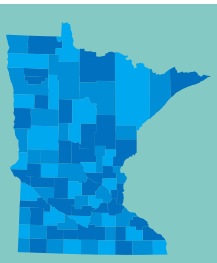
Wetland quality

July 2025

Status and Trends of Wetlands in Minnesota: Minnesota Wetland Condition Assessment (2011 – 2021)

MINNESOTA POLLUTION CONTROL AGENCY



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Cover photo

A field crew establishes a sample-site in a depressional wetland basin with a floating mat rich fen plant community (Douglas Co.).

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Executive summary

The Minnesota Wetland Condition Assessment (MWCA) is a probabilistic survey done in cooperation with the U.S. Environmental Protection Agency's National Wetland Condition Assessment to track wetland vegetation quality and associated stressors at statewide and regional scales and complement Minnesota Department of Natural Resources efforts to track changes in wetland acreage. The overall objective is to assess whether Minnesota is meeting the no-net-loss policy goal of maintaining (and increasing) wetland quality and biological diversity.

Minnesota's overall wetland vegetation quality is largely unchanged between 2011 and 2021. The majority of the state's wetland extent is in exceptional-good vegetation condition, however, there are considerable regional differences. Wetlands in the largely undeveloped northern region are mostly intact and support high quality native plant communities with 72% of wetland extent in exceptional-good condition. Wetlands in the former hardwood forest and prairie regions (which are largely developed for agriculture, urban, suburban, and rural land use) are mostly degraded with 74% of wetland extent in the two regions combined in fair-poor-absent condition. A few significant vegetation condition changes over time were detected at the regional scale that were most likely due to random and observation error. No significant differences were detected at the statewide scale, however, signaling that no-net-loss of vegetation quality and biological diversity was broadly maintained over the time period.

Despite these encouraging results, there continue to be ongoing wetland vegetation quality concerns. Non-native invasive vegetation is associated with virtually all the degraded wetland in the former hardwood forest and prairie regions and is not a self-correcting impact. Both legacy and ongoing hydrologic and physical alterations are also widespread in these regions. In the northern region, timber harvest in coniferous swamps is extensive and may lead to vegetation quality changes. Across the state, Emerald Ash Borer impacts have now been observed and over a million acres of black ash swamp and floodplain forest are under threat.

In this third cycle of the MWCA, our classification systems and stressor assessment approach were greatly enhanced to provide greater detail. Field sampling for the next iteration is scheduled to begin in 2026, and potential changes in the different wetland classes and associated impacts will be a focus of future cycles.

Introduction

Wetlands are a vital component of Minnesota's water resources that provide many beneficial ecosystem services. At an estimated 10.65 million acres (Kendig et al. 2024), wetlands are also the most abundant surface water feature in the state—dwarfing the extent of lakes and streams combined. Concerns stemming from over a century of systematic wetland drainage and filling has led to the adoption of a broad national and state policy goal to achieve no-net-loss (and promote increases) in the quantity, quality, and biological diversity of wetlands. (Minn. R. 8420.0100, subp. 1(A) [2024])

No-net-loss is advanced through many regulatory and non-regulatory programs administered at the local, state, and federal levels of government. While programmatic actions can be tracked—exempt activities, natural processes, and other indirect influences (e.g., drought-deluge cycles, climate change, changes in beaver populations) can cause wetland acreage losses or gains outside of a regulatory or conservation program. Furthermore, wetland quality and biological diversity can be impacted by a variety of human activities such as changes in hydrology, direct physical alterations, or excess nutrient

loading (Adamus et al. 2001) that have until somewhat recently gone largely unrecognized and are largely exempt from regulatory programs.

Given the programmatic accounting challenges and the large scope and variety of Minnesota's wetland resource, random (or probabilistic) surveys—where a limited number of random samples can be used to represent the larger resource and track changes over time—are the most cost-effective way to systematically determine whether we are meeting no-net-loss (Gernes and Norris 2006). Since 2006, the Minnesota Department of Natural Resources (DNR) and Pollution Control Agency (MPCA) have initiated a series of random surveys with the goal of tracking both wetland quantity and quality status and trends in Minnesota.

The DNR leads the Wetland Status and Trends Monitoring Program (WSTMP) to track wetland acreage. The WSTMP consists of repeated wetland mapping at 3,750 one mi^2 plots randomly located across the state on a three-year basis to provide wetland extent estimates at state and regional scales (Kendig et al. 2024). Five DNR WSTMP cycles have been completed between 2006 and 2020—establishing our current baseline wetland statewide acreage estimate and showing statistically significant wetland gains over time (Kendig et al. 2024). Over the course of the WSTMP, significant conversions of emergent to open water wetland and forested to emergent and scrub-shrub wetlands were also detected with implications for loss of wetland quality (Kloiber and Norris 2013, Kendig et al. 2024).

The MPCA leads wetland quality status and trends monitoring for the state through two complementary random surveys: The Depressional Wetland Quality Assessment (DWQA) and the Minnesota Wetland Condition Assessment (MWCA).

The DWQA focuses on tracking macroinvertebrate and water quality at open-water depressional wetlands in the former hardwood forest and prairie regions of the state (Genet et al. 2025). Four DWQA cycles have been completed between 2007 and 2023 and found that a greater proportion of open-water depressional wetland has good macroinvertebrate and water quality in the former hardwood forest compared to the former prairie region in the state where agricultural land use is more prevalent. In addition, these two indicators have been stable from 2007 to 2023 in both regions (Genet et al. 2025).

The Minnesota Wetland Condition Assessment (MWCA) is broader in scope, with the overall goal to track vegetation quality status and trends in virtually all of Minnesota's wetlands regardless of type. Initiated in 2011, the MWCA is completed in conjunction with the U.S. Environmental Protection Agency's National Wetland Condition Assessment (NWCA) and is repeated on a 5-year cycle.

Two previous MWCA cycles were completed in 2011 and 2016 with the following findings (Bourdaghs et al. 2015, Bourdaghs et al. 2019):

- Most of Minnesota's wetlands have exceptional-good vegetation quality, however, vegetation quality varies greatly in different parts of state.
- Wetlands have predominantly exceptional-good vegetation quality in the northern forested region of the state. Conversely, wetlands in the former hardwood forest and prairie regions largely have degraded vegetation quality. As most of Minnesota's wetlands occur in the northern region, the larger extent drives the statewide results.
- This regional pattern of wetland vegetation quality corresponds to a regional pattern of human-caused stressors. Stressors are localized in the northern forested region (with most wetlands being minimally impacted). Conversely, stressors are widespread at severe levels in both the hardwood forest and former prairie regions where the landscape has been largely converted to agriculture, rural, suburban, and urban development.

- Non-native invasive vegetation is the most widespread and impactful stressor at degraded wetlands. While different types of stressors tend to co-occur at degraded wetlands, it is the non-native invasive vegetation that is most often the common denominator and driver of vegetation community change.
- Emergent wetlands are the most affected wetland type with non-native invasive cattail (*Typha angustifolia* and *T.* x *glauca*) and reed canary grass (*Phalaris arundinacea*) having the greatest impact.
- A few significant changes in vegetation quality were detected between 2011 and 2016, however, they were most likely due to random and observation error.
- Ultimately, increased abundance of non-native invasives is not typically self-correcting, thus an emphasis on protecting wetlands with exceptional-good vegetation quality would be an appropriate strategy to further promote no-net-loss of wetland quality and biological diversity in Minnesota.

This report presents results from the third MWCA cycle covering the 2011 – 2021 time period.

Methods

A summary of MWCA methods is provided here. Detailed documentation regarding site evaluation, field sampling, survey design, and data analysis can be found in the MWCA site evaluation procedure (Bourdaghs 2019a), MPCA wetland vegetation sampling procedure (Bourdaghs 2019b), and Appendix B of the 2016 MWCA report (Bourdaghs et al. 2019), respectively.

Vegetation assessment approach

Vegetation condition (i.e., the deviation of plant species composition and/or abundance distribution from native plant communities in a minimally impacted state) is the primary MWCA indicator and is expressed through an approach called the Floristic Quality Assessment (FQA); (Bourdaghs 2012, MPCA 2014). FQA is based on a numerical rating (0-10) of an individual plant species' fidelity to specific habitats and disturbance tolerance called the Coefficient of Conservatism (*C*) (Swink and Wilhelm 1994, Taft et al. 1997, Milburn et al. 2007). The FQA metrics are derived from vegetation data and the *C*-values, and have been found to be the most responsive and frequently used class of metrics to assess wetland vegetation condition across the nation (Mack and Kentula 2010).

The MPCA relies on a weighted average Coefficient of Conservatism (*wC*) metric that incorporates the relative abundance of all species identified in a plant community into a single score (Bourdaghs 2012). The *wC* scores have been calibrated to defined wetland vegetation condition categories that describe conditions ranging from those thought to be prevalent prior to European settlement, to conditions found at sample-sites known to be severely impacted by human activities (Table 1, Table B-8 *in* Bourdaghs et al. 2019).

Table 1. Wetland vegetation condition categories and descriptions.

Condition Category	Description
Exceptional	Community composition and structure as they exist (or likely existed) in the absence of measurable effects of anthropogenic stressors representing pre-European settlement conditions. Non-native taxa may be present at very low abundance (< 1% cover) and not causing displacement of native taxa.
Good	Community structure similar to natural community. Some additional taxa present and/or there are minor changes in the abundance distribution from the expected natural range. Extent of expected native composition for the community type remains largely intact.

Condition Category	Description
Fair	Moderate changes in community structure. Sensitive taxa are replaced as the abundance distribution shifts towards more tolerant taxa. Extent of expected native composition for the community type diminished.
Poor	Large to extreme changes in community structure resulting from large abundance distribution shifts towards more tolerant taxa. Extent of expected native composition for the community type reduced to isolated pockets and/or wholesale changes in composition.
Absent	Plant life only marginally supported or soil/substrate largely devoid of hydrophytic vegetation due to ongoing severe anthropogenic impacts

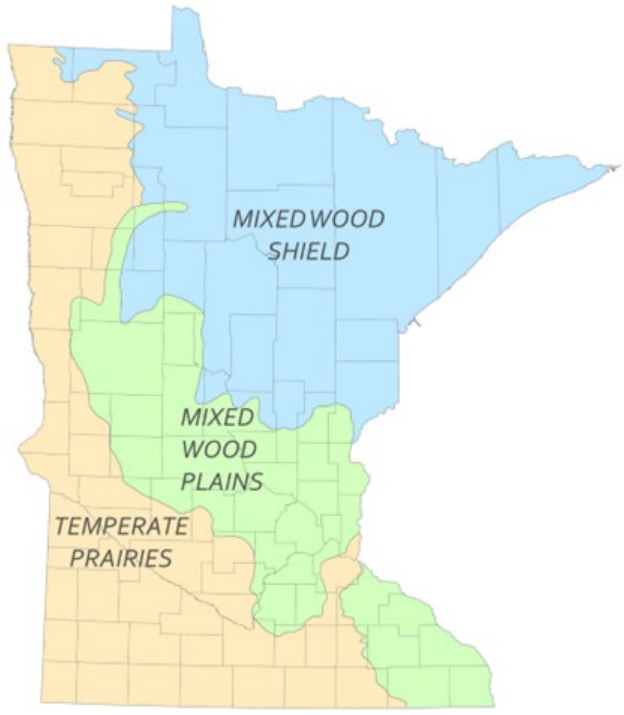
MWCA vegetation quality results are expressed in terms of the proportion of the estimated statewide or regional total wetland acreage by condition category and by *wC* score.

Survey design

The MWCA target population included all wetlands with < 1 meter (m) depth of surface water that were not in active cultivation—representing virtually all wetlands in Minnesota.

Three widely recognized ecoregions occur in the state and the MWCA utilized Omernik's level II ecoregions (Omernik 2004) to characterize these ecologically distinct regions (Figure 1). The ecoregions are described as the Mixed Wood Shield (northern forest), Mixed Wood Plains (former hardwood forest), and the Temperate Prairies (former prairie) in the Omernik system.

Figure 1. Omernik level II ecoregions and county boundaries.



The DNR WSTMP mapping was applied as the sample frame to randomly locate MWCA sample-sites. The total MWCA target sample design was 150 sample-sites statewide with equal allocation by ecoregion (i.e., 50 sample-sites/ecoregion) and a 50% revisit rate of sample-sites established in the previous survey iteration (i.e., 75 revisit and 75 new sample-sites). Individual MWCA sample-sites were ultimately sampled over two survey iterations: once when they were established as a new sample-site and then again in the next iteration as a revisit sample-site. Following each survey iteration, revisit sample-sites were replaced by new sample-sites.

The MWCA sample design was fully integrated with the U.S. Environmental Protection Agency's NWCA design, with 41 of the 150 MWCA target sample-sites designated as national sample-sites. In addition, the design was spatially balanced (i.e., Generalized Random Tessellation Stratified approach was employed; Stevens and Olsen 2004) to minimize clustering. The sample-site location draw was provided by the EPA's National Health and Environmental Effects Research Laboratory (Corvallis, OR).

Potential MWCA points were then evaluated (both from the desktop and in the field) to determine whether 1) they were in-fact located on target wetland, 2) a sample-site could be effectively established, 3) access permission could be obtained, and 4) the sample-site was physically accessible to complete work in a day (Bourdaghs 2019a). The standard sample-site was a 0.5-hectare (ha) circle centered on the point. A point could be shifted up to 60 m and alternative layouts could be employed if field conditions did not permit a standard sample-site layout. Points were rejected if they failed to meet any of the above criteria and overdraw points were then evaluated in design order to maintain the integrity of the random design when replacing rejected points.

A total of 150 sample-sites were successfully established through the site evaluation process and sampled for the 2021 MWCA (Table 2). The revisit sample-site allocation was lower than expected due to a combination of unexpected access denials (n = 6) and physical inaccessibility (n = 4).

Table 2. Number of 2021 MWCA revisit and new target sample sites by ecoregion.

Ecoregion	Revisit Sites	New Sites	Total
Mixed Wood Shield	30	23	53
Mixed Wood Plains	18	30	48
Temperate Prairies	17	32	49
Total	65	85	150

Data collection

Two field sampling approaches were used to collect MWCA vegetation data due to the integrated design with the NWCA. At the 109 MWCA only sample-sites, plant community classes (Table A-1) were first determined and mapped at a sample-site. A meander sampling approach was then used to collect vegetation data—where the observer walked through the sample-site recording plant taxa and cover estimates in each plant community present (Bourdaghs 2019b). At the 41 national sample-sites, the NWCA vegetation protocol was employed (EPA 2021) and consisted of identifying taxa and making cover estimations within five regularly placed 10 x 10 m plots at a sample-site. Individual NWCA vegetation plots were then assigned to a plant community and data were aggregated by community type to create a corresponding data structure to the meander data. In a 2011 MWCA paired trial, both sampling approaches were found to produce consistent results (Bourdaghs et al. 2015). Field sampling was completed during the growing season from 2021 to 2023. Results are referred to as the 2021 cycle in the report for simplicity.

Stressor observations (i.e., human impacts to wetland vegetation) within the sample-site were also made during each visit consisting of stressor type (e.g., vehicle use, ditching) and cover extent (Bourdaghs 2019b).

Following field sampling, additional desktop data were generated. Sample-site mapping was updated from layout changes made during field sampling and plant community mapping was completed in a Geographic Information System (GIS). Sample-sites were further classified according to predominate general wetland class (Table A-2), water regime (Table A-3), and hydrogeomorphic (HGM) wetland class (Table A-4).

Wetland vegetation stressors were also further characterized through the MPCA wetland Human Disturbance Assessment (HDA). The HDA is a qualitative approach to systematically observe, document, and rate the severity of human stressors at wetland monitoring sample-sites and was re-designed for the 2021 MWCA (Appendix B). It incorporates five independent stressor factors that have been

associated with degraded wetland vegetation including: landscape alteration, immediate catchment alteration, physical alteration, hydrologic alteration, and invasive species. Field stressor observations were enhanced through desktop aerial photo interpretation and geospatial data sources (e.g., National Landcover Database, Minnesota altered watercourse) at ecologically meaningful scales corresponding with the sample-site (e.g., HGM based wetland units with homogenous hydrology that include the sample-site). Each HDA factor was then assessed a qualitative severity level based on the stressor observations and systematic criteria and an overall HDA rating of minimally, moderately, or severely impacted was then derived from the combinations of the various factors for all sample-sites. Severely impacted HDA ratings can occur due to cumulative impacts (e.g., moderate levels of hydrology, physical, and surrounding landscape impacts are present) or when a direct stressor occurs at a severe level (e.g., sample-site has been previously farmed). The revised approach allows for not only generating overall HDA and factor rating estimates, but for a wide variety of specific stressors as well.

All vegetation, geospatial, and HDA data were reviewed for completeness and consistency with established procedures prior to generating vegetation metrics, assessments and MWCA survey estimates to minimize observational error.

Data analysis

To generate sample-site level wetland vegetation condition assessments, *wC* metric scores were first computed at the plant community level and scores were compared against established assessment thresholds (Table B-8 *in* Bourdaghs et al. 2019) to determine the community condition category (Table 1). When multiple plant communities were present within the sample area, a sample-site level condition category was determined by calculating a weighted average condition category based on the relative extent of each community within a sample-site (Figure B-5 *in* Bourdaghs et al. 2019).

All 2021 MWCA analyses were derived in R (version 4.4.1) through the RStudio interface (version 2024.09.01) using the Spatial Sampling Design and Analysis (spsurvey) package (version 5.5.1, Dumelle et al. 2023) and associated packages. Weights for each sample-site were calculated based on the total sample frame wetland area the sample-site represents by ecoregion and adjusted for non-target, access denial, and physical inaccessibility rates encountered during site evaluation.

The following estimates were generated at statewide and ecoregion scales:

- Vegetation condition category extent and proportion estimates and changes over time
- *wC* sample means, cumulative distribution functions (CDFs), changes over time, and trend analyses
- Overall HDA and component factor ratings as well as individual stressor extent and proportion estimates
- Relative risk (the probability of poor condition at a severe level of stress divided by the probability of poor condition at a low level of stress) by the overall HDA and component factors at the statewide scale

Vegetation condition estimates were further broken out according to the following subpopulations:

- General wetland class (Table A-2)
- Predominant water regime (Table A-3)
- Hydrogeomorphic (HGM) class (Table A-4)
- Plant community class (Table A-1)
- Land ownership type (i.e., public, private)

All estimates were based on wetland area (e.g., acres of good condition wetland divided by total wetland acres) as opposed to a discrete number of wetlands on the landscape. Reported error margins (±) represent 95% confidence intervals and statistical significance was considered to be achieved at $P < 0.05$. Finally, the exceptional and good, as well as the poor and absent condition categories (Table 1) were (respectively) combined to simplify the change analyses, subpopulation estimates, and HDA associated condition estimates.

Results and discussion

2021 wetland condition

Most of Minnesota's wetlands supported high-quality native vegetation in the 2021 MWCA, with 38% of the wetland extent represented in the survey (roughly 9.9 million acres) in exceptional condition and an additional 21% in good condition (Figure 2, Table 3). Correspondingly, a modest share had fair (28%) and a relatively small proportion had poor (12%) condition at the statewide scale. Absent vegetation condition, where hydrophytic vegetation was largely devoid due to a direct impact, was observed but occurred at less than 1% of wetlands statewide.

Figure 2. 2021 statewide and regional wetland vegetation condition category percent extent estimates. Error bars represent 95% confidence intervals.

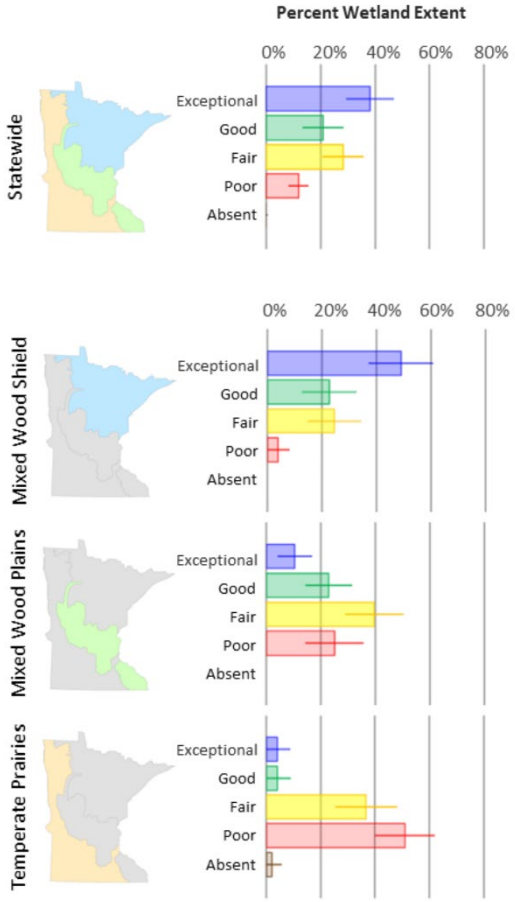


Table 3. 2021 statewide and regional wetland vegetation condition category extent (acres) and percent wetland estimates. Error margins (±) represent 95% confidence intervals. Not Assessable cases include sample-sites that had a seasonally flooded plant community which the MPCA does not have FQA vegetation assessment criteria for or did not meet data quality standards during review.

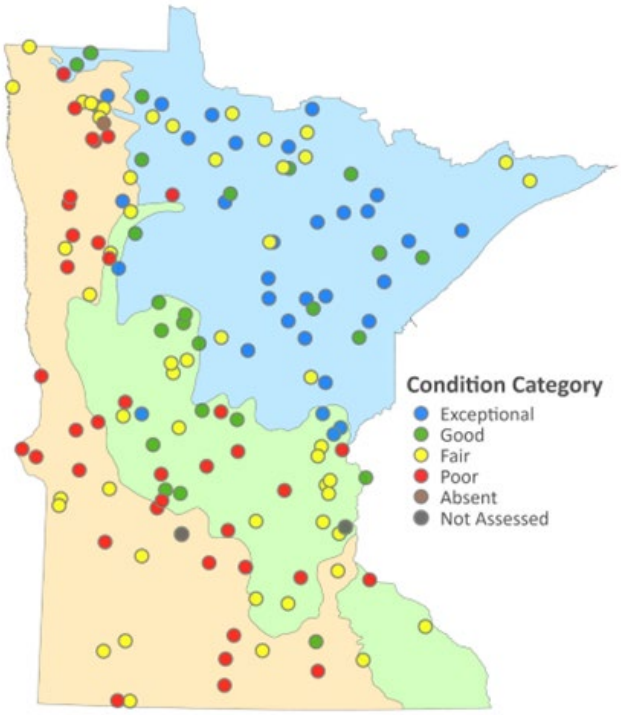
Geographic Extent	Condition Category	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)
State	Exceptional	33	3,791,425	867,845	38.2	8.8
	Good	25	2,078,062	763,474	20.9	7.5
	Fair	50	2,806,687	738,379	28.3	7.5
	Poor	39	1,180,966	380,799	11.9	3.7
	Absent	1	19,258	33,086	0.2	0.3
	Not Assessable	2	54,627	68,776	0.6	0.7
	State Total	150	9,931,025	490,729	100.0	0.0
Mixed Wood Shield	Exceptional	26	3,576,066	867,060	49.1	11.9
	Good	12	1,650,492	731,944	22.6	10.0
	Fair	13	1,788,033	714,676	24.5	9.8
	Poor	2	275,082	317,982	3.8	4.4
	Absent	0	0	0	0.0	0.0
	Not Assessable	0	0	0	0.0	0.0
	Ecoregion Total	53	7,289,672	193,713	100.0	0.0
Mixed Wood Plains	Exceptional	5	176,842	107,182	10.4	6.3
	Good	11	389,053	145,339	22.9	8.6
	Fair	19	672,001	183,001	39.6	10.8
	Poor	12	424,422	180,873	25.0	10.7
	Absent	0	0	0	0.0	0.0
	Not Assessable	1	35,368	60,860	2.1	3.6
	Ecoregion Total	48	1,697,688	105,119	100.0	0.0
Temperate Prairies	Exceptional	2	38,517	44,056	4.1	4.7
	Good	2	38,517	46,938	4.1	5.0
	Fair	18	346,652	106,836	36.7	11.3
	Poor	25	481,462	103,959	51.0	11.0
	Absent	1	19,258	33,066	2.0	3.5
	Not Assessable	1	19,258	31,835	2.0	3.4
	Ecoregion Total	49	943,665	89,500	100.0	0.0

As with previous MWCA cycles, wetland vegetation condition varied widely in different parts of the state (Figure 2, Figure 3, Table 3).

