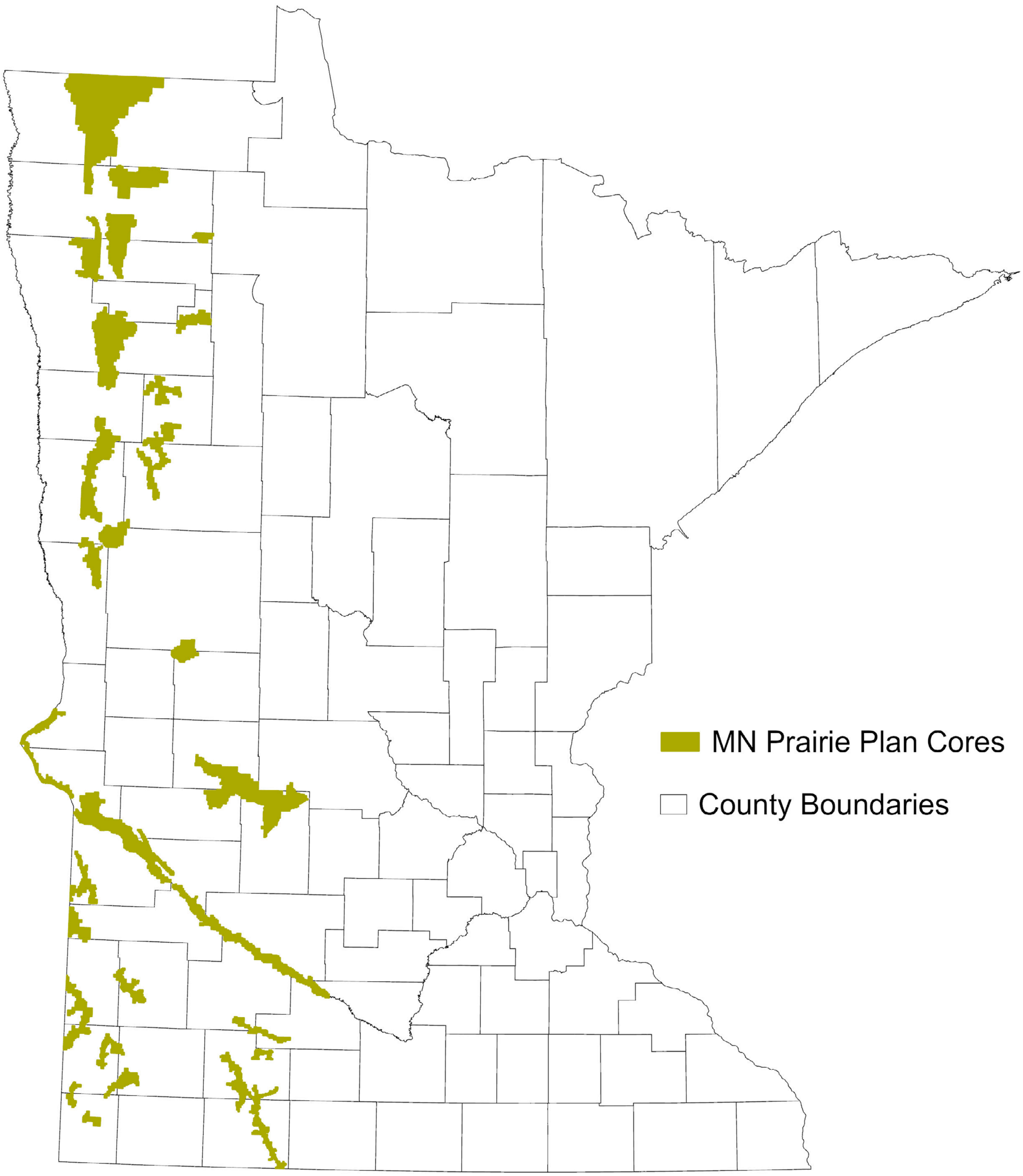

Figure 6.21. Minnesota Prairie Conservation Plan cores.

Building the Network

The 16 vector GIS data layers (Table 6.1) representing CAN cores were combined, using the union tool in ArcGIS pro 3.3, into an aquatic core layer using the streams and lakes GIS layers (3 layers) as well as a terrestrial core layer using the species, forest, prairie, wetland and ecosystem GIS layers (13 layers). Combined, the composite aquatic and terrestrial layers comprise the base core map for the CAN (Figure 6.1 on page 8 of this chapter). The aquatic and terrestrial layers were then overlayed on top of the prairie and forest connectivity layers to create the unscored Conservation Action Network (Figure 6.22).

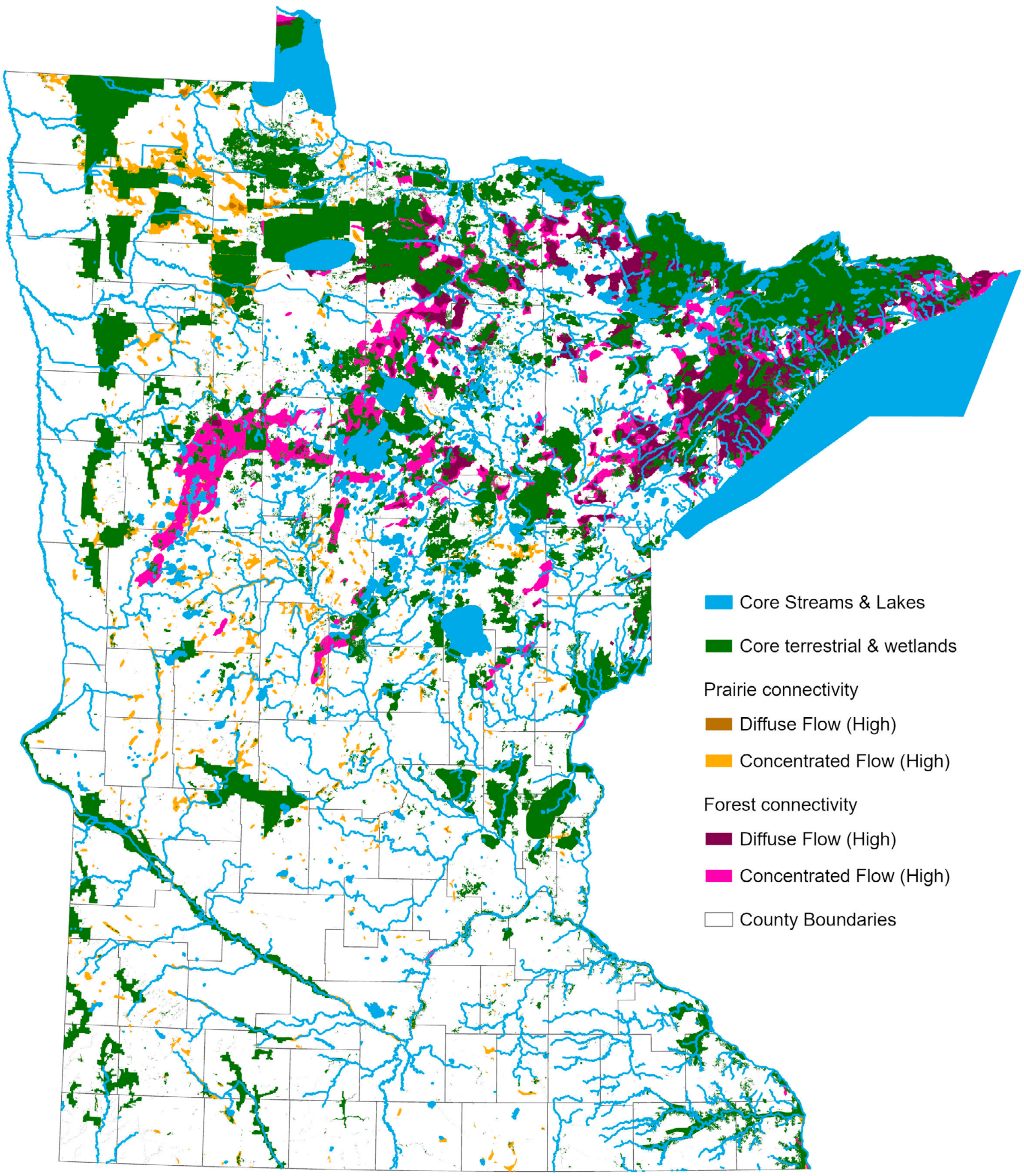

Figure 6.22. The unscored Conservation Action Network (CAN) depicting stream and lake cores (blue), core terrestrial and wetland habitats (Green), prairie connections (orange/brown) and forest connections (purple/pink). The area in Northeastern Minnesota delineating part of Lake Superior represents Minnesota's managed portion of the lake.

Scoring the Conservation Action Network

To prioritize the information provided in the Conservation Action Network cores and corridors map, we carried out a GIS scoring exercise. The core layers of terrestrial habitat (including wetlands) and aquatic habitat (lakes and streams), and the connectivity layers of forest connectivity and prairie connectivity were each individually scored using five layers that represent the scales of species (All SGCN richness and Endangered and Threatened species richness), habitat (lake health scores/ lakes of biological significance and stream IBIs), and ecosystems/landscape (Sites of Biodiversity Significance, Table 6.2 and Figures 6.3-6.8). These layers were also selected for their statewide coverage and for having attributes that could be expressed as either continuous values (like 0 to 100) or ordinal categories (like Low, Medium, High). Values for layers with continuous variables (Stream IBI and Lake Health Score) were normalized between 0 and 1. Layers with categorical rankings (Sites of Biodiversity Significance and Lakes of Biological Significance) were linearly scaled starting at 0.4 for medium, 0.6 for high, and 0.8 for outstanding. The starting point of 0.4 for medium was used since these