In the Mixed Wood Shield ecoregion, the majority of wetlands were in exceptional-good condition (72% of wetland extent combined), with 24% in fair and 4% in poor condition. Wetland vegetation outside of the Mixed Wood Shield, however, was largely degraded with the combined fair-poor-absent condition wetland extent at an estimated 65% in the Mixed Wood Plains and 90% in the Temperate Prairies. *wC* score CDF tests between ecoregion pairs were all statistically significant, confirming regional wetland

condition differences in Minnesota. The ecoregion *wC* sample means further illustrated regional differences, where mean *wC* was 5.8 in the Mixed Wood Shield, 3.4 in the Mixed Wood Plains, and 2.1 in the Temperate Prairies.

Figure 3. 2021 MWCA sample site locations by vegetation condition category with Omernik level II ecoregions.



The regional wetland vegetation quality patterns largely explain the statewide results (Figure 2, Table 3). Approximately 73% of the wetland extent represented in the 2021 MWCA occurs in the Mixed Wood Shield. The predominately high-quality wetland found in this ecoregion drives the statewide results–largely masking the widespread degraded conditions occurring in the Mixed Wood Plains and Temperate Prairies.

Wetland type estimates

For the 2021 MWCA, estimates were generated for a greater variety of subpopulations compared to previous cycles. Highlights for the 2021 cycle subpopulations are reported below. Comprehensive wetland extent, condition estimates, and sample-site location maps by the different subpopulations are provided in Appendix C. It should be noted that in many cases the subpopulation condition estimates have a wide margin of error (i.e., large uncertainty) due to small sample sizes. Potential vegetation quality changes in the subpopulations over time will be a focus of future MWCA iterations.

General wetland class

As with previous MWCA cycles, wetland extent and vegetation condition varied by the predominate general wetland class in the 2021 MWCA (Figure C-1, Table C-1). General wetland classes describe the broad type of vegetation present (e.g., forested, scrub-shrub, emergent) or if they are open water (i.e., aquatic bed and unconsolidated bottom classes combined) (Table A-1).

- Forested wetland comprised the greatest share of wetlands at the statewide scale at 42% of wetland extent, with a similar share of emergent (38%), and a smaller share of scrub-shrub wetland (19%).
- Open-water wetland was underrepresented in the MWCA (roughly 167,000 acres) due to excluding wetlands with > 1 m of depth. For context, the DNR WSTMP estimates 757,000 acres (ac) of open-water wetland in Minnesota (Kendig et al. 2024). Open-water wetland quality is better represented in the DWQA (Genet et al. 2025).
- In terms of vegetation quality concerns, emergent wetland had a greater extent in poor-absent condition compared to forested and scrub-shrub wetland (Table C-1). This was likely a reflection of the regional vegetation quality pattern, where emergent wetland was more prevalent in the Mixed Wood Plains (71% of wetland extent) and Temperate Prairies (67%), and forested and scrub-shrub wetland were more prevalent in the Mixed Wood Shield (53% and 21% respectively).

Water regime

Wetland extent and condition also varied by predominate water regime in the 2021 MWCA (Figure C-2, Table C-2). Water regime describes wetland hydrology in terms of soil saturation and/or flooding duration (Table A-3).

- The continuously saturated water regime (saturation at or near the surface throughout the year) was the most extensive water regime at the statewide scale (69% of wetland extent) (Table C-2). The only other water regimes estimated at > 3% of wetland extent statewide were seasonally flooded (surface water present for > 1 month, absent later in the season) at 18% and temporarily flooded (surface water present for brief periods, water table typically well below ground surface) at 6%.
- Water regime extent varied by ecoregion, with continuously saturated wetland prevalent in the Mixed Wood Shield (83% of wetland extent) and temporarily and seasonally flooded wetland more common in the Mixed Wood Plains (44% of wetland extent combined) and Temperate Prairies (80% of wetland extent combined) (Table C-2).
- Vegetation condition by water regime varied correspondingly to the regional extent patterns of the classes, with exceptional-good vegetation most associated with the continuously saturated wetland occurring in the Mixed Wood Shield and degraded vegetation more associated with the temporarily and seasonally flooded wetland occurring in the Mixed Wood Plains and Temperate Prairies (Table C-2).

Hydrogeomorphic type

Similarly, wetland extent and condition varied by wetland hydrogeomorphic (HGM) type in the 2021 MWCA (Figure C-3, Table C-3). Wetland HGM classification incorporates landform, water-source, and hydrodynamics to provide a framework to fundamentally describe wetland hydrology and water quality functions (Smith et al. 1995).

- Organic soil flats (precipitation driven wetlands with vertical peat accretion) were by far the most extensive HGM type statewide (66% of wetland extent) and were strongly associated with the continuously saturated water regime (Table C-3). Organic soil flats were prevalent in the Mixed Wood Shield (81% of wetland extent), and the majority were in exceptional-good condition (72%).
- Depressional wetlands (within a topographical depression with a closed elevation contour) were common throughout the state (18% of wetland extent) but were more prevalent in the Mixed Wood Plains and Temperate Prairies ecoregions (38% and 63% of wetland extent, respectively) and correspondingly had a greater share of degraded wetland vegetation (44% and 71% poor-absent condition, respectively) (Table C-3).
- The elevated share of degraded vegetation found at depressional wetlands may also be related to differences in surface water connectivity with the surrounding landscape. Depressional wetlands can receive relatively large amounts of surface water from the surrounding catchment, whereas most organic soil flats (the exception being those that formed in depressional basins) are precipitation driven with little or no surrounding catchment area. In the Mixed Wood Plains, depressional and organic soil flats occurred essentially equally (35 - 37% of wetland extent) but organic soil flats had 59% exceptional-good and 41% fair vegetation condition compared to 17% exceptional-good, 33% fair and 44% poor-absent found in depressionals (Table C-3).
- Lacustrine fringe (wetlands with bi-directional hydrology with adjacent lakes, 5% of wetland extent) and riverine-lower perennial wetlands (wetlands with bi-directional hydrology with adjacent 3rd order or greater streams, 4% of wetland extent) were the only other HGM types estimated at > 3% of the statewide extent (Table C-3).

- Although the less extensive HGM types are overall not as common, they provide distinct wetland functions and are important components of Minnesota's wetland resource (e.g., calcareous fens, which are protected due to their unique characteristics, would be considered a slope-groundwater HGM wetland – one of the less common types).
- The HGM type estimates provided here differ significantly from similar HGM estimates produced from the updated National Wetland Inventory (NWI, a statewide wetland mapping effort) (Kloiber et al. 2019). The NWI estimates much larger shares of mineral soil flat (32% vs. 2%) and lacustrine fringe wetland (termed "lentic" in NWI, 23% vs. 5%) in Minnesota compared to the MWCA estimates. Conversely, the MWCA estimates a much larger share of organic soil flats (termed "peatland" in NWI; 66% vs. 25%). These differences were likely due to differing operational type definitions between the projects (the MWCA adhered closely to original definitions (Smith et al. 1995), whereas the NWI relied on a modified approach developed for mapping (Tiner 2014)) and that the NWI was a remote sensing/mapping effort as opposed to the field based MWCA.

Plant community type

Plant community type is the most detailed level of classification applied in the survey, with 14 types (Table A-1). For the 2021 MWCA, plant community extent and condition estimates were derived using the predominate community at a sample-site, as opposed to estimates from the mapped plant community extent within sample-sites as was done in the 2011 and 2016 iterations. This will allow for tracking plant community change in future iterations but precludes direct comparison of 2021 plant community estimates with previously reported estimates. Again, plant community change estimates will be a focus in future MWCA cycles.

- Coniferous swamp was the most prevalent wetland plant community type statewide at an estimated 2.6 million acres (27% of wetland extent) (Table C-4). Coniferous swamps are forested communities and were strongly associated with the continuously saturated water regime, organic soil flat HGM type, and were prevalent in the Mixed Wood Shield ecoregion (36% of wetland extent) (Figure C-4). Roughly half of the coniferous swamp extent in the Mixed Wood Shield was at exceptional-good (47%) and half fair condition (53%) (although with a wide margin of error). The fair condition coniferous swamp totals > 1 million acres – which is more than the estimated total wetland acreage in the Temperate Prairies ecoregion and accounted for most of the fair condition wetland observed in the Mixed Wood Shield (Figure 2).
- Shallow marsh (14% of wetland extent) and rich fen (14%) were the other two plant community types estimated at > 1 million acres statewide in the 2021 MWCA (Table C-4).
- Shallow marshes are emergent communities and were most often associated with depressional and lacustrine fringe HGM wetland types and the seasonally flooded water regime. They were found throughout Minnesota (Figure C-4) but were more prevalent in the Mixed Wood Plains and Temperate Prairies ecoregions, where the majority were in poor-absent vegetation condition (56% and 79%, respectively) (Table C-4). The shallow marsh community had the highest rates of poor-absent condition of any community type.
- Rich fens are also emergent communities and occurred in a variety of HGM settings often with a continuously saturated or seasonally flooded (when occurring as a floating vegetation mat) water regime. They occurred most often in the Mixed Wood Shield and Mixed Wood Plains ecoregions (Figure C-4) and were found to largely be in exceptional-good condition statewide (95%) (Table C-4).
- Like shallow marshes, fresh meadows are an emergent community type occurring throughout the state but were more prevalent in the Mixed Wood Plains and Temperate Prairies ecoregion

(Figure C-4). They were associated with a variety of HGM types and most often associated with temporarily flooded and continuously saturated water regimes. Fresh meadows also were observed to have elevated rates of fair (30% and 58%) and poor-absent (10% and 42%) condition in the Mixed Wood Plains and Temperate Prairies (respectively) (Table C-4).

- Degraded vegetation was most associated with shallow marshes and fresh meadows in the Mixed Wood Plains and Temperate Prairies ecoregions (Table C-4).

Ownership

Ownership type was evaluated in the MWCA for the first time as a subpopulation in the 2021 cycle. Wetland extent and condition estimates varied depending on whether the wetland was publicly versus privately owned at the statewide scale, but vegetation condition did not vary within ecoregions by ownership (Table C-5).

- At the statewide scale, most of the wetland extent was in public ownership (72%) and publicly held wetland condition was consistent with statewide estimates (i.e., majority in exceptional-good condition). Privately owned wetlands had a relatively higher extent of poor-absent and a lower extent of exceptional-good condition as well as significantly different *wC* scores compared to public wetlands (CDF test, $P < 0.05$).
- At the regional scale, most of the wetland extent in the Mixed Wood Shield (87%) was publicly held, whereas most of the wetland extent in the Mixed Wood Plains (73%) and Temperate Prairies (59%) were privately held (Table C-5).
- The condition category estimates indicate some potential vegetation quality differences between public and private wetland in the Mixed Wood Shield and Mixed Wood Plains ecoregions (Table C-5), however, there were no significant differences in *wC* scores within any of the ecoregions (CDF tests, $P > 0.05$). Given that, it is more likely that there is no difference in vegetation quality between public and privately owned wetland within any of the ecoregions.
- The overall regional differences in wetland extent and condition again largely explain the statewide ownership results. As the largest share of publicly held wetland occurs in the Mixed Wood Shield where vegetation condition tends to be exceptional-good and the largest share of privately held wetland occurs in the Mixed Wood Plains and Temperate Prairies where vegetation tends to be degraded, the statewide public versus private estimates reflect the larger regional vegetation quality pattern, as opposed to a true difference in vegetation quality due to ownership.

Wetland condition change (2011-2021)

Vegetation condition change is gauged in several different ways in the MWCA – year-pair condition category estimates (i.e., changes in the percent condition category estimates from one cycle to the next), year-pair *wC* score sample means (i.e., changes in the *wC* score sample means from one cycle to the next), and the overall trend of *wC* score sample means across all iterations are tested for statistically significant changes. Agreement among statistical tests for the different approaches provide greater confidence that change is occurring over time, as opposed to change due to random or observation error. For example, a sample-site may have a true *wC* score near a condition category threshold and could be assessed as different condition categories between survey cycles due to acceptable sample variation. If this occurs over multiple sample-sites within an ecoregion and they tend to fall towards one category in one cycle and the other in the next by random chance – this could produce a significant change in condition category extent without a significant change in the sample mean *wC*. Thus, corroborating statistical tests provides greater evidence of an actual change.

At the statewide scale, there were no significant year-pair differences in the condition category estimates, no significant sample mean *wC* score year-pair differences, and no significant trend in *wC* scores across the MWCA iterations from 2011 to 2021 (Figure 4).

Figure 4. Change in percent wetland vegetation condition category extent and sample mean weighted Coefficient of Conservatism (*wC*) values statewide and by ecoregion (2011 to 2021). Exceptional-good and poor-absent condition category estimates have been combined to simplify the change analysis. Shaded bar or diamond symbols indicate a statistically significant ($P < 0.05$) change from the previous survey iteration. Trendlines are provided for *wC* plots that have a statistically significant ($P < 0.05$) slope. Error bars represent 95% confidence intervals. Comprehensive condition category year-pair estimates and *wC* year-pair sample mean results are in Tables C-6, C-7, and C-8.

There were, however, several statistically significant changes at the regional scale.

The Mixed Wood Shield had a significant downward trend in *wC* scores from 2011 to 2021 (Figure 4). There were, however, no corresponding significant year-pair changes in the condition category estimates or *wC* sample means.

The Mixed Wood Plains had a 19% decrease of poor-absent condition wetland (with a corresponding non-significant 11% increase in fair wetland) from 2011 to 2016, and a 14% increase in exceptional-good with a 18% decrease in fair from 2016 to 2021 (Figure 4). In other words, there was an apparent shift of poor condition wetland to fair from 2011 to 2016 and from fair to exceptional-good between 2016 and 2021. There were, however, no corresponding significant year-pair changes in *wC* sample means or a *wC* trend across survey iterations.

Likewise, there was a significant 22% increase of fair condition wetland in the Temperate Prairies from 2011 to 2016 with a corresponding significant 15% decrease of exceptional-good condition wetland (Figure 4). From 2016 to 2021, however, there was a significant 18% decrease in fair condition wetland and a 6% increase in exceptional-good condition wetland. In other words, there was a significant shift of exceptional-good condition wetland to fair from 2011 to 2016 and a significant return in those two categories from 2016 to 2021. As with the Mixed Wood Plains, there were no corresponding significant year-pair changes in *wC* sample means or a *wC* trend across survey iterations.

Given the significant changes observed at the regional scale lacked agreement among tests to provide supporting evidence, it is more likely they were the result of random or observation error as opposed to actual changes in wetland vegetation condition. An additional factor is the smaller regional sample size (targeted n = 50 for each ecoregion, Table 2) allows for a greater likelihood for random/observation error to produce a significant result. Our ability to discern meaningful change at both the statewide and regional scales should increase with additional survey iterations.

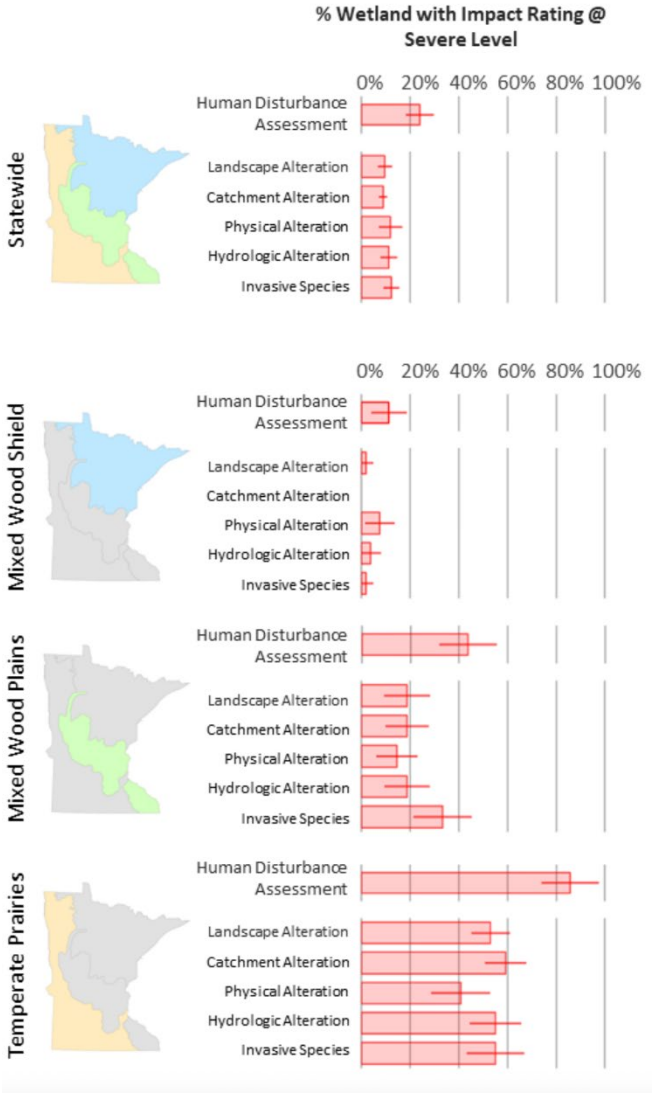
2021 wetland stressors

The 2021 HDA highlights are reported in the subsections below. The HDA improvements made for this cycle, unfortunately, prohibit direct comparison to previously reported results. Potential change in wetland stressors over time will be a focus of future MWCA cycles. Comprehensive 2021 HDA and component ratings, individual stressor, and associated wetland vegetation condition estimates are provided in Appendix D. As with the subpopulation estimates, in many cases these estimates have a wide margin of error due to small sample size.

Human Disturbance Assessment

- Most of Minnesota's wetlands (58%) had minimally impacted HDA ratings for the 2021 MWCA, with only 24% rated as severely impacted (Figure 5, Table D-1).

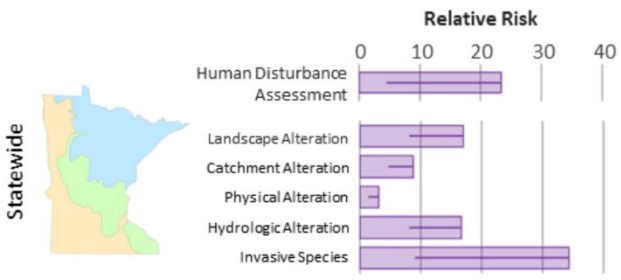
Figure 5. 2021 wetland Human Disturbance Assessment (HDA) and component factor severe level rating percent extent estimates statewide and by ecoregion. Error bars represent 95% confidence intervals. Comprehensive HDA and component factor rating percent extent estimates are in Tables D-1 and D-2.



- As with wetland vegetation condition, there was large regional variation in overall wetland HDA ratings (Figure 5, Table D-1). In the Mixed Wood Shield, few stressors were observed as only 11% of wetland extent was at the severe HDA level. Stressors were relatively more prevalent in the Mixed Wood Plains, with 44% of wetland extent at the severe HDA level. Stressors were widespread in Temperate Prairies wetlands, where 86% of wetland extent was rated at the severe HDA level. Given the large share of wetlands statewide in the Mixed Wood Shield, the low occurrence of stressors there drives the statewide result.
- The HDA estimates broadly correspond with the vegetation condition estimates at statewide and regional scales, largely explaining the regional variation in vegetation condition (Figure 2, Figure 5). The Mixed Wood Shield is mostly undeveloped, there are few stressors, and vegetation condition is largely intact. The Mixed Wood Plains and Temperate Prairies are largely developed, stressors are widespread, as is degraded wetland vegetation quality.

- A relative risk analysis (the probability of poor-absent condition when a stressor is at a severe level divided by the probability of poor-absent condition at a low level of stress) for the overall HDA and component factors was completed at the statewide scale to directly evaluate the associations of high level of stress and degraded vegetation condition. The overall HDA and all the component factors had a statistically significant relative risk (i.e., > 1) of being associated with poor-absent vegetation condition, with the invasive species factor posing the greatest risk of the individual factors at 34 times increased risk of poor-absent condition statewide (Figure 6).

Figure 6. Relative risk of poor-absent condition when HDA and constituent factors are at a severe level at the statewide scale. Error bars represent 95% confidence intervals.



Landscape & Immediate catchment alteration

Both the landscape and immediate catchment alteration HDA factors evaluate potential wetland impacts due to surrounding human land use (Appendix B). The landscape alteration factor describes the broad scale landscape context (ranging from a 1,000 m buffer to the upstream drainage network depending on wetland HGM type), whereas the immediate catchment factor describes the adjacent area that directly generates surface runoff to the sample-site. For both factors, the primary metric is percent perennial vegetation cover with a severe rating at < 30% perennial vegetation cover (i.e., the lower the percent perennial vegetation cover the greater the human land use).

- Statewide, the landscape and immediate catchment HDA factors were rated at the severe level over roughly 9% of wetland extent (Figure 5, Table D-2). Landscape and immediate catchment alteration was < 3% of wetland extent at the severe level in the Mixed Wood Shield, roughly 19% in the Mixed Wood Plains, and > 50% of wetland extent in the Temperate Prairies.
- The sample mean percent perennial vegetation cover for both factors at statewide and regional scales reflect the ratings estimates, where percent perennial vegetation cover at the landscape and immediate catchment scales was well above the minimal severity rating (> 80%) in Mixed Wood Shield, within the low severity rating range (60 – 80%) in the Mixed Wood Plains, and in the moderate severity range (30 – 60%) in the Temperate Prairies (Table D-3).
- The immediate catchment alteration scale percent perennial vegetation cover sample means were consistently greater compared to the landscape alteration scale, except for the Mixed Wood Shield (Table D-2). In other words, human land use tended to be slightly less extensive on average within closer proximity to wetlands compared to the broader landscape.

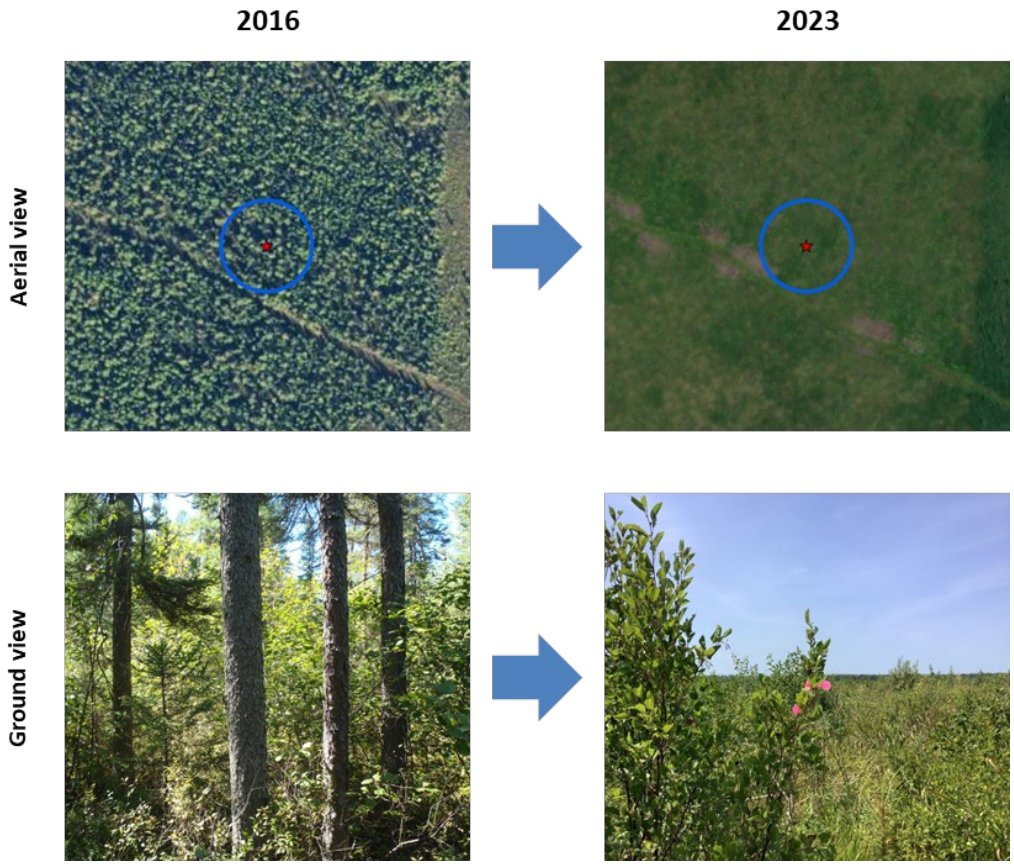
Physical alteration

The physical alteration HDA factor describes direct soil and vegetation impacts within a sample-site (Appendix B). Impact severity (e.g., soil excavation vs. vegetation removal), the footprint of the impact (e.g., a cut ATV trail through a sample-site vs. timber harvest across the entire sample-site), and recency is factored into the ratings.

- Statewide, severe level physical alteration occurred at 12% of wetland extent, with 8% severe in the Mixed Wood Shield, 15% in the Mixed Wood Plains, and 41% in the Temperate Prairies (Figure 5, Table D-4). Physical alteration was the most common type of stressor at moderate and severe levels in the Mixed Wood Shield (Table D-2).

- 46% of Minnesota's wetland acres had at least one physical alteration present (Table D-5). Physical alterations occurring at high-cover (i.e., > 25% of a sample-site, that could result in a severe rating), however, occurred at a much lower 15% of wetland extent statewide.
- Soil modification and vegetation removal physical alteration types occurred at roughly the same wetland extent in the Mixed Wood Shield and Mixed Wood Plains ecoregions, but soil modifications were more prevalent in the Temperate Prairies, particularly when they occurred at high-cover, where 31% of wetland extent had a high-cover soil modification (Table D-5).
- In terms of specific physical alterations tracked in the 2021 MWCA, four were present at > 5% of wetland extent statewide: vehicle damage (19%), logging (17%), shrub removal (7%), and prior plowing (6%) (Table D-6). While both vehicle damage and shrub removal were common physical alterations, those activities rarely occurred at high-cover, indicating that they tend to be localized at the sample-site scale (e.g., an ATV track through a wetland) and contributed to low-moderate levels of impact in the HDA. Logging and prior plowing, however, both had relatively greater occurrence at high-cover statewide (9% and 4%, respectively), indicating that these were primary drivers of the severe level physical alterations described in the HDA (Table D-4).
- Logging was present in essentially all variety of forested wetlands throughout Minnesota, however, logging at high-cover (where a significant portion of a sample-site had been cut) primarily occurred in coniferous swamp plant communities in the Mixed Wood Shield (Figure 7).

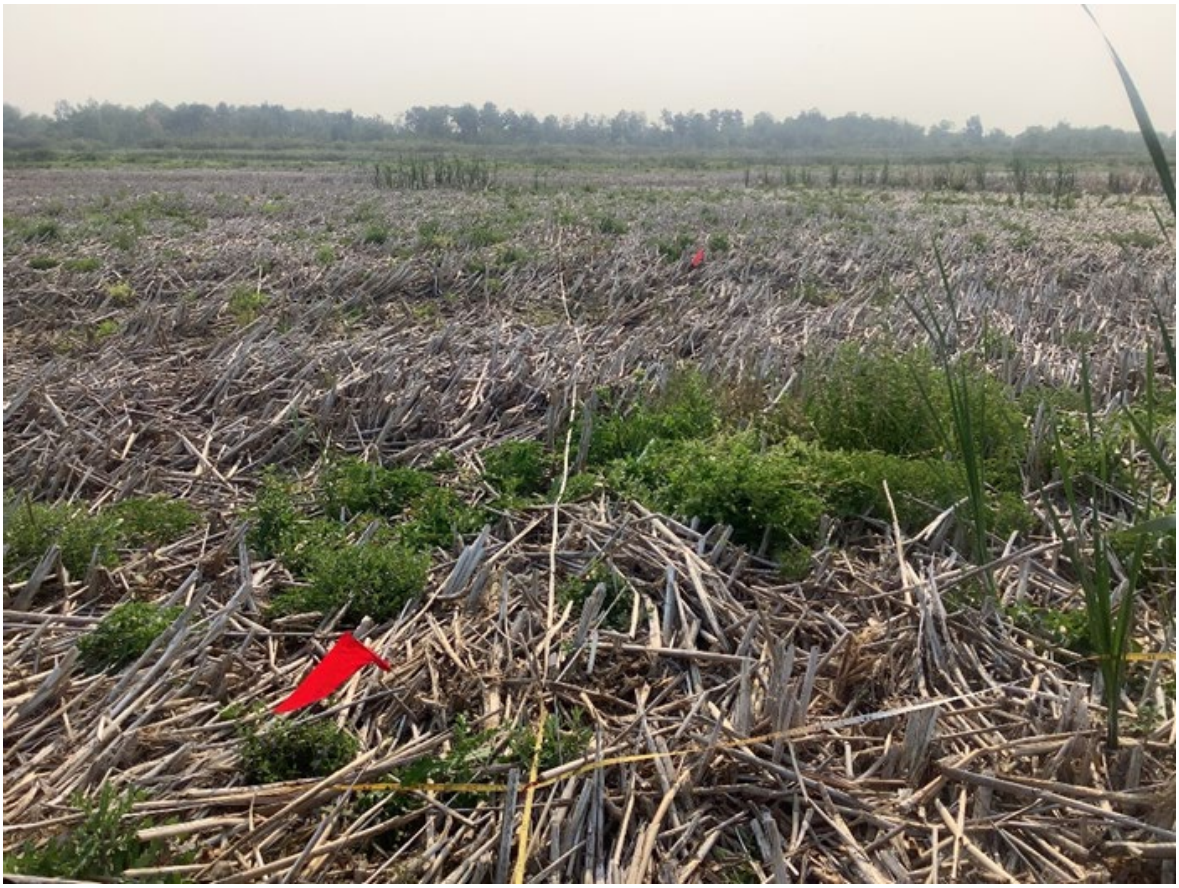
Figure 7. Aerial and ground views of a coniferous swamp sample site with silvicultural activities between the 2016 and 2021 survey cycles. The sample site was established in 2016 and had 25-50% cover of both black spruce and tamarack with a *wC* = 6.0 and exceptional condition. Timber harvest occurred over the winter of 2016-2017. Black spruce and Tamarack cover during the 2023 revisit were both < 5% (with trees < 6' in height) with increased aspen, Canada bluejoint, woolgrass, and red raspberry cover resulting in a *wC* = 5.2 and a fair condition.



- Approximately one third (32%) of the coniferous swamp acres in the Mixed Wood Shield had a high-cover for logging (although with wide error margins) equating to roughly 825,000 acres (Table D-7). One third (33%) of cutover coniferous swamp was recently harvested such that regenerating trees were < 6' in height. The remaining roughly 550,000 acres of logged coniferous swamp in the ecoregion was described as recovered-recovering with expected tree species (typically black spruce (*Picea mariana*) and/or tamarack (*Larix laricina*)) found in abundance and generally > 6' in height.
- Wetland silvicultural activities are largely exempt in the Minnesota Wetland Conservation Act (Minn. R. 8420.0105, subp. 2(B) [2024]) and timber harvest in what foresters call the lowland conifer forest type (which equates to coniferous swamp and bog plant communities) is an important component of our forest resource industry with upwards of 200,000 cords harvested annually (De Pellegrin et al. 2024).
- Both the DNR and U.S. Fish and Wildlife Service wetland status and trends surveys have reported significant transition of forested to emergent and scrub-shrub wetland in the Mixed Wood Shield ecoregion of Minnesota (Kendig et al. 2024, Lang et al. 2024). While the logging observations made as part of the MWCA considers longer time scales compared to these efforts, it's likely that timber harvest in coniferous swamps is the primary driver for the conversion of forested wetlands given our estimates (Table D-7). No other direct physical impact associated with forested wetland occurred at comparable extent and observations of tree mortality due to hydrology changes (whether natural or potentially related to climate changes) or insect pests were much more localized.
- Condition estimates at high-cover logged coniferous swamps did not provide a clear picture of whether the activity significantly affects vegetation quality (Table D-7). Given the limited sample size, condition estimates had a very wide error margin. Also, the indicator may require some improvement as *wC* scoring criteria for fair and poor condition coniferous swamps are preliminary due to data limitations at the time of development (Bourdaghs 2012) and lacks a tree canopy structural component.
- Prior plowed wetland (a previously agriculturally cultivated wetland that has been abandoned or restored and hydrophytic vegetation has repopulated) was common in the Mixed Wood Plains and Temperate Prairies, where 16% of wetland extent had prior plowing at high-cover (Table D-8). Prior plowing was more prevalent in the Temperate Prairies, where 27% of wetland extent had prior plowing at high-cover compared to 10% in the Mixed Wood Plains.
- Degraded vegetation quality was strongly associated with prior plowed wetland with roughly half fair and half poor-absent condition (with wide error margins) (Table B-8). These results were broadly consistent with previous MWCA prior plowed wetland estimates (Bourdaghs et al. 2015, Bourdaghs et al. 2019) and the Minnesota Board of Water and Soil Resources assessment of vegetation condition at wetland restoration banks, where most sample-sites in the Mixed Wood Plains and Temperate Prairies ecoregions were prior plowed and in either fair or poor condition (Powell and Rodacker 2023). It should be noted that a number of the high-cover prior plowed sample-sites in the 2021 MWCA included areas of shallow open water, which currently lack condition assessment criteria for a poor condition category, potentially resulting in artificially boosting the extent of fair condition wetland at these sample-sites.
- The remaining specific physical alterations (Table D-6) were localized such that they were only observed sporadically, were more prevalent in only certain ecoregions (e.g., grazing was present at 12% of wetland extent in the Temperate Prairies) or exist in Minnesota but were not detected in the survey (e.g., pipelines).
- One last physical alteration of note is herbicide treated wetland, which was present at 8% of wetland extent in the Temperate Prairies and 4% (or roughly 38,000 acres) at high-cover

(Table D-6). Relatively recently, wetland managers have started aggressively treating invasive cattail in an effort to increase native vegetation (particularly in the northwestern part of the state). Two 2021 MWCA sample-sites had received such herbicide treatments. One had abundant native vegetation with fair condition, and the other had yet to re-vegetate and accounted for our estimated absent condition wetland (Figure 8). The DNR has recently initiated an effort to assess the efficacy of large-scale invasive cattail herbicide treatment (*M. Fitzpatrick,* personal communication, February 9, 2024).

Figure 8. A shallow marsh sample site that has been herbicide treated to control invasive cattail (three years post treatment) resulting in an absent vegetation condition (Marshall Co.).



Hydrologic alterations

The hydrologic alteration HDA factor describes impacts to a wetland's natural hydrologic regime including increases or decreases to wetland water volume, flooding frequency/duration, and/or water source changes (Appendix B). Specific hydro-alterations are categorized by whether they represent a water subtraction, addition, or flow obstruction. For the severity ratings, three independent processes (water regime change, seasonal/semi-permanently flooded water regime stabilization, and enhanced flashiness), are first rated according to a systematic process – and the most severe rating of these three is selected as the overall hydro-alteration rating.

- Severe level hydro-alteration occurred at 11% of wetland extent statewide, with 4% severe in the Mixed Wood Shield, 19% in the Mixed Wood Plains, and 55% in the Temperate Prairies (Figure 5, Table D-9). Severe hydro-alteration was also strongly associated with degraded wetland condition.

- Water subtraction, water addition, and flow obstruction hydro-alteration categories were roughly equally prevalent at the statewide scale and in the Mixed Wood Shield and Mixed Wood Plains (Table D-10). Flow obstruction was more prevalent in the Temperate Prairies (59% of wetland extent) compared to water subtraction (45%) and addition (47%).
- Four specific hydro-alterations were present at > 5% of wetland extent statewide: ditching inflow (14%) and outflow (13%), dam/dike/control structure (7%), and road/railroad bed (8%) (Table D-11). Ditching inflow and outflow often co-occurred (i.e., a wetland sample-site received surface water and water also exited via a ditch) resulting in very similar estimates.
- Apparent significant changes in wetland water regime associated with observed hydro-alterations were infrequent (Table D-12). If hydro-alterations were observed at a sample-site, but no interpretable water regime change was present (based on aerial photo interpretation as far back as available, vegetation artifacts), the water regime change was rated a low severity level (Appendix B). Almost all wetland extent (98%) with a hydro-alteration was rated low for water regime change.
- There are many cases, however, where wetland hydrology had been modified to such a degree that the pre-impact water regime was not interpretable, and the current hydrology may be much different (Figure 9). These existence level type hydro-alterations essentially reset wetland hydrology (often intentionally to restore wetlands or increase wetland water quality or specific wildlife functions) and when they occur the hydro-alteration activity is disregarded as part of the water regime change rating in the HDA (Appendix B).

Figure 9. An example of an existence level hydro-alteration (Yellow Medicine County). The wetland was drained and in agricultural production as far back as 1938 (based on historic aerial photos). A depressional wetland basin was restored between 1991 and 2003 as part of the Conservation Reserve Enhancement Program (CREP). As of 2022 (when sampled as part of the MWCA), the basin had an open water interior and shallow marsh dominated by invasive cattail, with the MWCA sample site located in the shallow marsh. While the sample site had poor vegetation condition, the basin provides valuable water storage, water quality, and wildlife functions in a landscape that has lost almost all wetlands. As it is impossible to determine what the wetland was like prior to drainage and plowing, and the restoration activity is responsible for the wetland as it exists today, any hydro-alterations prior to or part of the restoration are ignored in the HDA rating.

- Existence level hydro-alteration occurred in all three ecoregions but was most prevalent in the Temperate Prairies where 35% of the current wetland extent was the result of a man-made manipulation of wetland hydrology (Table D-13). Degraded wetland vegetation condition was also associated with existence level hydro-alterations, with 25% of wetland extent in fair and 54% in poor condition at the statewide scale. While few significant water regime changes were accounted for in the water regime change portion of the HDA (Table D-12), the existence level hydro-alteration extent more fully captures the legacy of wetland human hydrology impacts.

- Invasion and increased abundance of invasive cattail is associated with water level stabilization from roads, dikes, or other control structures in seasonally or semi-permanently flooded water regimes (Boers and Zedler 2008, Bansal et al. 2019). Seasonally/semi-permanently flooded water regime stabilization was common in the Temperate Prairies (20% of wetland extent) and was strongly associated with degraded condition (Table D-14).
- Enhanced flashiness (the speed and magnitude that water levels rise and fall in response to storm events due to changes in the surrounding catchment) in waterbodies is largely influenced by catchment impervious surface and wetland storage (Hurley and Brandes 2024) and has been identified as a wetland vegetation stressor (Shaw and Schmidt 2003). Enhanced flashiness is described in the HDA by summing the % impervious surface (from the National Land Cover Database) and % drained wetland (from Restorable Wetland Inventory, verified with photo interpretation) within the immediate catchment and is rated severe at > 10% (Appendix B).
- Enhanced flashiness at the severe level occurred at 9% of wetland extent statewide and was responsible for most of the severe hydro-alteration ratings (Appendix D-15). Severe enhanced flashiness was common in the Mixed Wood Plains (19% of wetland extent) and most prevalent in the Temperate Prairies (45% of wetland extent). In both ecoregions, degraded vegetation was strongly associated with enhanced flashiness.

Invasive species

The invasive species HDA factor focuses primarily on non-native invasive vegetation, but also incorporates potential impacts from insect pests (e.g., Emerald Ash Borer) and fish (e.g., turbid water states due to carp; Peterson et al. [2022]) (Appendix B).

- Non-native invasive plant species play a unique role in wetland stressor-response relationships where they often increase in response to other stressors but may also act as a stressor independently and replace native plant communities in the absence of other stressors (Galatowitsch 2012). Previous MWCA iterations have established that high abundance of non-native invasives is the common denominator in virtually all the degraded condition wetland in the Mixed Wood Plains and Temperate Prairies (Bourdaghs et al. 2015, Bourdaghs et al. 2019).
- Non-native invasives were again the most important stressor affecting wetland vegetation quality in 2021 – both in terms of wetland extent at high non-native invasive cover statewide (12% or 1.2 million acres, Table D-16) and strength of association with poor condition as expressed in terms of relative risk (Figure 6).
- As with most of the other stressors, prevalence of non-native invasives varied regionally (Table D-16). In the Mixed Wood Shield, 43% of wetland extent had a non-native species present, but only 3% had high non-native invasive cover. Non-native invasives were much more prevalent in the Mixed Wood Plains and Temperate Prairies where virtually all wetland extent had a non-native species present (94% and 98% respectively) and high non-native invasive cover was widespread (33% and 53% of wetland extent, respectively).
- Reed canary grass and invasive cattail were the most impactful non-natives and were largely associated with the degraded vegetation condition found at fresh meadows and shallow marshes in the Mixed Wood Plains and Temperate Prairies (Table C-4).
- Emerald Ash Borer (EAB, *Agrilus planipennis*) wetland impacts were detected for the first time in the 2021 MWCA. First observed in Minnesota in 2009, EAB impacts are now widespread throughout the Twin Cities area and the southeastern part of the state with scattered populations present throughout much of the remainder of the state south of the Iron Range (MDA 2025). EAB causes near 100% fatality in all Minnesota ash species. Black ash swamps and floodplain forests that support abundant ash are facing large scale impacts (Figure 10) including

plant community conversion to emergent or scrub-shrub types (Diamond et al. 2018), altered hydrology (Slesak et al. 2014), and decreased water quality and carbon storage functioning (MN EQB 2019).

Figure 10. An intact black ash swamp in exceptional condition that supports 73 native plant species. Over a million acres of wetland with significant cover of ash trees is under threat by the Emerald Ash Borer.

- Ash trees (both green [*Fraxinus pensylvanica*] and black [*F. nigra*]) greater than 1" in diameter were widespread in Minnesota's wetlands with ash trees present at 33% of wetland extent statewide (Table D-17) and above 20% of wetland extent in all three ecoregions. Wetland with significant ash tree cover (> 15 % cover at the sample-site, typically black ash swamps or floodplain forest communities), which are at greatest risk for EAB impacts, was 13% of wetland extent (roughly 1.3 million acres) statewide.
- At the statewide scale, significant ash tree cover wetland with EAB present was 0.7% of wetland extent (or roughly 74,000 acres) with a wide margin of error (Table D-17). This equates to an estimated 6% of significant ash cover wetland impacted by EAB. EAB was also present at wetlands where ash trees were present but do not make up a significant portion of the plant community.
- As widespread tree mortality in Minnesota due to EAB is relatively recent and coincided with our sampling, the 2021 cycle had limited capacity to precisely describe the impact at these beginning stages. For context, the DNR's 2024 forest health report estimates 61,000 acres of wetland and upland forest with high EAB damage since 2016 (DNR 2025). Unfortunately, the extent of EAB impacted wetland is expected to increase in the future, with likely corresponding decreases in wetland vegetation condition. Research into alternative tree species to try to mitigate some of the ecological effects in black ash swamps (Palik et al. 2021), as well as recent

discoveries of “lingering ash” that have persisted in a healthy condition following an EAB outbreak and may lead to breeding resistant ash species (Penn State University 2025) are ongoing.

- Eastern Larch Beetle (*Dendroctonus simplex*) is a native species that has caused widespread mortality in Tamarack trees across the state since the current outbreak began in 2001. Eastern Larch Beetle damage was present at 4% of wetland extent (or roughly 275,000 acres) in the Mixed Wood Shield. This estimate is broadly consistent with the DNR’s estimate of 232,000 acres of Eastern Larch Beetle impacted forest (DNR 2025). While widespread, it is unclear, how the Eastern Larch Beetle outbreak affects overall wetland vegetation condition as *wC* criteria may need improvement for coniferous swamps and that understory saplings likely provide advance tree regeneration when canopy trees die (Shaunette 2022).

Conclusions

Minnesota’s overall wetland vegetation quality appears to be stable between 2011 and 2021, and therefore the no-net-loss goal for wetland quality and biological diversity is broadly being met for vegetation over the time period. The majority of Minnesota’s wetlands support high quality vegetation driven by the large share of wetlands in the northern region of the state, where human stressors are comparatively low, and wetlands are largely intact. Wetland vegetation quality, however, is largely degraded outside the Mixed Wood Shield, where human stressors are widespread. Wetlands in the Mixed Wood Plains are more likely to be in fair than poor condition, whereas wetlands in the Temperate Prairies are more likely to be in poor than fair condition. Some significant vegetation quality changes between MWCA cycles were detected at the regional scale, but they were most likely due to random and observational error.