data already represent a prioritization, and other areas not represented in this prioritization (e.g. Sites of Biodiversity Significance areas mapped as "below", or areas not mapped at all, have a distribution of levels with a "quality" below these prioritized layers. Also, the maximum value of 0.8 was chosen to slightly reduce the weight since ranks are subjective and a maximum value cannot be determined. We used two scores for species richness – one for all SGCN and the other for Endangered, Threatened, S1 and S2 SGCN. We used this two-pronged approach to add weight for species rarity. Given the highly skewed distribution of the number of species per hexagon (there were many more hexagons with one or 2 species than the hexagons with a high number of species), we used Jenks natural breaks to classify the number of SGCN species in richness hexagons into five categories.

The five scoring layers were intersected individually with each of these layers: terrestrial core, aquatic core, forest connectivity, and prairie connectivity. Each of the five component scores were then summed into an overall score with a possible range of 0 to 4 for any unique polygon. The maximum possible score was 4 despite that there were five scoring layers because the lake and stream scoring layers were spatially distinct and did not overlap. Calculated maximum scores ranged from 3.2 for the prairie connectivity layer to 3.5 for the terrestrial, lake and streams and forest connectivity layers. Composite scores were normalized to the maximum value resulting in the scores ranging from 0 to 1. Since the distributions of scores were skewed to lower values, Jenks natural breaks were applied to derive the six CAN score categories (Table 6.5). Higher scores indicate areas where multiple layers with high values overlap, representing locations with greater SGCN diversity as well as elevated community and ecosystem values. The scored layers were overlayed to create the final scored Conservation Action Network map (Figure 6.8 on page 17 of this chapter).

Table 6.5. CAN score category and corresponding ranges of score values.

CAN score category	Score value range
No score	0.0
Low	0.01 to 0.30
Low-medium	0.31 to 0.37
Medium	0.38 to 0.44
Medium-high	0.45 to 0.56
High	0.57 to 1.00