While the statewide vegetation quality estimates are encouraging, there are ongoing concerns. Foremost among these are non-native invasive cattail and reed canary grass that are the common denominator in virtually all the degraded wetland in the Mixed Wood Plains and Temperate Prairies. Increased non-natives here correspond to a widespread backdrop of legacy wetland drainage, existence level hydro-alterations, and prior-plowing impacts, as well as ongoing impacts from water level stabilization and enhanced flashiness. Once non-native invasives become abundant, active management is typically required to enhance vegetation quality (Bohnen and Galatowitsch 2005) which is prohibitively expensive at large scales. In the Mixed Wood Shield, timber harvest in coniferous swamps is the most widespread type of stressor in the most extensive wetland type, though it is unclear whether the activity results in long term plant community change or simply a temporal impact where expected trees and the understory recover over time. Given the extent of logged coniferous swamp, further study is warranted. Wetland impacts due to Emerald Ash Borer are at the beginning stages and over a million acres of black ash swamp and ash floodplain forest plant communities are under threat in upcoming years as the outbreak continues to spread across Minnesota.

The MPCA intends to continue the MWCA to track wetland quality and potential impacts, with sampling for the next cycle scheduled to begin in 2026. Additional cycles will be needed to provide greater clarity on wetland vegetation quality trends. The 2021 cycle marks an improved ability to describe vegetation quality and human stressors in greater detail. Data from previous cycles will be enhanced with the subpopulation classifications and revised HDA to enable change analyses across all cycles moving forward.

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Appendix A – Wetland classification tables

Table A-1. Plant community classes and brief descriptions. The MWCA plant community classes provides the greatest level of wetland differentiation and is adapted from Eggers & Reed (2011). Two classes have been modified from the original system (Bourdaghs 2012). The MWCA Fresh Meadow class combines the Sedge Meadow and Fresh (Wet) Meadow classes found in Eggers & Reed (2011) into a single class and the Rich Fen class incorporates the Eggers and Reed (2011) Sedge Mat class as well as fen ecosystems not previously described.

Community Class	Description
Shallow Open Water	Open water aquatic wetland habitats with submergent and floating leaved aquatic species
Deep Marsh	Emergent vegetation rooted within the substrate that is typically inundated with > 6" of water throughout the year. Submergent and floating leaved aquatic species typically a major component of community
Shallow Marsh	Emergent vegetation on saturated soils or inundated with typically < 6" of water. May consist of a floating mat. Submergent and floating leaved aquatic species typically a minor component
Fresh Meadow	Graminoid dominated vegetation, typically on saturated or temporarily flooded soils
Wet Prairie	Similiar to Fresh Meadow but dominated by prairie grasses and forbs
Calcareous Fen	Soils calcareous peat (i.e., organic w/high pH) due to groundwater discharge with high levels of calcium/magnesium bicarbonates. Specialized calcareous indicator species (calciphiles) present-dominant
Rich Fen	Communities on circumneutral or slightly acidic peat soils. Often occurs as a floating mat with *Carex lasiocarpa* (wiregrass sedge) a dominant species. Occasionally shrub dominated.
Shrub-Carr	Tall shrub community typically dominated by Willows (*Salix* spp.). Understory species composition often similiar to Fresh Meadow
Alder Thicket	Tall shrub community typically dominated by Alder (*Alnus incana* ssp. *rugosa*)
Open Bog	Low shrub or graminoind dominated community on a mat of *Sphagnum* moss/acidic deep peat. Specilized acid tolerant (indicator) species dominant
Coniferous Bog	Forested community dominated by coniferous trees on a mat of *Sphagnum* moss/acidic deep peat. Specilized acid tolerant (indicator) species dominant
Coniferous Swamp	Forested community dominated by coniferous trees on saturated soils. Soils typically circumneutral to acidic
Hardwood Swamp	Forested community dominated by deciduous hardwood trees on saturated soils
Floodplain Forest	Forested community dominated by deciduous trees on alluvial soils associated with riverine systems

Table A-2. General wetland classes, abbreviations, and brief descriptions (EPA 2021). NWCA classes are adapted from the Cowardin classification system used in National Wetland Inventory (NWI) and DNR WSTMP mapping (FQDC 2013). They describe the general appearance of the wetland habitat in terms dominant vegetation or substrate and provide a moderate level of wetland differentiation, where each NWCA class includes one-many different plant communities.

NWCA Class	Abbreviation	Description
Forested	FO	Trees (> 6 m in height) are the dominant vegetation (> 30% cover). Corresponding plant communities: hardwood swamp, floodplain forest, coniferous swamp and coniferous swamp plant communities.
Scrub-Shrub	SS	Woody plants < 6 m are the dominant vegetation (> 30% cover). This includes tall shrubs (e.g., Willows, Alder), low-stature shrubs (e.g., Leatherleaf, Shrubby cinquefoil), and young or stunted trees. Corresponding plant communities: shrub-carr, alder thicket, open bog, rich fen (shrub dominant).
Emergent	EM	Herbaceous graminoids (e.g., Grasses, Sedges, Bulrushes), linear-leaved forbs (e.g., Cattails, Bur-reeds), and/or broad leaved forbs (e.g., Arrowhead) are the dominant vegetation and woody vegetation is < 30% cover. Corresponding plant communities: deep marsh, shallow marsh, fresh meadow, wet prairie, calcareous fen, rich fen, and open bog (sedge dominant).
Aquatic Bed-Unconsolidated Bottom	ABUB	Open water aquatic wetland habitats (< 1 m) that may or may not be vegetated with submergent (e.g., Coontail, Pondweeds) and/or floating-leaved (e.g., White water-lily) vegetation. Aquatic Bed (> 30% aquatic vegetation cover) and Unconsolidated Bottom (< 30% aquatic vegetation cover) are separate Cowardin classes but are combined into a single class for the N/MWCA. Corresponding plant community: shallow open water.

Table A-3. Cowardin water regimes, letter codes, and brief class descriptions (FDGC 2013). Water regimes describe long-term hydrologic wetland characteristics in terms of duration/timing of surface inundation and saturation within the soil. Only water regimes observed in the MWCA are listed here and they are listed in order from dry to wet (which does not correspond to the letter codes).

Water Regime	Letter Code	Description
Seasonally Saturated	B	Substrate is saturated at or near the surface at the growing season, but unsaturated conditions prevail by the end of the season in most years. Surface water typically absent except for a few days after heavy rain.
Temporarily Flooded	A	Surface water is present for a few days to a few weeks during the growing season due to precipitation or flooding, but the water table usually lies below the surface for most of the growing season.
Continuously Saturated	D	Substrate is saturated at or near the surface throughout the year (in most years). Widespread inundation is rare, though water may be present in shallow depressions or holes in floating vegetation mats.
Seasonally Flooded	C	Surface water is present for extended periods (> 1 month) during the growing season but is absent by the end of the season (in most years). When surface water is absent substrate often remains saturated at or near the surface.
Semi-permanently Flooded	F	Surface water persists throughout the growing season (in most years). Typically supports emergent vegetation.
Intermittently Exposed	G	Water covers the substrate throughout the year except during drought. Typically supports aquatic vegetation when flooded and annuals when substrate exposed.
Permanently Flooded	H	Water covers the substrate throughout the year in all years. Typically supports aquatic vegetation.

Table A-4. Hydrogeomorphic (HGM) wetland classes and brief class descriptions. HGM classification combines wetland geomorphic setting, water source, and water dynamics to group wetlands with similar hydrology and water quality functions. MWCA HGM classes were adapted from original HGM class definitions (Smith et al. 1995), NWCA classes (US EPA 2021), and Minnesota wetland hydrology classes (MN BWSR 2025).

HGM Class	Description
Depressional	Wetlands in topographical depressions with a closed elevation contour that allows for surface water accumulation. Water sources include precipitation, groundwater discharge, stream/ditch inputs, and saturation overland flow from the immediate catchment. May have any combination of inlets/outlets or be surrounded by uplands.
Depressional - Floodplain	Distinct topographical depressional wetlands within a larger floodplain that receive overbank flow during flooding events and retains water after overbank flow has receded.
Lacustrine Fringe	Wetlands adjacent to lakes where the lake water elevation maintains wetland hydrology. Surface water flow is bi-directional controlled by lake fluctuations. May occur as a floating vegetation mat.
Mineral Soil Flat	Topographically flat wetland areas lacking a closed elevation contour or bi-directional hydrology dynamics with a stream or lake with mineral soils (organic surface soil layer < 20 cm). Wetland hydrology is precipitation driven with soil saturation typically below the surface for most of the growing season.
Organic Soil Flat	Precipitation driven wetlands where vertical accretion of organic matter (e.g., peat) is a predominate process (organic surface soil layer ≥ 20 cm). Can occur in topographically flat areas that lack a closed elevation contour or in depressions that become filled with peat to form a flat surface.
Riverine - Lower Perennial	Wetlands occurring directly adjacent to 3rd order or higher streams where the dominant water source is from overbank flow from the channel.
Riverine - Upper Perennial	Wetlands occurring directly adjacent to 2nd order or lower streams that are precipitation or groundwater driven but also receive overbank flow from the channel.
Slope-Groundwater	Groundwater driven wetlands that lack a topographic contour. Typically, are located on sloping land (> 1 % slope) but may occur on flat areas where groundwater is a dominant source. Groundwater discharge maintains a continuously saturated water regime and organic soils often form. This is an infrequent type of wetland and often intergrades with other HGM classes.
Slope-Surface Water	Wetlands occurring on sloping (> 1 % slope) land where surface water is the dominant water source. Typically occurs at headwater wetlands with loamy/clayey soils where the surrounding topography directs surface water towards the wetland and water is held in the soil following precipitation and subsequent runoff.

Appendix B – General human disturbance assessment

The Human Disturbance Assessment (HDA) is a qualitative approach to systematically observe, document, and assess the severity of human stressors at MPCA wetland monitoring sample-sites. The HDA results are used for developing indicators and assessment criteria and as explanatory variables in the Minnesota Wetland Condition Assessment (MWCA).

Anthropogenic impacts/stressors are divided into five individual components (or factors) in the HDA:

- Landscape alteration
- Immediate catchment alteration
- Physical alteration
- Hydrologic alteration
- Invasive species

Stressor observations and a severity assessment are made for each component. An overall qualitative HDA severity rating (i.e., minimally, moderately, or severely impacted) is then derived for a wetland sample-site based on the combination of the component ratings. A severely impacted HDA rating can result from multiple impact categories being rated at least moderate levels of impact or when a single direct factor is rated at a severe level. Thus, the HDA can account for either cumulative impacts or a single overwhelming direct impact.

Defining an appropriate assessment scale for a sample-site is a key element of the HDA. While all wetlands share a common range of hydrology, soil, and vegetation characteristics, they occur over a wide variety of landforms and landscape settings and can develop under vastly different hydrological regimes. These differences in geomorphic setting and hydrologic processes can lead towards differences in how a wetland may interact with the surrounding landscape and/or the degree in which hydrologic alterations may affect wetland biota. In addition, wetlands are not often easily definable as distinct units on the landscape and MPCA sample-sites typically represent only portions of larger wetland complexes. Initial HDA steps consist of defining an HDA-Assessment Area – which is a relatively hydrologically homogenous wetland area (based on wetland hydrogeomorphic (HGM) classification) that includes the sample-site.

The goal is to assess the degree of stressors/impacts present at a wetland sample-site following a structured process based on what can be readily observed and/or reasonably interpreted through a combination of direct field observation, recent and historical aerial photo interpretation, geospatial data sources, and landowner accounts. Detailed sample-site history investigations such as comprehensive ownership history or subsurface drainage network determinations are beyond the scope of the HDA. Impacts that have occurred decades in the past (e.g., ditching, diking, plowing, road building) are typically in-scope if they continue to be readily observable/interpretable.

This current version replaces the HDA in use from 2008 to 2017 and it is designed more specifically towards wetland vegetation impacts. Modifications may be needed to appropriately adapt this version of the HDA for other biological assemblages (i.e., aquatic macroinvertebrates). Enhancements of the current version include:

- A standardized approach to defining an HDA-Assessment Area and the landscape alteration factor scale depending on HGM classification and connectivity to upgradient streams and lakes.

- Delineating the immediate catchment (*sensu* the Oregon Rapid Wetland Assessment Protocol and Minnesota Stream Quantification Tool) to assess nearby human land use impacts.
- Utilizing National Land Cover Database data and the percent perennial vegetation cover for the landscape alteration and immediate catchment alteration factors.
- Stepwise processes to assess physical and hydrologic alterations that expand on the approach used in EPA's National Wetland Condition Assessment (NWCA, EPA 2021)
- Explicit non-native invasive vegetation and Emerald Ash-Borer (EAB) cover criteria to assess invasive species impacts.

HDA procedure

The following numbered steps document the process to complete an HDA for a sample-site. The MPCA utilizes ArcGIS Pro to edit and manage the necessary feature classes, view, and summarize spatial data as well as an Access database to record impact observations and run logic-based processes.

1) Determine the HGM class of the sample-site

Wetland hydrogeomorphic (HGM) classification incorporates geomorphic setting, predominate water source, and hydrodynamics into a single system to provide a framework to assess wetland hydrology and water quality functions and is applied here to help define the HDA-Assessment Area.

Use the HGM key provided on the following page to determine the appropriate HGM class for the sample-site. Start with couplet #1 and choose the option which best applies to the sample-site. Proceed through subsequent couplets until a HGM class is identified.

The HGM classes and key were adapted from the original HGM class definitions (Smith et al. 1995), NWCA HGM key (EPA 2021), with refinements from Minnesota wetland hydrology classes (MN BWSR 2025). The classes and key incorporate the following concepts that have not been previously addressed:

- Floating vegetation mat wetlands
- Wetlands within depressional basins where vertical organic matter accumulation is a predominate process (i.e., organic soil flat)
- Topographically flat wetlands where groundwater is the predominate source (i.e., slope-groundwater)
- Contiguous saturated soil wetland with streams or lakes that are not floating and are largely above bi-directional flow influence from the stream or lake (i.e., flat or slope)
- Cowardin water regimes are referenced throughout the key. Definitions are summarized in Table A-4. The presence of a 20 centimeter (cm) or more organic soil layer has been adopted as a specification to differentiate between organic and mineral soil flats (Noble et al. 2015).

Key to the Hydrogeomorphic (HGM) Classes

1) Wetland is associated with a perennially flowing stream, floodplain, OR fringing a lake or reservoir . **2**

2) Wetland is associated with a perennially flowing stream or floodplain **3**

3) Stream is designated 1st or 2nd order in the National Hydrography Dataset (NHD) **4**

4) Regular overbank flooding occurs (e.g., there is an apparent change in water regime or vegetation close to the channel compared to broader contiguous wetland**)** .....**RIVERINE - Upper Perennial**

4) Regular overbank flooding typically *does not* occur (e.g., no apparent change in water regime or vegetation in broader contiguous wetland)..... **7**

3) Stream is designated 3rd order or higher in NHD and regular overbank flooding occurs **5**

5) Wetland lacks a closed topographic contour to retain water following overbank flooding conditions (i.e., the wetland is the floodplain) .....**RIVERINE - Lower Perennial**

5) Wetland has a closed topographic contour such that floodwater is retained relative to the adjacent floodplain wetland following overbank flooding conditions (i.e., a depression within a broader floodplain).....**DEPRESSIONAL - Floodplain**

2) Wetland is fringing a lake or reservoir (e.g., named lake in Public Water Inventory, has Limnetic NWI subsystem polygons in the continuous basin)..... **6**

6) Lake water elevation maintains wetland hydrology – surface water flows bi-directionally between the wetland and lake (wetlands with A, C, or F water regimes) AND/OR the wetland consists of a floating mat (with a C or D water regime) ..... **LACUSTRINE FRINGE**

6) Wetland elevation above typical high water lake elevation and not consisting of a floating mat (typically wetlands with a D water regime that are not floating)..... **7**

1) Wetland is not associated with a perennially flowing stream channel, floodplain, or fringing a designated lake..... **7**

7) Wetland is within a closed elevation contour that allows for water accumulation (i.e., a depressional basin, includes beaver and manmade impoundments and excavations) **8**

8) Wetland has a predominately D water regime, is not floating, AND vertical accretion of peat has produced a flat surface ..... **ORGANIC SOIL FLAT**

8) Wetland has any other predominate water regime or has a D water regime, consists of a floating mat, and does not have significant vertical accretion of peat..... **DEPRESSIONAL**

7) Wetland is not within a closed elevation contour..... **9**

9) Wetland is on a topographic slope (e.g., > 1% percent slope) **10**

10) Groundwater is the primary water source (e.g., histic epipedon/histosol, groundwater indicator species).....**SLOPE – Groundwater**

10) Precipitation is the primary water source (e.g., groundwater indicator species not prevalent) ..... **SLOPE – Surface Water**

9) Wetland is topographically flat (e.g., < 1% slope)..... **11**

11) Wetland has predominately mineral soil (if organic surface layer present, < 20 cm in depth) .....**MINERAL SOIL FLAT**

11) Wetland has predominately organic soil (an organic surface layer ≥ 20 cm present) **12**

12) Precipitation is the primary water source..... **ORGANIC SOIL FLAT**

12) Groundwater is the primary water source (e.g., groundwater indicator spp. present) .....**SLOPE - Groundwater**

2) Delineate the HDA-Assessment Area

The MPCA wetland monitoring sample-sites are often established over a small portion of much larger wetland complexes (Bourdaghs 2019x). When this occurs, the sample-site scale may be too small to accurately account for important hydrological and/or landscape scale impacts acting upon the larger wetland system the sample-site is located in.

The HDA-Assessment Area represents a hydrologically homogenous wetland area that includes the sample-site where it is reasonable to assume that hydrology and immediate landscape scale stressors act upon (Figure B-1). The HDA-Assessment Area establishment depends on HGM class and connectivity to upstream drainage networks to appropriately account for water sources/dynamics and scale. They may be limited in size to the sample-site boundary depending on how the boundary was established and HGM type or they can extend to include an entire depressional wetland or lake basin. The landscape alteration area and immediate catchment scales (where landscape metrics are calculated) are defined based on the HDA-Assessment Area.

The following information sources are used to delineate HDA-Assessment Areas in ArcGIS Pro:

- HDA-Assessment Area feature class
- National Wetland Inventory (NWI, HGM attributes, water regime, polygons)
- Aerial photography
- 2’ elevation contours (MN Topo)
- Public Waters Inventory (PWI)
- Web Soil Survey
- National Hydrography Dataset (NHD)
- DNR Watershed Suite (DNR Level 8/9, flow network, pour-points)
- Quaternary geology (i.e., glacial landforms)
- Field observations

Use the following guidelines to delineate an HDA-Assessment Area according to the HGM class determined in step 1:

Depressional & Depressional-Floodplain (Figure B-1A,B)

- HDA-Assessment Area = the upland margin OR HGM class boundary the sample-site occurs in (i.e., the entire depressional basin is the HDA-Assessment Area).
- Use basin barriers (e.g., beaver dams, dikes, roads), water regime changes where fill-spill dynamics occur (e.g., transitions from C to D water regimes), and constrictions as basin breakpoints.
- Floating vegetation mats with C/F water regimes are considered depressional up to a transition where the vegetation is no longer floating/D water regime (i.e., the change in water regime represents an HGM type transition).
- For large diked systems: use mapped pool units or DNR Level 8-9 watershed boundaries and pour-points (in addition to water regime transitions) as basin breakpoints.

Lacustrine Fringe (Figure B-1C)

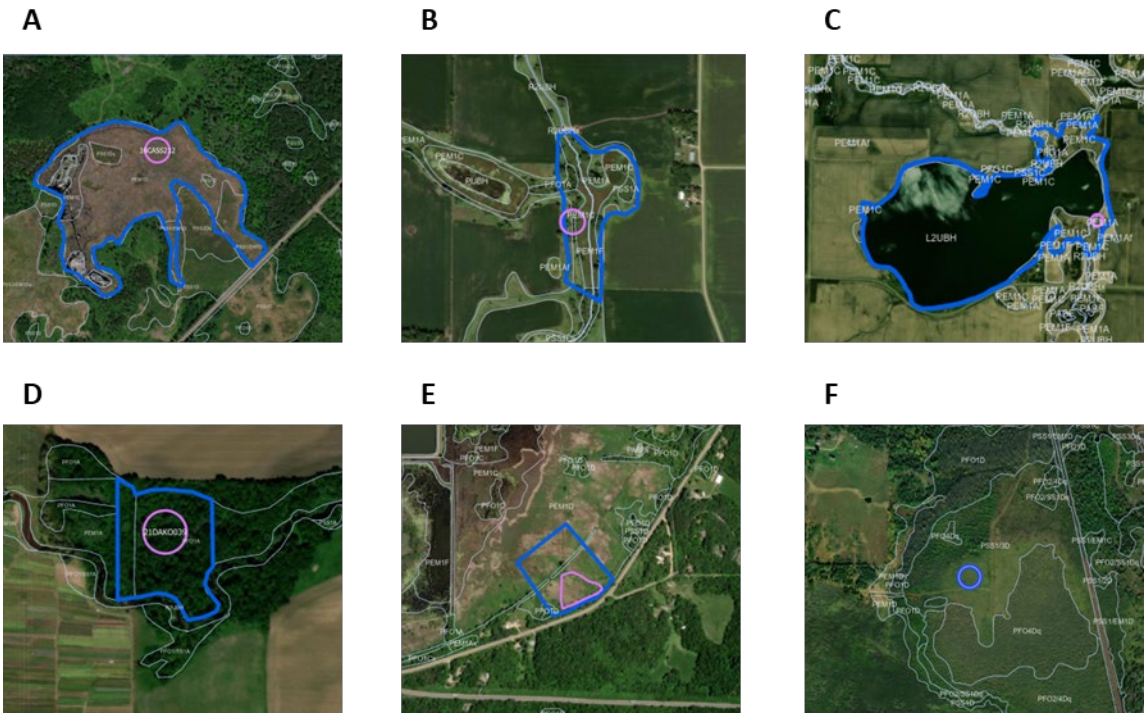
- HDA Assessment Area = the open water lake basin plus adjacent wetland with A, C, and F water regimes or adjacent wetland with D water regime if a floating mat.

- Contiguous wetland with D water regime that is not floating typically does not have bi-directional flow dynamics with the lake and more appropriately classed as an HGM Flat or Slope.
- Use established Public Waters Inventory basin delineations to define smaller units on large lakes.

Riverine-Upper & Lower Perennial (Figure B-1D)

- Longitudinal boundaries (i.e., boundaries running parallel to stream-flow):
    - If the sample-site excludes the stream channel → Longitudinal boundaries are the upland margin/HGM class boundary and the stream channel.
    - If the sample-site includes the stream channel → Longitudinal boundaries are the upland margin/HGM class boundary on both sides of the valley.
- Lateral boundaries (i.e., boundaries running perpendicular to stream-flow):
    - 3x the stream channel width both downstream and upstream from the sample-site boundary (up to 80 m).
        - Example*:* Stream channel is 10 m wide → Lateral boundaries should be 30 m down/upstream from the sample-site boundaries.

Figure B-1. Example HDA-Assessment Areas (A-F). Purple = sample site boundary. Blue = HDA Assessment Area. Light blue = National Wetland Inventory. A) Beaver impounded floating mat depressional wetland: HDA-Assessment Area boundaries at the dam, uplands, and saturated soil wetland. B) Depressional wetland: HDA-Assessment Area boundaries at uplands and basin constrictions. C) Lacustrine fringe wetland: HDA-Assessment Area boundaries include entire lake basin plus adjacent wetland with A and/or C water regimes. D) Riverine-lower perennial wetland: HDA-Assessment Area boundaries at the upland margin, channel, and 3x the channel width from the sample site. E) Slope-groundwater wetland: HDA-Assessment Area boundaries at the upland margin (southeast), depressional wetland transition (northwest), and approximately the longitudinal boundary distance. F) Extensive organic soil flat wetland: HDA-Assessment Area boundaries equal the sample-site boundary.



Slope-Groundwater & Surface Water (Figure B-1E)

- Longitudinal boundaries (i.e., boundaries running perpendicular to the wetland slope/groundwater discharge) → The upland margin and the receiving waterbody margin (stream, lake, or different HGM wetland).
- Lateral boundaries (i.e., boundaries running parallel to the wetland slope/groundwater discharge) → Approximately equal to the distance between the longitudinal boundaries.

Organic & Mineral Soil Flat

- HDA-Assessment Area depends on the landform context, scale, and whether vertical accumulation of peat is a predominate process.
- Choose the option that best applies:
    - Overall landform of the area where the sample-site occurs in is +/- flat (e.g., landscape is flat for miles in all directions) → HDA Assessment Area =sample-site boundary.
    - Sample-site is located within a glacial outwash swale (i.e., moderately broad area of saturated soil wetland that has parallel sides but can extend for miles in either direction with no distinct topographic contour to pond surface water) → HDA Assessment Area = sample-site boundary.
    - Organic soil flat HGM wetland (i.e., vertical accumulation of peat) within a large (> 100 ac) depressional basin → HDA Assessment Area = sample-site boundary.
    - Organic soil flat HGM wetland (i.e., vertical accumulation of peat) within a moderate – small (≤ 100 ac) depressional basin → HDA Assessment Area = entire depressional basin.

3) Delineate the Landscape Alteration factor area

Prior to completing the Landscape Alteration HDA factor, an appropriately scaled area around the HDA-Assessment Area used to tabulate land use metrics must first be delineated. The previous HDA iteration relied on a 500 m buffer as a standard Landscape Alteration HDA factor scale. A buffer approach is a reasonable approximation to describe surrounding land use but has limitations in riverine, lacustrine, and depressional HGM systems that have significant drainage areas (i.e., a 500 m buffer may vastly under-represent the actual area that is draining to the wetland).

As spatial data and GIS capabilities have improved in past 10-15 years, we now can create small to large scale watersheds much more readily. This provides the ability to scale a Landscape Alteration factor up if a significant (and mapped) drainage area exists for an HDA-Assessment Area. In cases where an HDA-Assessment Area is too small and/or lacks surface connectivity to upstream waters (e.g., isolated depressional wetland) or is an organic/mineral flat system where precipitation is the primary water-source, and the wetland has little surface water interaction with the surrounding landscape – a buffer continues to be the preferred approach. The buffer distance has been increased to 1,000 m due to adopting the immediate catchment scale to tabulate nearby land use metrics.

The following data sources are used to delineate Landscape Alteration factor areas in ArcGIS Pro:

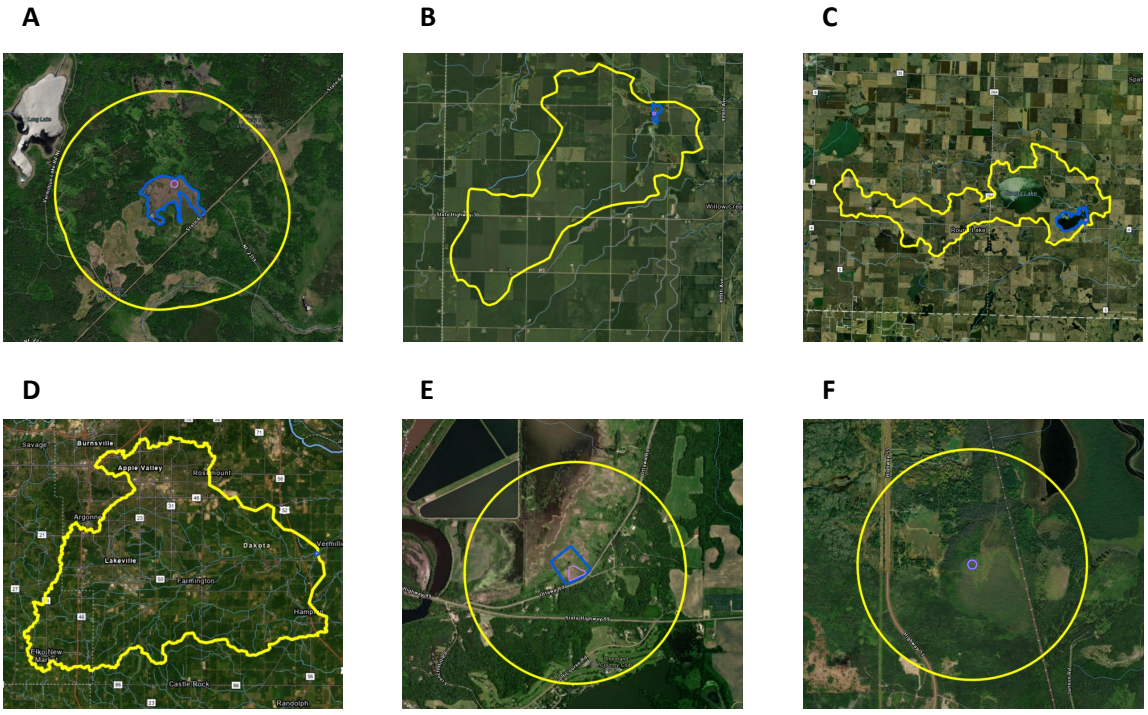
- HDA-Assessment Area and Landscape Factor Area feature classes
- National Hydrography Dataset (NHD)
- DNR Watershed Suite
- Hydrologic Unit Code (HUC) level 08 (for drainage delineations that extend beyond MN)

Use Table B-1 to determine which landscape alteration type is needed depending on the HDA-Assessment Area type and upstream surface water connectivity. Buffers are then generated as a batch process and upstream drainage areas selected and edited from appropriate established watershed units.

Table B-1. Landscape alteration area types by HDA-Assessment Area type and upstream surface water connectivity.

	Upstream Surface Water Connectivity	
HDA-Assessment Area Type	**None OR stream/ditch input 1st order**	**Stream/ditch input ≥ 2nd order**
Depressional OR Organic Soil Flat - within ≤ 100 ac basin (Figure B-2A, B)	1,000 m buffer	Immediate catchment + entire upstream drainage area
Lacustrine Fringe (Figure B-2C)	Immediate catchment + entire upstream drainage area	
Riverine-Upper Perennial OR Riverine-Lower Perennial OR Depressional-Floodplain (Figure B-2D)	Immediate catchment + entire upstream drainage area	
Slope-Groundwater OR Slope-Surface Water (Figure B-2E)	1,000 m buffer	
Organic Soil OR Mineral Soil Flat (all other settings, Figure B-2F)	1,000 m buffer	

Figure B-2. Example landscape alteration factor areas (A-F). Purple = sample site boundary. Blue = HDA Assessment Area. Yellow = landscape alteration factor area. A) Beaver impounded floating mat depressional wetland with 1st order incoming stream: landscape alteration factor area = 1,000m buffer. B) Depressional wetland with 2nd order incoming stream: landscape alteration factor area = upstream drainage area. C) Lacustrine fringe wetland: landscape alteration area = upstream drainage area. D) Riverine-lower perennial wetland: landscape alteration area = upstream drainage area. E) Slope-groundwater wetland: landscape alteration area = 1,000 m buffer. F) Extensive organic soil flat: landscape alteration area = 1,000 m buffer.



4) Calculate percent perennial vegetation cover within the Landscape Alteration area and rate the factor

Historically, most of Minnesota's landscape was permanently vegetated. Outside of the Mixed Wood Shield ecoregion, almost all of Minnesota's native vegetation has now been replaced with agricultural fields or urban development, which are much less efficient at absorbing precipitation. In addition, many of Minnesota's waterways have been altered (i.e., ditched) and approximately half of the pre-settlement wetlands have been drained. This results in higher runoff rates carrying more sediment, nutrients, and other pollutants to our present-day lakes, streams, and wetlands which can negatively affect their quality.

Watershed percent perennial vegetation cover is a well-established landscape scale metric that has a strong positive relationship with water quality, and it can be readily calculated using the National Land Cover Database (NLCD, Table B-2). The general equation is:

% Perennial Cover = Land area with perennial veg cover/(total area – open water)

Table B-2. 2019 National Land Cover Database (NLCD) perennial vegetated and non-perennial vegetated classes.

Perennial Veg NLCD Classes	Non-perennial Veg NLCD Classes
Deciduous Forest	Developed Open Space
Evergreen Forest	Developed Low Intensity
Mixed Forest	Developed Medium Intensity
Shrub/Scrub	Developed High Intensity
Grassland/Herbaceous	Barren Land
Moss	Cultivated Crops
Pasture/Hay	
Woody Wetlands	
Emergent Herbaceous Wetlands	

Area is tabulated for each NLCD class within the landscape alteration areas and percent perennial vegetation cover is calculated in a batch process. The landscape alteration factor is then rated according to criteria adapted from the DNR Watershed Health Assessment Framework (Table B-3).

Table B-3. Percent perennial vegetation cover Landscape and Immediate Catchment Alteration factor rating criteria.

% Perennial Cover	Landscape/Immediate Catchment Alteration Rating
> 80%	Minimal
60 - 80%	Low
30 - 60%	Moderate
< 30%	Severe

5) Delineate the immediate catchment of the HDA-Assessment Area

An immediate catchment needs to be delineated around the HDA-Assessment Area before percent perennial vegetation cover, impervious surface, and drained wetland metrics utilized in the Immediate Catchment and Hydrologic Alteration HDA factors can be tabulated.

The immediate catchment is the drainage area that contributes runoff *directly* to the HDA-Assessment Area not via ≥ 2nd order streams or bi-lateral flow from a lake or stream (*sensu* the "lateral drainage area" in the Minnesota Stream Quantification Tool [SQT, MNSQT SC 2020] or the "runoff contributing area" in the Oregon Rapid Wetland Assessment Protocol [ORWAP, Adamus and Verble 2020]). The drainage area scale via ≥ 2nd order streams or riverine/lacustrine bi-lateral flow is captured at the larger landscape alteration area scale (see part 3).

The upper elevation limits of an immediate catchment are the topographic breaks where precipitation can possibly drain towards an HDA-Assessment Area and the pour points of any upgradient depressional wetlands and lakes. Upgradient depressional wetlands and lakes are often hydrologic gate-keeper systems in watersheds that store runoff and have internal biogeochemical processes to provide water quantity and quality functions and should be excluded from a wetland HDA-Assessment Area immediate catchment. The lower elevation limit of an immediate catchment is the HDA-Assessment Area boundary.

The following data sources are used to delineate immediate catchments in ArcGIS Pro:

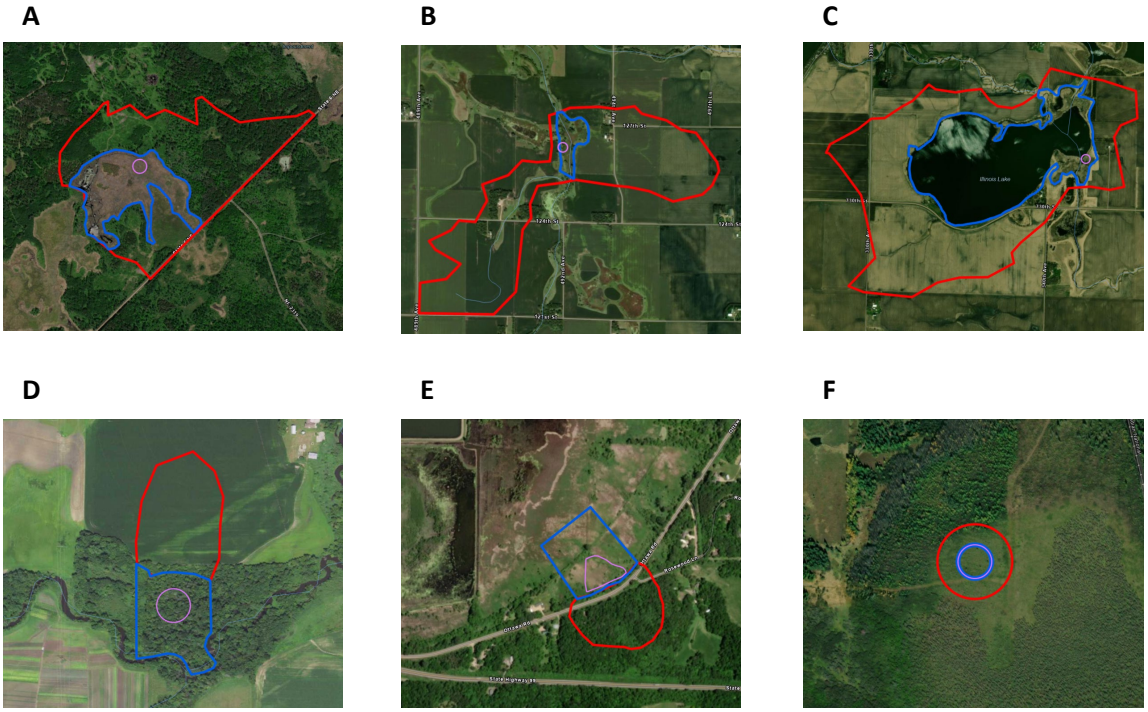
- HDA-Assessment Area and Immediate Catchment feature classes
- National Wetland Inventory (NWI, HGM attributes, water regime, polygons)
- Aerial photography
- National Hydrography Dataset (NHD)
- DNR Watershed Suite (DNR Level 8/9, flow network, pour-points)
- 2' elevation contours (MN Topo)
- Field observations

Immediate catchments are manually delineated in ArcGIS Pro for the majority of HDA-Assessment Area types (Table B- 4, Figure B-3 A-B, C-E) according to the above guidelines. Exceptions are for Lacustrine Fringe (where the immediate catchment drains to the lake scale and established watersheds are readily available at that scale) and Organic and Mineral Soil flats that are not associated with a ≤ 100 ac depressional basin (where precipitation is the dominant water source and the broader wetland often lacks a definable catchment). For these HDA-Assessment Area types, aggregated DNR Level 09 watersheds and 50 m buffers are respectively employed to delineate the immediate catchment.

Table B-4. Immediate catchment types by HDA-Assessment Area type.

HDA-Assessment Area Type	Immediate catchment type
Depressional OR Organic Soil Flat - within ≤ 100 ac basin (Figure B-3A, B)	Manual delineation
Lacustrine Fringe (Figure B-3C)	Aggregated DNR Level 09 watersheds that intersect the HDA-Assessment Area (deleting down gradient area)
Riverine-Upper Perennial OR Riverine-Lower Perennial OR Depressional-Floodplain (Figure B-3D)	Manual delineation
Slope-Groundwater OR Slope-Surface Water (Figure B-2E)	Manual delineation
Organic Soil OR Mineral Soil Flat (all other settings, Figure B-2F)	50 m buffer

Figure B-3. Example immediate catchments (A-F). Purple = sample site boundary. Blue = HDA Assessment Area. Red = immediate catchment. A) Beaver impounded floating mat depressional wetland with 1st order incoming stream: immediate catchment excludes drainage from the southeast due to a depressional wetland. B) Depressional wetland with 2nd order incoming stream: immediate catchment excludes drainage from the south and west due to other depressional wetlands intercepting surface flow. C) Lacustrine fringe wetland: immediate catchment = aggregated DNR Level 09 watersheds. D) Riverine-lower perennial wetland: immediate catchment = upland area draining directly to the HDA-Assessment Area. E) Slope-groundwater wetland: immediate catchment = upland area draining directly to the HDA-Assessment Area. F) Extensive organic soil flat: immediate catchment = 50 m buffer.



6) Calculate percent perennial vegetation cover within the immediate catchment and rate the factor

This process is the same as part 4 (percent perennial vegetation cover and rating the Landscape Alteration HDA factor) but at the immediate catchment scale. Area is tabulated for each NLCD class within the immediate catchments for a set of data, percent perennial vegetation cover is calculated, and the immediate catchment is rated as a batch process (Table B-3).

7) Assess the physical alteration within the *sample-site boundary*

The Physical Alteration HDA factor describes direct soil and vegetation impacts at the sample-site scale. Any hydrology changes that result from a soil or vegetation impact within a sample-site are addressed in the Hydrologic Alteration HDA factor (e.g., ditching through a sample-site constitutes a direct physical soil impact as well as a water addition/subtraction impact).

Two primary concepts are applied in the Physical Alteration HDA factor: the general severity (e.g., soil excavation vs. vegetation removal) and extent (e.g., a cut trail through a sample-site vs. timber harvest over the entire sample-site) of the alteration. Recency of vegetation alterations is also factored into the rating (e.g., timber harvest occurred < 5 years ago vs. timber harvest occurred > 30 years ago and expected trees are well established).

The previous iteration of the HDA incorporated severity/extent/recency concepts into the Physical Alteration factor but relied on a best-professional-judgement based approach (following narrative guidance) to make the rating.

The approach presented here follows a stepwise and observation-based progression. Severity and recency are addressed through systematically categorizing different types of physical alterations and extent is incorporated by making cover estimates. The categorization and cover approach to describing physical alterations was adapted from EPA's National Wetland Condition Assessment (EPA 2021).

The following data sources are used to make human physical alteration observations within a sample-site:

- Sample-site feature class
- Aerial photography (recent and historical as available)
- Hillshade (LIDAR)
- MPCA altered watercourse layer
- Field observations
- Site history accounts provided by landowners/managers

Follow the below numbered sequence to complete a Physical Alteration HDA rating for a sample-site:

1) List all the observed human physical alteration types (Table B-5) present within the sample-site boundary and estimate the extent of the *affected area* of each by cover class (Table B-6). Also, narratively describe the physical alteration observations in the notes. Include information source details and approximate timelines of the impact (e.g., 2003 aerial photography showed wetland was farmed, wetland restored by 2008 photography).

Table B-5. Human physical alteration types and definitions. Types are categorized primarily as either a soil or vegetation removal physical alteration (or both for grazing). Veg-removal types are further sub-categorized as unvegetated, altered, or recovered/recovering. All soil modification, veg-removal unvegetated, and veg-removal altered categories/sub-categories are considered as a severe level of impact in the HDA. Veg-removal recovered/recovering is considered a low to moderate level of impact.

Physical alteration type	Category	Vegetation Sub-Category	Definition
Prior Plowing	Soil modification	Not Applicable	Wetland currently supporting hydrophytic vegetation but soil tilling/plowing from agricultural practices has occurred in the past (from direct field evidence, historical aerial photography interpretation, or landowner account)
Active Plowing			Soil tilling/plowing for agricultural practices is actively occurring in current or previous growing season
Grading			Soil surface has been modified by machinery to alter the natural grade
Vehicle Damage			Vehicle ruts or off-road vehicle damage to the soil surface in the wetland (Note: vehicle use on raised roadbeds should be captured in the Fill category)
Filling			Fill has been added to the wetland (e.g., for road/railroad beds, development etc, often limited to a boundary of the wetland sample site)
Excavation			Active or historic excavation or dredging, including cattle/wildlife ponds, channels/ditches
Sedimentation			Freshly deposited or historical deposition of soil/sediment as a result of human activities
Pipeline			Presence of oil/gas/utility pipeline
Grazing	Soil modification/ Veg removal	Unvegetated OR Altered OR Recovered/ Recovering	Livestock have been grazed on the site, consuming living vegetation and compacting/plugging the soil
Logging	Vegetation removal		Trees have been recently cut or clear evidence (stumps, aerial photography) of logging in the past
Shrub Removal			Cutting (or herbicide application) of shrubs (e.g., to maintain powerline corridors)
Mowing			Mowing of emergent vegetation (e.g., to maintain trails)
Haying			Cutting emergent vegetation for livestock fodder
Fire Suppression			Evidence of fire suppression (e.g., site located near/within cities, surrounded by agricultural fields) within a naturally fire-dependent landscape (e.g., Temperate Prairies ecoregion, naturally fire-dependent forest type) and/or plant community, such that fire-dependent species are absent/depressed and fire intolerant species are abundant (e.g., non-native invasives, woody species). Type is noted but not currently used in the rating
Herbicide			Evidence of herbicide use (e.g., broad-based cattail treatment)

Table B-6. Cover classes and ranges.

Cover Class	Range
1	> 0 - 1%
2	> 1 - 5%
3	> 5 - 25%
4	> 25 - 50%
5	> 50 - 75%
6	> 75 - 95%
7	> 95 - 100%

2) Each vegetation removal physical alteration type and grazing needs to be further sub-categorized based on the recency of the impact and the species composition/abundance distribution of the recovering vegetation.

   Choose the vegetation removal sub-category that best applies:

   - **UNVEGETATED** – The physical impact was recent, and the affected area has not yet revegetated (e.g., herbicide treated area largely un-vegetated) OR for logged areas regenerating trees < 6' in height.
   - **ALTERED** – Affected area has largely re-vegetated following the physical alteration, but has *significantly different species composition and/or abundance distribution compared to the expected native plant community* (e.g., replacement of native vegetation with non-native invasives, area can be classified as a different plant community)
   - **RECOVERED/RECOVERING** – Affected area has largely re-vegetated following the physical alteration and the *species composition/abundance distribution is generally within expectations for the native plant community* (e.g., following logging expected tree spp. > 6' in height)

3) Estimate the composite extent of the SOIL MODIFICATION, VEG REMOVAL-UNVEGETATED, and VEG REMOVAL-ALTERED physical alterations (Table B-5) within the sample-site by cover-class (Table B-6). Estimate cannot exceed 95-100% cover. This provides the overall footprint of all soil modification, veg removal-unvegetated and veg removal-altered physical impacts within the sample-site, ignoring any overlap between different individual impacts.

4) Estimate the composite extent of the VEG REMOVAL-RECOVERED/RECOVERING physical alterations (Table B-5) within the sample-site by cover-class (Table B-6). Estimate cannot exceed 95-100%.

5) Use the physical alteration rating matrix (Table B-7) to make the overall physical alteration factor rating based on the composite SOIL MODIFICATION/VEG REMOVAL-UNVEGETATED/VEG REMOVAL-ALTERED cover and the VEG REMOVAL-RECOVERED/RECOVERING cover.

Table B-7. Physical alteration impact rating matrix by cover class range of veg removal-recovered/recovering (rows) and soil modification/veg removal-unvegetated/veg-removal altered composite cover. For example, if >50 - 75% of a sample-site had been logged (but the trees were regenerating and > 6' tall) and a winter logging road (vehicle use) had >1-5% cover: Veg Removal Recovered/Recovering = > 50 -75% and Soil Modification = >1 - 5% resulting in an overall "Moderate" physical alteration rating.

		SOIL MODIFICATION/VEG REMOVAL-UNVEGETATED and VEG REMOVAL-ALTERED composite cover							
		0	> 0 - 1%	> 1 - 5%	> 5 - 25%	> 25 - 50%	> 50 - 75%	> 75 - 95%	> 95 - 100%
VEG REMOVAL-RECOVERED/RECOVERING	0	Minimal	Minimal	Low	Moderate	Severe	Severe	Severe	Severe
	> 0 - 1%	Minimal	Minimal	Low	Moderate	Severe	Severe	Severe	Severe
	> 1 - 5%	Minimal	Low	Low	Moderate	Severe	Severe	Severe	Severe
	> 5 - 25%	Low	Low	Moderate	Moderate	Severe	Severe	Severe	
	> 25 - 50%	Low	Moderate	Moderate	Severe	Severe	Severe		
	> 50 - 75%	Moderate	Moderate	Moderate	Severe	Severe			
	> 75 - 95%	Moderate	Moderate	Moderate	Severe				
	> 95 - 100%	Moderate	Moderate	Moderate					

8) Assess the hydrologic alteration with the *HDA-Assessment Area*

The Hydrologic Alteration HDA factor describes human alterations to a wetland's natural hydrologic regime. Wetland hydro-alterations are not unidirectional meaning that increases OR decreases to wetland water volume, flooding duration/frequency, and/or water source changes may represent a significant change to wetland hydrology and constitute a significant impact to wetland vegetation.

The hydro-alteration HDA factor addresses three independent hydro-alteration processes – any of which could result in a severe impact:

- Water Regime Change
- Seasonally/Semi-Permanently Flooded Water Regime Stabilization
- Enhanced Flashiness

The general approach is to first record observed human hydro-alteration impacts and estimate their extent within the HDA-Assessment Area and calculate landscape metrics within the immediate catchment/upstream drainage area. The HDA-Assessment Area scale is applied here as hydro-alterations tend to occur at scales larger than the sample-site and the HDA-Assessment Area is assumed are hydrologically homogenous units. A series of questions is then completed for each independent hydro-alteration process which results in a rating for each process. The overall hydro-alteration factor rating (minimal, low, moderate, severe) is then the most impacted rating of the three hydro-alteration processes.

The following data sources are used to make hydro-alteration observations for an HDA-Assessment Area:

- HDA-Assessment Area feature class
- Aerial photography (recent and historical as available)
- National Hydrography Dataset (NHD)
- DNR Watershed Suite (DNR Level 8/9, flow network, pour-points)
- 2' elevation contours (MN Topo)

- Hillshade (LIDAR)
- MPCA altered watercourse layer
- NLCD impervious surface
- Restorable Wetland Inventory (RWI)
- Field observations
- Sample-site history accounts provided by landowners/managers

Follow the below numbered sequence to complete the hydro-alteration HDA factor:

Hydro-alteration observations

The first part of the Hydro-Alteration HDA process is to systematically describe any/all hydro-alterations within (or immediately adjacent to) an HDA-Assessment Area, compute surrounding landscape metrics, and (in cases where there have been existence level hydro-alterations such as diking, excavation, complete drainage/restoration) determine whether include/exclude those observations.

1) List all the observed human hydro-alteration types present within (or immediately adjacent to) the HDA-Assessment Area (Table B-8) and estimate the extent of the affected area within the HDA-Assessment Area of each by cover class (Table B-6). Often a single ditch or control structure can affect the hydrology of the entire HDA-Assessment Area.

Table B-8. Human hydro-alteration types and definitions. Hydro-alteration types categorized as a water addition, water subtraction, or flow obstruction.

Hydro-alteration type	Category	Definition
Ditch (outflow)	Water Subtraction	Ditch (or channelized stream) routing water away from the wetland (includes lateral effect)
Tile (drainage/outlet)		Tile drainage within the wetland or a surface tile outlet
Water Withdrawal		Any type of water withdrawal pump that is removing water directly from the wetland, or is nearby and likely has a lateral effect on the water table
Ditch (inflow)	Water Addition	Ditch (or channelized stream) routing water to the wetland (includes road ditches and channels to direct stormwater or agricultural field runoff)
Tile (inflow)		Drainage tile routing water to the wetland from the surrounding landscape
Point Source/Pipe		Point source pipe for routing effluent, sewer outfall, or stormwater to HDA-AA (may be within proximity of the HDA-AA and have a clear drainage path)
Dam/Dike/Control Structure	Flow Obstruction	A barrier constructed by humans, or a barrier constructed by beaver against a human-made structure (e.g., culvert) that is perpendicular to the direction of flow, holding back water and artificially raising and stabilizing the water level
Berm/levee		Artificially-raised banks (typically constructed parallel to river flow) that obstructs natural flooding dynamics
Road/RR bed		Artificially-raised road, railroad, or walkway above low ground
Excavation		Recent or historical removal of wetland soil for the purposes of increasing the water storage volume, resource extraction (e.g., gravel mining) or extent of open water in the wetland (e.g., wildlife habitat)
Incised channel		Stream running through (or immediately adjacent) to HDA-AA is incised thereby decreasing natural flooding dynamics from the stream to the wetland **APPLIES ONLY IN HGM RIVERINE WETLANDS

2) Estimate the composite hydro-alteration extent (i.e., overall footprint of all the hydrologically affected area considered in aggregate) within the HDA-Assessment Area accounting for overlapping hydro-alterations. Estimate cannot exceed 95-100%.

3) Tabulate the % impervious surface in the immediate catchment (or at the landscape alteration area scale for riverine wetlands) from NLCD data. This is calculated as a batch process in ArcGIS Pro.

4) Tabulate verified % drained wetland in the immediate catchment (or at the landscape alteration area scale for riverine wetlands) from RWI data. RWI area is first calculated as a batch process in ArcGIS Pro. RWI is then visually inspected within the immediate catchment. RWI pixels at ≥40% probability that occur on developed land is considered "verified" drained wetland. RWI pixels occurring on un-developed lands and at the margin or throughout other wetlands are likely false positives and not drained wetland. Visually estimate RWI pixels on developed lands and record the verified % drained wetland.

5) Sum % impervious surface and % verified drained wetland within the immediate catchment/landscape alteration area.

6) Is the reason that the HDA-Assessment Area exists in its current state due to a human made hydrologic alteration (e.g., excavated open water, diked wetland, reservoir, drained/restored lakebed) AND the intention of the biological monitoring is to assess the sample-site in its current state[1]?

   - YES → Ignore the human hydro-alteration activities that created the HDA-Assessment Area for the remainder of the hydro-alteration assessment (~ 8% of cases statewide)
   - NO → Consider all interpretable human hydro-alteration activities during the hydro-alteration assessment (most cases)

Water regime change

This sequence rates hydro-alteration severity in terms of interpretable water regime change. If hydro-alterations are observed, but no interpretable water regime change also occurred the impact is rated low. Water regime changes associated with large scale changes in vegetation (e.g., continuously saturated (D) supporting native sedges changed to semi-permanently flooded (F) supporting non-native cattail) are rated as severe.

7) Have any potential hydro-alterations been observed in (or immediately adjacent to) the HDA-Assessment Area (excluding any hydro-alterations identified in question #6)?

   - YES → Continue to Question #8
   - NO → Water regime change process rating = **MINIMAL** (continue to question #8)

[1] The goal of MPCA wetland monitoring is to detect/describe wetland changes due to human impacts – including impacts that result in a wetland type change. A wetland can be assessed as a former type if the change is clearly attributable to a direct human impact (e.g., drainage, control structures, excavations) *AND* evidence of the former type is present (e.g., remnant characteristic species/features, dead/dying shrubs/trees, historic aerial photography, landowner accounts). If a change cannot be attributed to a direct human impact or evidence of former type is absent – the wetland should be assessed as the current type.

8) Is the composite hydro-alteration extent within the HDA-Assessment Area ≤ 5%?

   - YES → Water regime change process rating = **LOW** (continue to question #10)
   - NO → Continue to question #9

9) Has the dominant long-term Cowardin water regime within the hydrologically affected area changed due to the hydro-alteration?

   - YES → Use the water regime change table to determine the magnitude of the impact (Table B-9) and continue to question #10
   - NO → Water regime change = **LOW** (continue to question #8)

Table B-9. Human caused water regime change impact ratings. First, find the interpreted initial dominant water regime (left hand column) and then compare to the observed water regime following the hydro-alteration (middle and right-hand columns in the same row). For example, if a wetland had a continuously saturated (D) water regime and a water subtraction impact (e.g., ditching) changed to the water regime to seasonally saturated (B), the resulting impact has a moderate rating. Conversely, if the site had a water addition impact (e.g., diking) with the water regime altered to semi-permanently flooded (F), the resulting impact has a severe rating.

	Change in dominant water regime due to human impact	
Initial dominant water regime	**Moderate level of impact**	**Severe level of impact**
Temporarily Flooded (A) OR Seasonally Saturated (B)	Continuously Saturated (D)	Seasonally Flooded (C) OR Semi-permanently Flooded (F) OR Intermittently Exposed (G) OR Permanently Flooded (H)
Continuously Saturated (D)	Temporarily Flooded (A) OR Seasonally Saturated (B)	Seasonally Flooded (C) OR Semi-permanently Flooded (F) OR Intermittently Exposed (G) OR Permanently Flooded (H)
Seasonally Flooded (C) OR Semi-permanently Flooded (F)	Continuously Saturated (D)	Temporarily Flooded (A) OR Seasonally Saturated (B) OR Intermittently Exposed (G) OR Permanently Flooded (H)
Permanently Flooded (H) OR Intermittently Exposed (G)	Semi-permanently Flooded (F)	Temporarily Flooded (A) OR Seasonally Saturated (B) OR Continuously Saturated (D) OR Seasonally Flooded (C)

Seasonally/Semi-permanently flooded water regime stabilization

Man made water control structures that stabilize seasonally (C) and semi-permanently (F) wetland water regimes promote increases non-native cattail abundance (Boers and Zedler 2008, Bansal et al. 2019).

10) Is the dominant HDA-Assessment Area water regime (based on desktop and field interpretation) C or F?

   - YES → Continue to question #11
   - NO → Seasonally/Semi-permanently flooded water regime stabilization process = **NOT APPLICABLE** (continue to question #12)

11) Is the water level in the HDA-Assessment Area stabilized as a C/F water regime behind a man-made structure (e.g., dike, road, control structure)?

- YES → Seasonally/Semi-permanently flooded water regime stabilization rating = **SEVERE** (continue to question #12)
- NO → Seasonally/Semi-permanently flooded water regime stabilization = **MINIMAL** (continue to question #12)

Enhanced Flashiness

Flashiness reflects the frequency, rapidity, and magnitude of short-term water level in response to storm events. Increased catchment impervious surfaces and decreased wetland storage is related to increased flashiness.

12) What is the summed % impervious surface and verified % drained wetland in the immediate catchment (or at the landscape alteration area scale for riverine HGM wetlands?

- < 1% → Enhanced Flashiness = **MINIMAL**
- > 1 – 5% → Enhanced Flashiness = **LOW**
- > 5 – 10% → Enhanced Flashiness = **MODERATE**
- > 10% → Enhanced Flashiness = **SEVERE**

Overall Hydro-Alteration HDA Factor Rating

Choose the highest-level impact rating (i.e., greatest level of impact along the "minimal" to "severe" categorical scale) from the three independent hydro-alteration process ratings as the overall Hydro-Alteration factor rating. For example, if water regime change was rated "Low", C/F water regime stabilization rated "Severe", and enhanced flashiness rated "Low" the overall hydro-alteration rating would be "Severe".

9) Assess invasive species within the *sample-site boundary*

In most instances, the presence and/or an increased abundance of non-native invasive plants in wetlands is associated with other human impacts. There are, however, cases where invasive plants become established and/or non-native vegetation abundance increases in the absence of other stressors. Thus, non-native invasive vegetation can also be considered as an independent type of impact. It is often difficult to separate whether non-native invasives are acting as a response or an independent stressor as different types of impacts often co-occur, but high abundance of non-native invasive species is the common denominator in the large majority vegetation-degraded wetland in Minnesota (Bourdaghs et al. 2015).

Non-native animals (or the rearing of native fish in wetlands) can also directly impact wetland vegetation. This includes insects like the Emerald Ash Borer, which cause near total mortality in stands of mature ash trees, and fish (e.g., Common Carp, Fathead Minnow) in open water depressional wetlands that cause turbid water conditions that negatively impact aquatic vegetation.

The invasive species HDA factor addresses three established pathways that invasive species negatively impact wetland vegetation in Minnesota:

- Non-native vegetation cover
- Turbid water state in open-water wetlands
- Emerald Ash Borer (EAB)

The general approach is to answer a series of questions for each invasive species pathway at the *sample-site* scale. The overall invasive species factor rating (minimal, low, moderate, severe) is the most impacted rating of the three (*sensu* the Hydro-Alteration HDA factor ratings).

Non-native vegetation cover

1) Sum the midpoint non-native vegetation cover for the entire sample-site (i.e., weighted by community extent) and rate according to the following criteria:
   - < 1% → Non-native vegetation cover = **MINIMAL**
   - 1 - 25% → Non-native vegetation cover = **LOW**
   - 25 – 50% → Non-native vegetation cover = **MODERATE**
   - > 50% → Non-native vegetation cover = **SEVERE**

Turbid water state in open-water wetlands

2) Are Shallow Open Water (SOW) and/or Deep Marsh plant communities present in the sample-site (these plant communities typically have a water column with Permanently Flooded (H) or Intermittently Exposed (G) water regimes and submergent/floating leaved aquatic vegetation)?
   - YES → Continue to question #3
   - NO → Turbid water state pathway = **NOT APPLICABLE**

3) Is most of the SOW/Deep Marsh plant community in a turbid water state (e.g., extensive turbid water, Secchi tube reading < 45 cm, pockets of turbid water in otherwise clear water do not constitute a turbid water state)?
   - YES → Continue to question #4
   - NO → Turbid water state pathway = **MINIMAL**

4) Is there *direct* evidence that invasive fish are present in SOW/Deep Marsh portion of the sample-site OR it is being used for minnow aquaculture (e.g., landowner/manager account, carp wallowing, bait traps present)?
   - YES → Use the below criteria to rate the turbid water state pathway based on the extent of mapped SOW/Deep Marsh plant communities within the sample-site:
     - SOW/Deep Marsh is 1 - 25% → Turbid water state pathway = **LOW**
     - SOW/Deep Marsh is 25 - 50% → Turbid water state pathway = **MODERATE**
     - SOW/Deep Marsh is > 50% → Turbid water state pathway = **SEVERE**
   - NO → Continue to question #5

5) Is there *indirect* evidence that invasive fish may be present (e.g., intermittent-permanent surface water connection between the sample-site and a stream or lake with a documented invasive fish population)?
   - YES → Use the below criteria based on the extent of mapped SOW/Deep Marsh plant communities within the sample-site:
     - SOW/Deep Marsh is 1 - 50% → Turbid water state = **LOW**
     - SOW/Deep Marsh is > 50% → Turbid water state = **MODERATE**
   - NO → Turbid water state = **LOW**

Emerald Ash Borer (EAB)

The approach taken to assess EAB impacts can apply to other insect pests (native or non-native) and effected host species including Eastern Larch Beetle (ELB) and Tamarack as well as the Cottony Ash Psyllid (CAP, which no verified Minnesota reports have been made) and Ash.

6) Are live or dead ash trees (with > 1" DBH) present at the sample-site?
   - YES → Continue to question #7
   - NO → Emerald Ash Borer pathway = **NOT APPLICABLE**
7) Use Table B-10 to rate EAB impacts based on the observed infestation severity and the summed midpoint cover of all *Fraxinus* species at the sample-site (i.e., weighted by community extent)

Table B-10. Emerald Ash Borer (EAB) impact ratings based on observed infestation and the total midpoint cover of ash species at the sample-site.

		Total midpoint cover of *Fraxinus* @ site						
		> 0 - 1%	**> 1 - 5%**	**> 5 - 25%**	**> 25 - 50%**	**> 50 - 75%**	**> 75 - 95%**	**> 95 - 100%**
Observed EAB Infestation Severity	**No EAB Observed**	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	A Few Trees w/EAB	Minimal	Low	Low	Low	Low	Low	Low
	Many Trees w/EAB	Minimal	Low	Moderate	Severe	Severe	Severe	Severe
	Most/All Trees w/EAB	Minimal	Low	Moderate	Severe	Severe	Severe	Severe

Overall Invasive Species HDA Factor Rating

Choose the highest impact rating (i.e., greatest level of impact along the "minimal" to "severe" categorical scale) from the three independent invasive species impact pathway ratings.

10) Complete the overall HDA rating

The overall HDA rating for a sample-site is derived from combinations from the five HDA factor ratings:

- Landscape alteration
- Immediate catchment alteration
- Physical alteration
- Hydrologic alteration
- Invasive species

Make the overall sample-site HDA rating according to the following criteria:

Minimally Impacted HDA Rating:

- No single HDA factor rated greater than "Low" severity
- No more than four HDA factors rated at "Low" severity (i.e., if all five factors are rated "Low" the overall HDA rating would be Moderately Impacted)
- At least one of the direct HDA factors (Physical Alteration, Hydro-Alteration, Invasive Species) rated as "Minimal"

Moderately Impacted HDA Rating:

- Any combination of HDA factor ratings that indicate impacts between the Minimally and Severely Impacted rating criteria

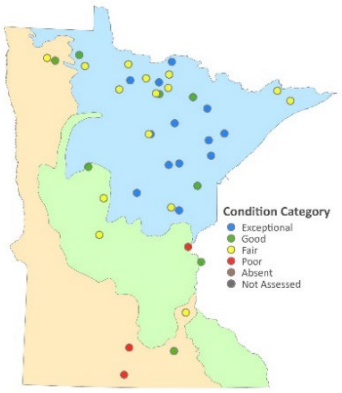
Severely Impacted HDA Rating:

- Any of the direct HDA factors (Physical Alteration, Hydro-Alteration, Invasive Species) rated as "Severe" (i.e., a single overwhelming direct impact)
- Four or more of the HDA factors rated as "Moderate" (e.g., if Landscape, Physical, Hydro-Alteration, and Invasive Species factors are all rated "Moderate" the overall HDA rating is Severely Impacted)

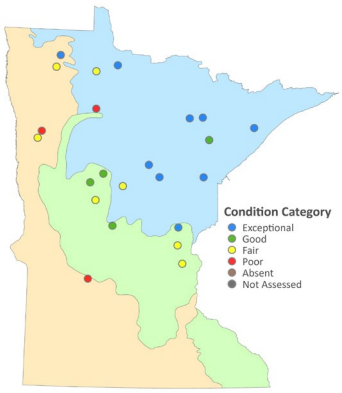
Appendix C – Detailed wetland vegetation condition estimates

Figure C-1 (A – D). 2021 MWCA monitoring site locations by general wetland class and vegetation condition category with Omernik level II ecoregions: A) Forested (FO), B) Scrub-shrub (SS), C) Emergent (EM), D) Aquatic Bed/Unconsolidated Bottom (ABUB).

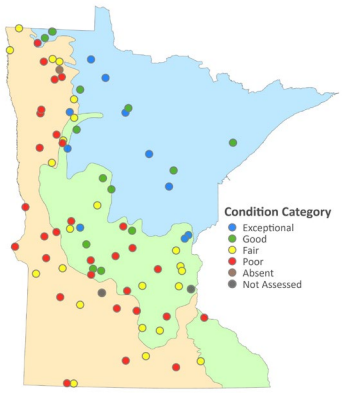
A



B



C



D

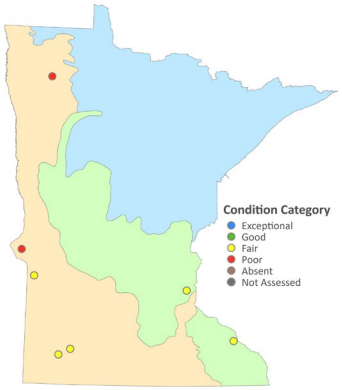


Table C-1. 2021 statewide and regional wetland extent and condition estimates by general wetland classes: Forested (FO), Scrub-Shrub (SS), Emergent (EM), Aquatic Bed/Unconsolidated Bottom (ABUB). Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Extent	General Wetland Class	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
State	FO	39	4,143,541	806,916	41.7	8.0	59.1	14.8	39.2	14.7	1.8	1.7
	SS	23	1,856,823	735,900	18.7	7.4	67.9	17.3	22.6	16.7	9.5	11.9
	EM	81	3,763,632	719,426	37.9	6.9	57.4	7.9	16.9	5.9	24.2	7.7
	ABUB	7	167,029	103,613	1.7	1.0	0.0	0.0	76.9	24.2	23.1	24.2
Mixed Wood Shield	FO	28	3,851,148	780,403	52.8	10.7	60.7	15.7	39.3	15.7	0.0	0.0
	SS	11	1,512,951	711,940	20.8	9.8	72.7	21.4	18.2	20.9	9.1	14.8
	EM	14	1,925,574	638,137	26.4	8.8	92.9	11.6	0.0	0.0	7.1	11.6
	ABUB	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mixed Wood Plains	FO	5	176,842	128,328	10.4	7.6	40.0	42.8	40.0	41.7	20.0	34.1
	SS	7	247,579	144,673	14.6	8.5	57.1	34.1	42.9	34.1	0.0	0.0
	EM	34	1,202,529	174,249	70.8	10.3	29.4	12.8	35.3	13.7	32.4	13.9
	ABUB	2	70,737	80,959	4.2	4.8	0.0	0.0	100.0	0.0	0.0	0.0
Temperate Prairies	FO	6	115,551	69,553	12.2	7.4	33.3	37.3	33.3	34.9	33.3	32.8
	SS	5	96,292	68,459	10.2	7.3	20.0	32.6	40.0	42.8	40.0	40.6
	EM	33	635,529	112,007	67.3	11.9	3.0	5.2	33.3	14.0	60.6	14.9
	ABUB	5	96,292	64,473	10.2	6.8	0.0	0.0	60.0	38.1	40.0	38.1

Figure C-2 (A – E). 2021 MWCA monitoring site locations by Cowardin water regime and vegetation condition category with Omernik level II ecoregions: A) Seasonally Saturated and Temporarily Flooded, B) Continuously Saturated, C) Seasonally Flooded, D) Semi-permanently Flooded, E) Intermittently Exposed and Permanently Flooded.

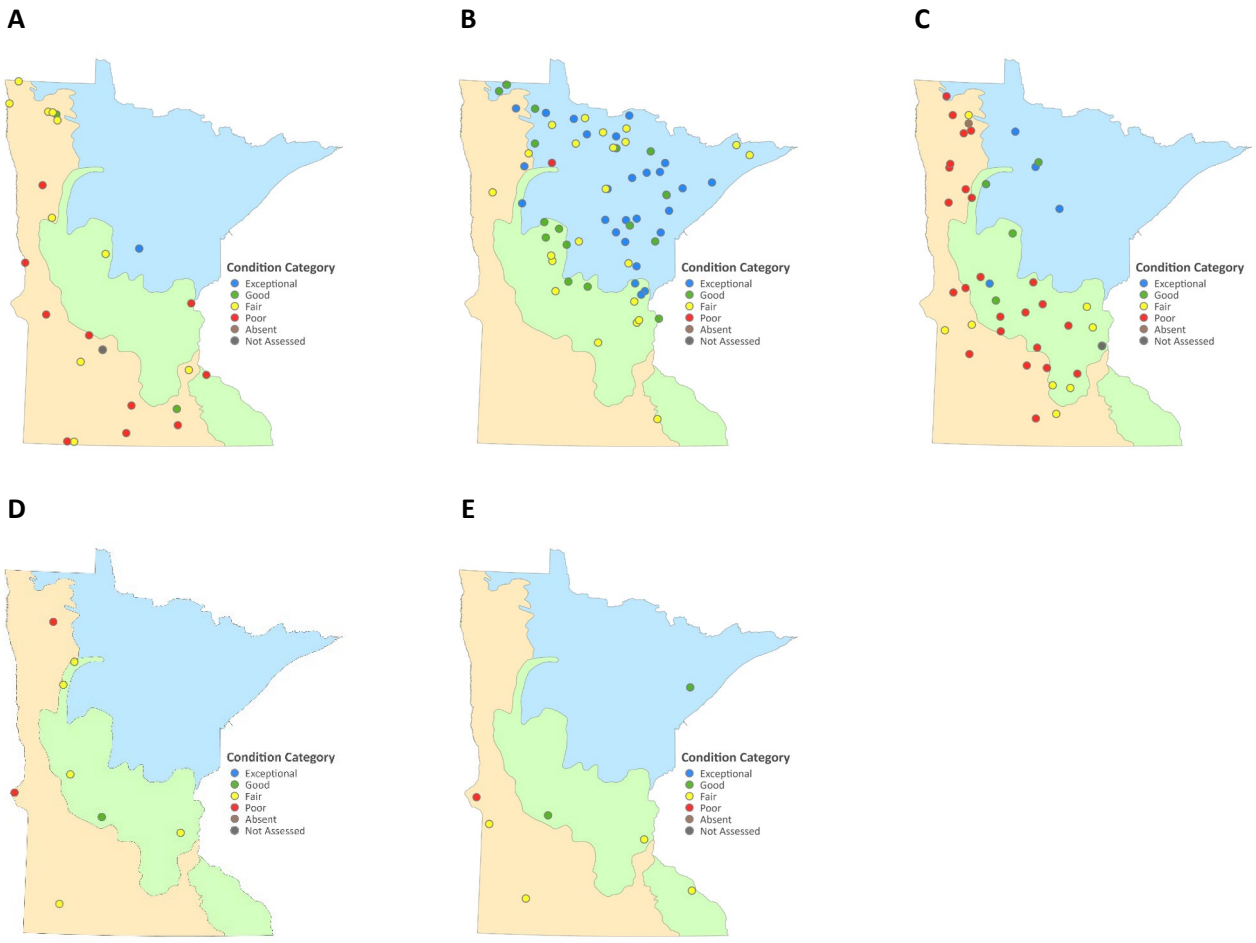


Table C-2. 2021 statewide and regional wetland extent and condition estimates by predominant HDA-Assessment Area Cowardin water regime. Water regimes are sorted from dryest to wettest and National Wetland Inventory codes are provided in parentheses. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Extent	Cowardin Water Regime	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
State	Seasonally Saturated (B)	1	137,541	235,260	1.4	2.4	0.0	0.0	100.0	0.0	0.0	0.0
	Temporarily Flooded (A)	24	628,816	264,523	6.3	2.7	28.0	27.4	33.2	18.9	35.8	18.4
	Continuously Saturated (D)	67	6,800,839	689,640	68.5	6.3	69.0	9.9	29.0	9.6	2.0	3.1
	Seasonally Flooded (C)	43	1,827,790	549,447	18.4	5.4	43.4	11.8	12.0	6.6	42.7	12.4
	Semi-permanently Flooded (F)	8	234,618	145,431	2.4	1.5	15.1	25.5	68.5	31.2	16.4	21.2
	Intermittently Exposed (G)	1	19,258	31,183	0.2	0.3	0.0	0.0	100.0	0.0	0.0	0.0
	Permanently Flooded (H)	6	282,163	263,418	2.8	2.7	61.3	40.3	31.9	37.6	6.8	12.4
Mixed Wood Shield	Seasonally Saturated (B)	1	137,541	238,257	1.9	3.3	0.0	0.0	100.0	0.0	0.0	0.0
	Temporarily Flooded (A)	1	137,541	221,708	1.9	3.0	100.0	0.0	0.0	0.0	0.0	0.0
	Continuously Saturated (D)	44	6,051,803	625,004	83.0	8.6	70.5	11.2	27.3	11.1	2.3	3.7
	Seasonally Flooded (C)	6	825,246	491,951	11.3	6.7	83.3	26.6	0.0	0.0	16.7	26.6
	Semi-permanently Flooded (F)	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Intermittently Exposed (G)	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Permanently Flooded (H)	1	137,541	238,933	1.9	3.3	100.0	0.0	0.0	0.0	0.0	0.0
Mixed Wood Plains	Seasonally Saturated (B)	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Temporarily Flooded (A)	3	106,105	106,973	6.3	6.3	0.0	0.0	33.3	53.5	66.7	53.5
	Continuously Saturated (D)	19	672,001	180,673	39.6	10.6	57.9	17.1	42.1	17.1	0.0	0.0
	Seasonally Flooded (C)	18	636,633	194,730	37.5	11.5	16.7	14.4	22.2	14.5	55.6	19.7
	Semi-permanently Flooded (F)	5	176,842	123,651	10.4	7.3	20.0	34.2	80.0	34.2	0.0	0.0
	Intermittently Exposed (G)	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

			Extent Estimates				Condition Estimates					
Geographic Extent	**Cowardin Water Regime**	**n**	**Wetland Extent (ac)**	**Extent (±)**	**% Wetland**	**% (±)**	**% Excep-tional/ Good**	**% (±)**	**% Fair**	**% (±)**	**% Poor/ Absent**	**% (±)**
	Permanently Flooded (H)	3	106,105	100,172	6.3	5.9	33.3	53.5	66.7	53.5	0.0	0.0
Temperate Prairies	Seasonally Saturated (B)	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Temporarily Flooded (A)	20	385,169	108,437	40.8	11.5	10.0	12.0	45.0	18.5	40.0	17.7
	Continuously Saturated (D)	4	77,034	56,819	8.2	6.0	50.0	48.5	50.0	48.5	0.0	0.0
	Seasonally Flooded (C)	19	365,911	113,566	38.8	12.0	0.0	0.0	21.1	16.6	78.9	16.6
	Semi-permanently Flooded (F)	3	57,775	55,242	6.1	5.9	0.0	0.0	33.3	53.5	66.7	53.5
	Intermittently Exposed (G)	1	19,258	31,183	2.0	3.3	0.0	0.0	100.0	0.0	0.0	0.0
	Permanently Flooded (H)	2	38,517	44,407	4.1	4.7	0.0	0.0	50.0	69.5	50.0	69.5

Figure C-3 (A – F). 2021 MWCA monitoring site locations by Hydrogeomorphic (HGM) type and vegetation condition category with Omernik level II ecoregions: A) Depressional, B) Lacustrine Fringe, C) Mineral Soil Flat, D) Organic Soil Flat, E) Riverine – Lower Perennial, F) Slope-Groundwater.

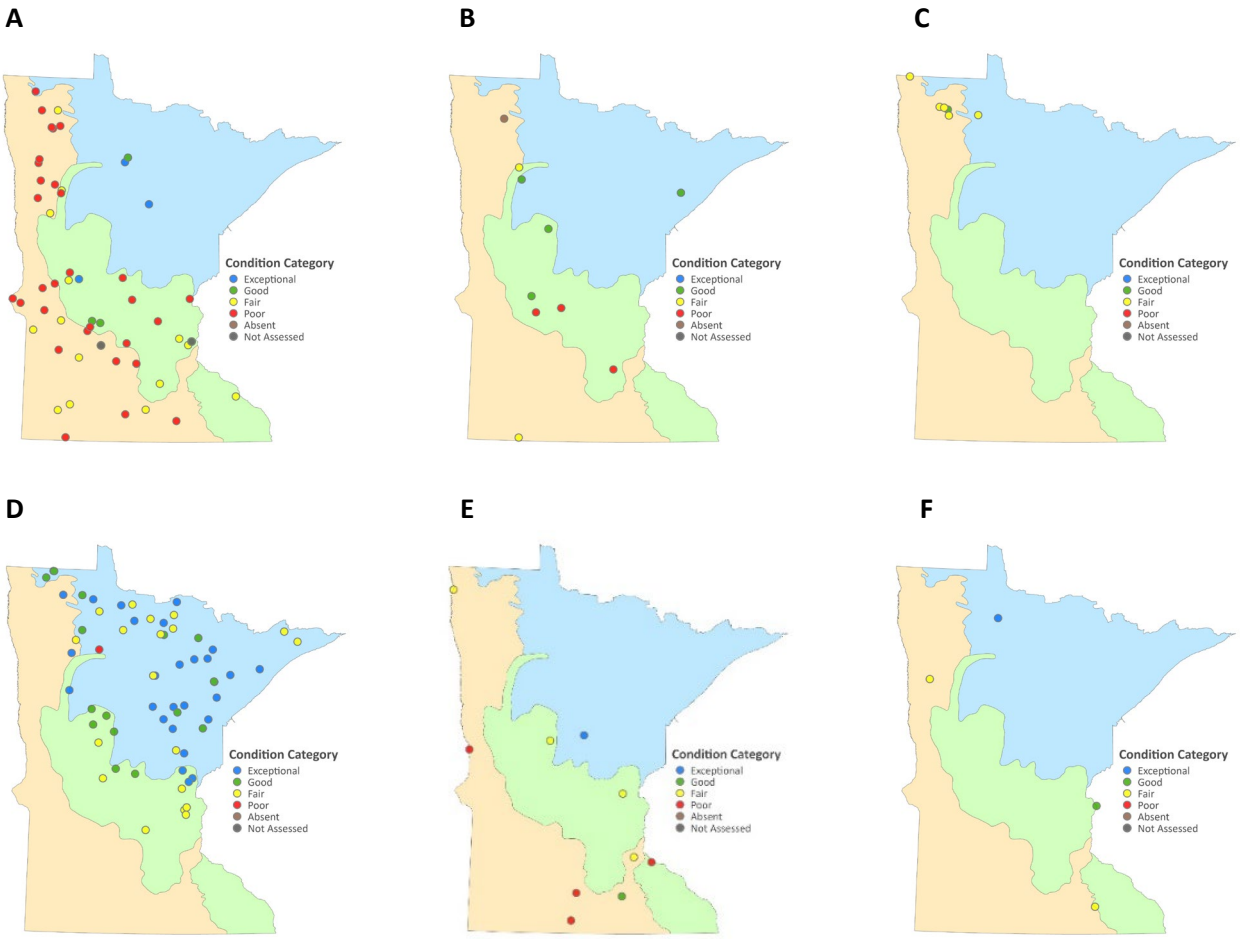


Table C-3. 2021 statewide and regional wetland extent and condition estimates by predominant Hydrogeomorphic (HGM) wetland class. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Extent	HGM Class	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
State	Depressional	53	1,783,809	452,527	18.0	4.5	29.1	10.2	20.5	8.9	47.3	11.5
	Depressional - Floodplain	2	54,627	70,381	0.6	0.7	0.0	0.0	100.0	0.0	0.0	0.0
	Lacustrine Fringe	10	525,810	339,467	5.3	3.4	65.8	26.2	10.4	15.3	23.8	20.2
	Mineral Soil Flat	6	233,833	243,104	2.4	2.5	8.2	17.1	91.8	17.1	0.0	0.0
	Organic Soil Flat	63	6,573,302	660,726	66.2	6.2	70.8	9.9	27.1	9.6	2.1	3.2

			Extent Estimates				Condition Estimates					
Geographic Extent	HGM Class	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
	Riverine - Lower Perennial	10	359,197	244,953	3.6	2.5	43.7	44.0	30.4	31.9	25.9	24.9
	Riverine - Upper Perennial	2	172,909	223,080	1.7	2.2	0.0	0.0	100.0	0.0	0.0	0.0
	Slope-Groundwater	4	227,536	243,600	2.3	2.5	76.0	36.2	24.0	36.2	0.0	0.0
	Slope-Surface Water	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mixed Wood Shield	Depressional	4	550,164	210,229	7.5	5.7	75.0	40.5	0.0	0.0	25.0	40.5
	Depressional - Floodplain	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Lacustrine Fringe	2	275,082	166,517	3.8	4.5	100.0	0.0	0.0	0.0	0.0	0.0
	Mineral Soil Flat	1	137,541	121,562	1.9	3.3	0.0	0.0	100.0	0.0	0.0	0.0
	Organic Soil Flat	43	5,914,262	317,257	81.1	8.5	72.1	11.0	25.6	10.8	2.3	3.8
	Riverine - Lower Perennial	1	137,541	113,118	1.9	3.0	100.0	0.0	0.0	0.0	0.0	0.0
	Riverine - Upper Perennial	1	137,541	110,910	1.9	3.0	0.0	0.0	100.0	0.0	0.0	0.0
	Slope-Groundwater	1	137,541	116,313	1.9	3.1	100.0	0.0	0.0	0.0	0.0	0.0
	Slope-Surface Water	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mixed Wood Plains	Depressional	18	636,633	188,447	37.5	11.1	16.7	14.8	33.3	17.6	44.4	20.0
	Depressional - Floodplain	1	35,368	58,020	2.1	3.4	0.0	0.0	100.0	0.0	0.0	0.0
	Lacustrine Fringe	6	212,211	141,491	12.5	8.3	33.3	36.0	16.7	26.4	50.0	32.1
	Mineral Soil Flat	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Organic Soil Flat	17	601,264	178,022	35.4	10.5	58.8	16.0	41.2	16.0	0.0	0.0
	Riverine - Lower Perennial	3	106,105	105,291	6.3	6.2	0.0	0.0	66.7	53.5	33.3	53.5

			Extent Estimates				Condition Estimates					
Geographic Extent	**HGM Class**	**n**	**Wetland Extent (ac)**	**Extent (±)**	**% Wetland**	**% (±)**	**% Excep-tional/ Good**	**% (±)**	**% Fair**	**% (±)**	**% Poor/ Absent**	**% (±)**
	Riverine - Upper Perennial	1	35,368	57,567	2.1	3.4	0.0	0.0	100.0	0.0	0.0	0.0
	Slope-Groundwater	2	70,737	80,090	4.2	4.7	50.0	69.5	50.0	69.5	0.0	0.0
	Slope-Surface Water	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperate Prairies	Depressional	31	597,013	104,561	63.3	11.1	0.0	0.0	25.8	13.4	71.0	14.0
	Depressional - Floodplain	1	19,258	32,892	2.0	3.5	0.0	0.0	100.0	0.0	0.0	0.0
	Lacustrine Fringe	2	38,517	45,451	4.1	4.8	0.0	0.0	50.0	69.5	50.0	69.5
	Mineral Soil Flat	5	96,292	57,118	10.2	6.1	20.0	34.3	80.0	34.3	0.0	0.0
	Organic Soil Flat	3	57,775	46,020	6.1	4.9	66.7	53.5	33.3	53.5	0.0	0.0
	Riverine - Lower Perennial	6	115,551	69,009	12.2	7.3	16.7	27.7	33.3	35.3	50.0	38.4
	Riverine - Upper Perennial	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Slope-Groundwater	1	19,258	34,500	2.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0
	Slope-Surface Water	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure C-4 (A – J). 2021 MWCA monitoring site locations by plant community type and vegetation condition category with Omernik level II ecoregions: A) Alder Thicket, B) Coniferous and Open Bog, C) Coniferous Swamp, D) Floodplain Forest, E) Fresh Meadow, F) Hardwood Swamp, G) Rich Fen, H) Shallow Marsh, I) Shallow Open Water, J) Shrub-Carr.

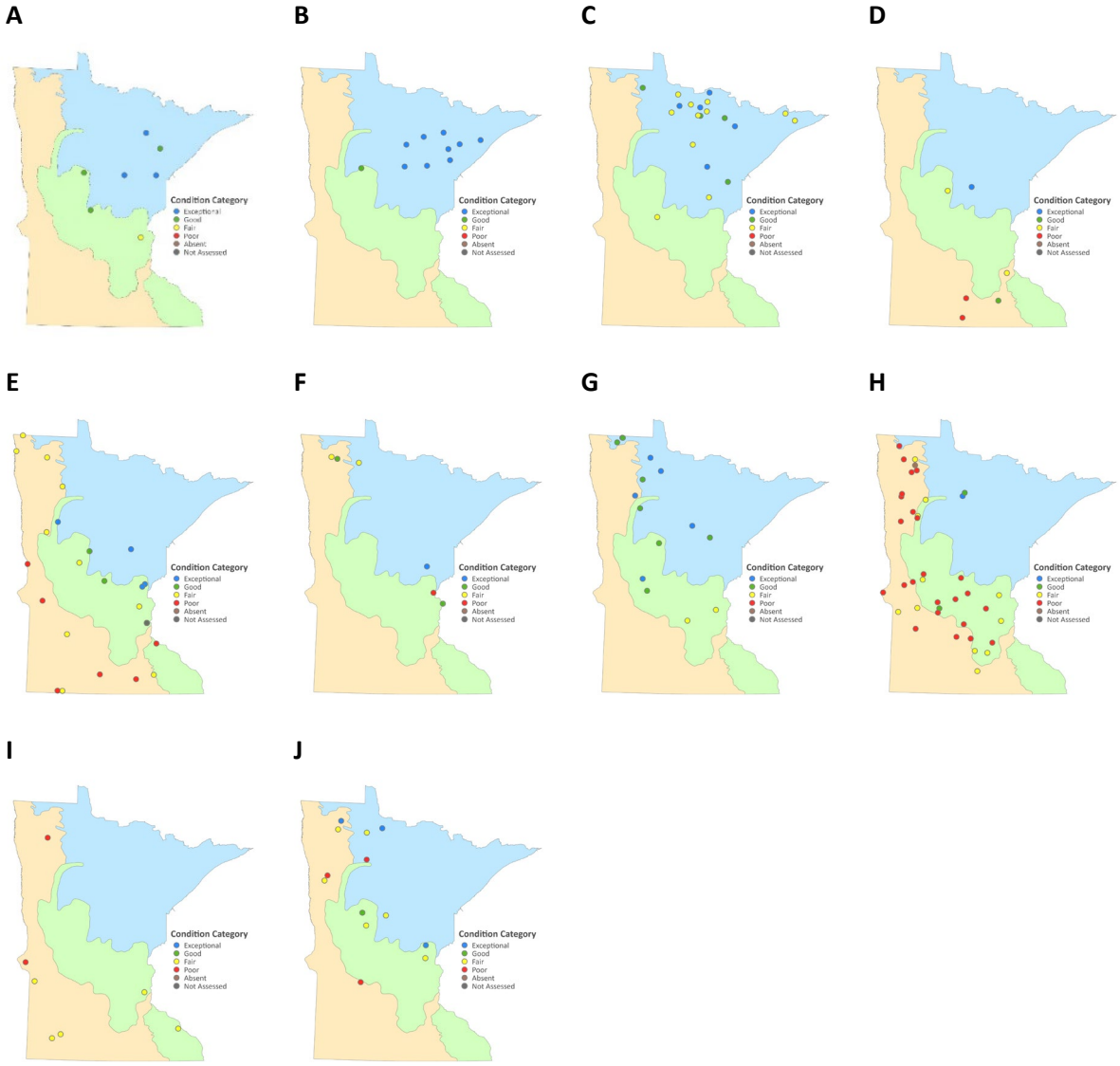


Table C-4. 2021 statewide and regional wetland extent and condition estimates by predominant plant community class. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Extent	Plant Community	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
State	Alder Thicket	7	656,269	476,431	6.6	4.8	94.6	9.9	5.4	9.9	0.0	0.0
	Calcareous Fen	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

			Extent Estimates				Condition Estimates					
Geographic Extent	Plant Community	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
	Coniferous Bog	7	860,614	497,577	8.7	5.0	100.0	0.0	0.0	0.0	0.0	0.0
	Coniferous Swamp	20	2,648,647	677,840	26.7	6.8	46.7	21.6	53.3	21.6	0.0	0.0
	Deep Marsh	2	172,909	246,968	1.7	2.5	100.0	0.0	0.0	0.0	0.0	0.0
	Floodplain Forest	6	249,943	227,878	2.5	2.3	62.7	42.4	21.9	33.8	15.4	19.8
	Fresh Meadow	23	722,328	299,984	7.3	3.1	43.5	18.8	33.4	17.8	18.2	11.8
	Hardwood Swamp	6	384,336	337,028	3.9	3.4	50.0	47.3	40.8	44.8	9.2	17.8
	Open Bog	3	412,623	400,881	4.2	4.0	100.0	0.0	0.0	0.0	0.0	0.0
	Rich Fen	15	1,433,970	597,657	14.4	5.8	95.1	4.8	4.9	4.8	0.0	0.0
	Seasonally Flooded	1	19,258	33,128	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0
	Shallow Marsh	40	1,415,167	396,079	14.2	3.9	21.9	13.5	22.9	11.5	55.1	13.7
	Shallow Open Water	7	167,029	103,613	1.7	1.0	0.0	0.0	76.9	24.2	23.1	24.2
	Shrub-Carr	13	787,930	454,965	7.9	4.5	28.9	29.4	48.8	33.2	22.3	26.7
	Wet Prairie	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mixed Wood Shield	Alder Thicket	4	550,164	467,855	7.5	6.4	100.0	0.0	0.0	0.0	0.0	0.0
	Calcareous Fen	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coniferous Bog	6	825,246	495,334	11.3	6.8	100.0	0.0	0.0	0.0	0.0	0.0
	Coniferous Swamp	19	2,613,279	673,774	35.8	9.2	47.4	21.8	52.6	21.8	0.0	0.0
	Deep Marsh	1	137,541	238,933	1.9	3.3	100.0	0.0	0.0	0.0	0.0	0.0
	Floodplain Forest	1	137,541	221,708	1.9	3.0	100.0	0.0	0.0	0.0	0.0	0.0
	Fresh Meadow	1	137,541	236,917	1.9	3.3	100.0	0.0	0.0	0.0	0.0	0.0
	Hardwood Swamp	2	275,082	325,592	3.8	4.5	50.0	69.5	50.0	69.5	0.0	0.0
	Open Bog	3	412,623	411,310	5.7	5.6	100.0	0.0	0.0	0.0	0.0	0.0
	Rich Fen	9	1,237,869	571,805	17.0	7.8	100.0	0.0	0.0	0.0	0.0	0.0

			Extent Estimates				Condition Estimates					
Geographic Extent	Plant Community	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
	Seasonally Flooded	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Shallow Marsh	3	412,623	343,145	5.7	4.7	66.7	53.5	0.0	0.0	33.3	53.5
	Shallow Open Water	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Shrub-Carr	4	550,164	443,157	7.5	6.1	25.0	41.0	50.0	48.3	25.0	41.6
	Wet Prairie	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mixed Wood Plains	Alder Thicket	3	106,105	104,076	6.3	6.1	66.7	53.5	33.3	53.5	0.0	0.0
	Calcareous Fen	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coniferous Bog	1	35,368	60,154	2.1	3.5	100.0	0.0	0.0	0.0	0.0	0.0
	Coniferous Swamp	1	35,368	57,564	2.1	3.4	0.0	0.0	100.0	0.0	0.0	0.0
	Deep Marsh	1	35,368	62,675	2.1	3.7	100.0	0.0	0.0	0.0	0.0	0.0
	Floodplain Forest	1	35,368	59,055	2.1	3.5	0.0	0.0	100.0	0.0	0.0	0.0
	Fresh Meadow	10	353,685	171,801	20.8	10.1	50.0	24.2	30.0	27.5	10.0	16.4
	Hardwood Swamp	2	70,737	77,771	4.2	4.6	50.0	69.5	0.0	0.0	50.0	69.5
	Open Bog	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Rich Fen	5	176,842	130,929	10.4	7.7	60.0	36.7	40.0	36.7	0.0	0.0
	Seasonally Flooded	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Shallow Marsh	18	636,633	172,260	37.5	10.1	5.6	9.7	38.9	18.9	55.6	20.4
	Shallow Open Water	2	70,737	80,959	4.2	4.8	0.0	0.0	100.0	0.0	0.0	0.0
	Shrub-Carr	4	141,474	110,797	8.3	6.5	50.0	48.5	50.0	48.5	0.0	0.0
	Wet Prairie	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperate Prairies	Alder Thicket	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Calcareous Fen	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coniferous Bog	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Geographic Extent	Plant Community	n	Extent Estimates: Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	Condition Estimates: % Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
	Coniferous Swamp	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Deep Marsh	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Floodplain Forest	4	77,034	53,009	8.2	5.6	25.0	41.6	25.0	40.5	50.0	44.9
	Fresh Meadow	12	231,102	100,050	24.5	10.6	0.0	0.0	58.3	21.6	41.7	21.6
	Hardwood Swamp	2	38,517	45,030	4.1	4.8	50.0	69.5	50.0	69.5	0.0	0.0
	Open Bog	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Rich Fen	1	19,258	31,346	2.0	3.3	100.0	0.0	0.0	0.0	0.0	0.0
	Seasonally Flooded	1	19,258	31,835	2.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0
	Shallow Marsh	19	365,911	112,694	38.8	11.9	0.0	0.0	21.1	16.3	78.9	16.3
	Shallow Open Water	5	96,292	64,473	10.2	6.8	20.0	32.6	60.0	38.1	40.0	38.1
	Shrub-Carr	5	96,292	68,459	10.2	7.3	20.0	32.6	40.0	42.8	40.0	40.6
	Wet Prairie	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table C-5. 2021 statewide and regional wetland extent and condition estimates by public and private ownership. Error margins (±) represent 95% confidence intervals.

Geographic Extent	Ownership	n	Extent Estimates: Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	Condition Estimates: % Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
State	Public	79	7,171,845	257,231	72.2	6.0	63.4	10.5	28.6	9.8	7.5	4.6
	Private	71	2,759,180	269,867	27.8	6.0	47.8	8.3	27.5	7.9	24.0	7.0
Mixed Wood Shield	Public	46	6,326,885	577,966	86.8	7.9	67.4	12.0	28.3	11.1	4.3	5.0
	Private	7	962,787	577,966	13.2	7.9	100.0	0.0	0.0	0.0	0.0	0.0
Mixed Wood Plains	Public	13	459,790	171,978	27.1	10.1	53.8	17.6	23.1	18.2	15.4	17.7
	Private	35	1,237,897	171,978	72.9	10.1	25.7	12.0	45.7	13.5	28.6	13.6
Temperate Prairies	Public	20	385,169	110,927	40.8	11.8	10.0	11.7	40.0	17.6	50.0	15.9
	Private	29	558,496	110,927	59.2	11.8	6.9	8.0	34.5	14.2	55.2	14.4

Table C-6. Percent extent condition category estimates for all MWCA cycles (2011, 2016, and 2021). Exceptional-good and poor-absent condition categories have been combined to simplify the change analysis. Error margins (±) represent 95% confidence intervals.

		2011		2016		2021	
Geographic Extent	Condition Category	% Wetland	% (±)	% Wetland	% (±)	% Wetland	% (±)
State	Exceptional/good	61.0	7.5	57.4	7.4	59.1	7.7
	Fair	28.2	7.5	33.3	7.1	28.3	7.5
	Poor/Absent	10.8	2.2	8.9	3.1	12.1	3.7
	Not Assessable	0.0	0.0	0.4	0.6	0.6	0.7
Mixed Wood Shield	Exceptional/good	76.4	9.6	73.8	9.6	71.7	10.6
	Fair	23.6	9.6	24.6	9.3	24.5	9.8
	Poor/Absent	0.0	0.0	1.5	2.6	3.8	4.4
	Not Assessable	0.0	0.0	0.0	0.0	0.0	0.0
Mixed Wood Plains	Exceptional/good	14.0	8.0	19.1	9.6	33.3	10.0
	Fair	46.0	11.8	57.4	12.7	39.6	10.8
	Poor/Absent	40.0	11.7	21.3	10.5	25.0	10.7
	Not Assessable	0.0	0.0	2.1	3.7	2.1	3.6
Temperate Prairies	Exceptional/good	17.8	9.1	2.5	4.0	8.2	6.4
	Fair	33.3	11.8	55.0	14.0	36.7	11.3
	Poor/Absent	48.9	11.4	42.5	14.0	53.1	11.0
	Not Assessable	0.0	0.0	0.0	0.0	2.0	3.4

Table C-7. Statewide and regional year-pair percent extent condition estimate differences. Light red shading indicates a significant (P < 0.05) increase and light blue shading a significant decrease between year-pairs. No shading indicates a non-significant result between year-pairs.

		Difference 2011-2016			Difference 2016-2021			Difference 2011-2021		
Geographic Extent	Condition Category	% Wetland	% (±)	*P*-value	% Wetland	% (±)	*P*-value	% Wetland	% (±)	*P*-value
State	Exceptional/good	-3.6	8.8	0.425	1.7	7.8	0.674	-1.9	10.8	0.731
	Fair	5.1	8.9	0.261	-5.0	9.0	0.274	0.1	10.6	0.988
	Poor/Absent	-1.9	3.2	0.245	3.1	3.8	0.105	1.3	4.3	0.567
	Not Assessable	0.4	0.6	0.264	0.2	0.9	0.706	0.6	0.7	0.120
Mixed Wood Shield	Exceptional/good	-2.5	11.8	0.676	-2.1	10.9	0.698	-4.7	14.3	0.523
	Fair	1.0	11.7	0.869	-0.1	10.5	0.987	0.9	13.7	0.898
	Poor/Absent	1.5	2.6	0.251	2.2	3.3	0.189	3.8	4.4	0.090
	Not Assessable	0.0	0.0	NA	0.0	0.0	NA	0.0	0.0	NA
Mixed Wood Plains	Exceptional/good	5.1	11.0	0.358	14.2	9.7	0.004	19.3	12.8	0.003
	Fair	11.4	16.0	0.161	-17.9	13.9	0.012	-6.4	16.0	0.432
	Poor/Absent	-18.7	13.9	0.008	3.7	12.5	0.560	-15.0	15.8	0.063
	Not Assessable	2.1	3.7	0.254	0.0	5.1	0.986	2.1	3.6	0.255
Temperate Prairies	Exceptional/good	-15.3	10.0	0.003	5.7	5.1	0.030	-9.6	11.2	0.091
	Fair	21.7	13.8	0.002	-18.3	17.3	0.039	3.4	16.3	0.683
	Poor/Absent	0.0	0.0	NA	10.6	17.1	0.227	4.2	15.8	0.606
	Not Assessable	-6.4	12.8	0.329	2.0	3.4	0.236	2.0	3.4	0.236

Table C-8. Statewide and regional sample mean weighted coefficient of conservatism (wC) scores for all MWCA cycles (2011, 2016, and 2021) and year-pair sample mean differences. Light red shading indicates a significant (P < 0.05) increase and light blue shading a significant decrease between year-pairs. No shading indicates a non-significant result between year-pairs.

	2011		2016		2021		Difference 2011-2016			Difference 2016-2021			Difference 2011-2021		
Geographic Extent	***wC***	***wC* (±)**	***wC***	***wC* (±)**	***wC***	***wC* (±)**	***wC***	***wC* (±)**	***P*-value**	***wC***	***wC* (±)**	***P*-value**	***wC***	***wC* (±)**	***P*-value**
State	5.3	0.2	5.1	0.3	5.0	0.2	-0.2	0.2	0.200	-0.1	0.3	0.524	-0.2	0.3	0.151
Mixed Wood Shield	6.2	0.3	6.0	0.3	5.8	0.3	-0.2	0.3	0.181	-0.2	0.3	0.253	-0.4	0.4	0.093
Mixed Wood Plains	2.7	0.4	3.1	0.4	3.4	0.5	0.3	0.4	0.104	0.4	0.4	0.085	0.7	0.6	0.013
Temperate Prairies	2.6	0.4	2.4	0.4	2.1	0.4	-0.2	0.4	0.436	-0.4	0.5	0.122	-0.5	0.5	0.043

Appendix D – Detailed wetland stressor estimates

Table D-1. 2021 Human Disturbance Assessment (HDA) extent and associated condition estimates by severity rating. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Scale	HDA Rating	n	Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
State	Minimally Impacted	53	5,708,755	770,840	57.5	7.6	76.7	10.3	20.9	10.0	2.4	4.1
	Moderately Impacted	28	1,845,430	683,330	18.6	6.7	57.3	20.2	40.8	20.3	0.0	0.0
	Severely Impacted	69	2,376,840	579,369	23.9	5.8	18.2	13.2	36.3	14.2	44.7	10.2
	State Total	150	9,931,025	446,568	100.0	0.0	59.1	7.7	28.3	7.5	12.1	3.7
Mixed Wood Shield	Minimally Impacted	38	5,226,557	774,685	71.7	10.6	76.3	11.1	21.1	10.8	2.6	4.4
	Moderately Impacted	9	1,237,869	645,438	17.0	8.9	66.7	27.2	33.3	27.2	0.0	0.0
	Severely Impacted	6	825,246	534,847	11.3	7.3	50.0	39.5	33.3	36.0	16.7	26.7
	Ecoregion Total	53	7,289,672	0	100.0	0.0	71.7	10.6	24.5	9.8	3.8	4.4
Mixed Wood Plains	Minimally Impacted	12	424,422	171,931	25.0	10.1	83.3	16.9	16.7	16.9	0.0	0.0
	Moderately Impacted	15	530,527	187,776	31.3	11.1	40.0	21.9	53.3	24.2	0.0	0.0
	Severely Impacted	21	742,738	200,687	43.8	11.8	0.0	0.0	42.9	17.4	57.1	17.4
	Ecoregion Total	48	1,697,688	0	100.0	0.0	33.3	10.0	39.6	10.8	25.0	10.7
Temperate Prairies	Minimally Impacted	3	57,775	48,345	6.1	5.1	66.7	53.9	33.3	53.9	0.0	0.0
	Moderately Impacted	4	77,034	55,797	8.2	5.9	25.0	41.0	75.0	41.0	0.0	0.0
	Severely Impacted	42	808,856	67,320	85.7	7.1	2.4	3.9	33.3	11.8	61.9	12.1
	Ecoregion Total	49	943,665	0	100.0	0.0	8.2	6.4	36.7	11.3	53.1	11.0

Table D-2. 2021 statewide and regional individual Human Disturbance Assessment (HDA) factor percent extent estimates by severity level. Error margins (±) represent 95% confidence intervals.

		HDA Severity Rating Estimates							
Geographic Scale	HDA Factor	% Minimal	% (±)	% Low	% (±)	% Moderate	% (±)	% Severe	% (±)
State	Landscape Alteration	77.3	3.3	4.4	1.8	8.7	2.8	9.6	2.9
	Immediate Upland Alteration	82.3	3.5	4.5	2.7	4.5	2.4	8.8	1.7
	Physical Alteration	65.3	7.9	9.2	4.8	13.5	6.1	11.9	4.8
	Hydrologic Alteration	70.5	5.9	14.1	5.7	4.2	1.8	11.2	3.5
	Invasive Species	60.1	6.6	22.6	6.7	5.0	2.7	12.3	3.3
Mixed Wood Shield	Landscape Alteration	96.2	4.3	0.0	0.0	1.9	3.0	1.9	3.1
	Immediate Upland Alteration	96.2	4.3	1.9	3.0	1.9	3.0	0.0	0.0

Geographic Scale	HDA Factor	HDA Severity Rating Estimates							
		% Minimal	% (±)	% Low	% (±)	% Moderate	% (±)	% Severe	% (±)
	Physical Alteration	71.7	10.3	7.5	6.2	13.2	8.2	7.5	6.0
	Hydrologic Alteration	84.9	7.7	11.3	7.5	0.0	0.0	3.8	4.3
	Invasive Species	77.4	8.9	18.9	8.6	1.9	3.1	1.9	3.1
Mixed Wood Plains	Landscape Alteration	33.3	10.7	16.7	9.1	31.3	11.7	18.8	9.4
	Immediate Upland Alteration	52.1	11.3	14.6	8.5	14.6	9.0	18.8	8.9
	Physical Alteration	58.3	11.9	12.5	8.5	14.6	8.0	14.6	8.5
	Hydrologic Alteration	37.5	11.3	25.0	10.9	18.8	9.9	18.8	9.3
	Invasive Species	14.6	7.5	37.5	11.9	14.6	8.4	33.3	12.0
Temperate Prairies	Landscape Alteration	10.2	6.5	16.3	8.9	20.4	9.5	53.1	7.9
	Immediate Upland Alteration	28.6	8.2	6.1	6.1	6.1	5.8	59.2	8.5
	Physical Alteration	28.6	11.0	16.3	8.6	14.3	8.5	40.8	12.1
	Hydrologic Alteration	18.4	9.0	16.3	9.0	10.2	6.4	55.1	10.5
	Invasive Species	8.2	6.3	24.5	10.2	12.2	8.0	55.1	11.8

Table D-3. 2021 statewide and regional sample mean % perennial cover at the HDA landscape and immediate catchment alteration scales. Error margins (±) represent 95% confidence intervals.

Geographic Scale	HDA Landscape Factor Scale	Mean % Perennial Cover	(±)
State	Landscape Alteration	84.2	2.0
	Immediate Catchment Alteration	88.3	1.6
Mixed Wood Shield	Landscape Alteration	96.0	2.7
	Immediate Catchment Alteration	98.6	1.5
Mixed Wood Plains	Landscape Alteration	60.8	6.0
	Immediate Catchment Alteration	70.6	6.9
Temperate Prairies	Landscape Alteration	35.1	4.4
	Immediate Catchment Alteration	41.1	6.2

Table D-4. 2021 statewide and regional physical alteration rating extent estimates by severity level and associated vegetation condition estimates. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Scale	Physical Alteration Rating	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
Statewide	Minimal	80	6,486,494	870,792	65.3	7.9	62.9	10.6	26.8	9.7	9.8	5.3
	Low	18	916,443	478,651	9.2	4.8	67.8	14.8	20.0	13.8	12.3	8.4
	Moderate	21	1,345,176	611,080	13.5	6.1	56.4	23.5	32.6	22.1	11.0	7.3
	Severe	31	1,182,913	474,434	11.9	4.8	34.9	21.9	38.0	22.1	25.5	9.6
Mixed Wood Shield	Minimal	38	5,226,557	749,685	71.7	10.3	68.4	13.0	26.3	11.7	5.3	6.2
	Low	4	550,164	455,380	7.5	6.2	100.0	0.0	0.0	0.0	0.0	0.0
	Moderate	7	962,787	594,979	13.2	8.2	71.4	31.8	28.6	31.8	0.0	0.0
	Severe	4	550,164	438,632	7.5	6.0	75.0	42.2	25.0	42.2	0.0	0.0
Mixed Wood Plains	Minimal	28	990,318	201,346	58.3	11.9	42.9	14.2	28.6	13.8	25.0	12.3
	Low	6	212,211	144,335	12.5	8.5	33.3	36.2	50.0	39.4	16.7	26.6
	Moderate	7	247,579	136,628	14.6	8.0	28.6	28.5	42.9	26.1	28.6	28.1
	Severe	7	247,579	144,462	14.6	8.5	0.0	0.0	71.4	25.9	28.6	25.9
Temperate Prairies	Minimal	14	269,619	104,071	28.6	11.0	28.6	20.7	28.6	17.6	42.9	22.8
	Low	8	154,068	81,050	16.3	8.6	0.0	0.0	50.0	31.9	50.0	31.9
	Moderate	7	134,809	79,930	14.3	8.5	0.0	0.0	42.9	29.4	57.1	29.4
	Severe	20	385,169	114,147	40.8	12.1	0.0	0.0	35.0	19.0	60.0	19.6

Table D-5. 2021 statewide and regional physical alteration category and sub-category extent estimates when an alteration is present within a wetland acre and when at high-cover (i.e., > 25% of a sample site). The unvegetated sub-category includes conditions where the wetland is largely devoid of vegetation and at recently logged wetland where re-generating trees are < 6' in height. Error margins (±) represent 95% confidence intervals.

			Alteration Present					Alteration @ High Cover				
Geographic Scale	Physical Alteration Category	Vegetation Sub-Category	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)
State	No Alteration Present	NA	55	5,338,582	871,039	54	8.4	NA				
	Soil Modification	NA	59	2,829,510	733,801	28.5	7.4	20	465,720	170,115	4.7	1.7
	Vegetation Removal	Unvegetated	5	451,140	385,425	4.5	3.9	3	294,340	333,068	3.0	3.4
		Altered	21	1,345,176	626,154	13.5	6.2	4	93,144	81,984	0.9	0.8
		Recovered/ Recovering	20	1,293,697	576,347	13.0	5.8	12	650,389	422,107	6.5	4.3
Mixed Wood Shield	No Alteration Present	NA	34	4,676,394	805,920	64	11.1	NA				
	Soil Modification	NA	12	1,650,492	692,672	22.6	9.5	0	0	0	0.0	0.0
	Vegetation Removal	Unvegetated	3	412,623	382,751	5.7	5.3	2	275,082	331,266	3.8	4.5
		Altered	7	962,787	596,775	13.2	8.2	0	0	0	0.0	0.0

Geographic Scale	Physical Alteration Category	Vegetation Sub-Category	Alteration Present					Alteration @ High Cover				
			n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)
		Recovered/ Recovering	7	962,787	558,100	13.2	7.7	3	412,623	397,484	5.7	5.5
Mixed Wood Plains	No Alteration Present	NA	16	565,896	209,989	33	12.4	NA				
	Soil Modification	NA	17	601,264	190,539	35.4	11.2	5	176,842	132,478	10.4	4.0
	Vegetation Removal	Unvegetated	0	0	0	0.0	0.0	0	0	0	0.0	0.0
		Altered	7	247,579	155,624	14.6	9.2	1	35,368	59,250	2.1	3.5
		Recovered/ Recovering	5	176,842	127,190	10.4	7.5	4	141,474	113,418	8.3	6.7
Temperate Prairies	No Alteration Present	NA	5	96,292	73,044	10	7.7	NA				
	Soil Modification	NA	30	577,754	108,753	61.2	11.5	15	288,877	108,923	30.6	5.9
	Vegetation Removal	Unvegetated	2	38,517	45,901	4.1	4.9	1	19,258	33,066	2.0	3.5
		Altered	7	134,809	73,563	14.3	7.8	3	57,775	54,540	6.1	5.8
		Recovered/ Recovering	8	154,068	84,058	16.3	8.9	5	96,292	70,103	10.2	7.4

Table D-6. 2021 statewide and regional specific physical alteration extent estimates when an alteration is present within a wetland acre and when at high-cover (i.e., > 25% of a sample site). Error margins (±) represent 95% confidence intervals.

Geographic Scale	Physical Alteration Category	Physical Alteration Type	Alteration Present					Alteration @ High Cover				
			n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)
Statewide	Soil Modification	Prior Plowing	28	635,897	183,316	6.4	1.9	18	427,203	166,826	4.3	1.7
		Active Plowing	0	0	0	0	0	0	0	0	0	0
		Grading	6	266,053	242,241	2.7	2.4	0	0	0	0	0
		Vehicle Damage	25	1,879,230	726,151	18.9	7.3	2	38,517	45,770	0.4	0.5
		Filling	4	141,474	117,813	1.4	1.2	0	0	0	0	0
		Excavation	10	375,307	258,809	3.8	2.6	1	19,258	31,424	0.2	0.3
		Sedimentation	4	125,364	109,538	1.3	1.1	0	0	0	0	0
		Pipeline	0	0	0	0	0	0	0	0	0	0
	Vegetation Removal	Grazing	10	257,025	141,501	2.6	1.4	5	112,402	88,256	1.1	0.9
		Logging	15	1,724,377	683,191	17.4	6.9	7	860,614	551,119	8.7	5.5
		Shrub Removal	7	656,269	471,382	6.6	4.7	1	35,368	60,572	0.4	0.6
		Mowing	6	147,771	105,305	1.5	1.1	0	0	0	0	0
		Haying	6	147,771	104,822	1.5	1.1	4	93,144	81,188	0.9	0.8
		Herbicide	4	77,034	63,687	0.8	0.6	2	38,517	44,518	0.4	0.4

Geographic Scale	Physical Alteration Category	Physical Alteration Type	Alteration Present					Alteration @ High Cover				
			n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)
Mixed Wood Shield	Soil Modification	Prior Plowing	0	0	0	0	0	0	0	0	0	0
		Active Plowing	1			1.9	3.2	0	0	0	0	0
		Grading	0	137,541	235,588	0	0	0	0	0	0	0
		Vehicle Damage	11	1,512,951	702,491	20.8	9.6	0	0	0	0	0
		Filling	0	0	0	0	0	0	0	0	0	0
		Excavation	1	137,541	219,314	1.9	3.0	0	0	0	0	0
		Sedimentation	0	0	0	0	0	0	0	0	0	0
		Pipeline	0			0	0	0	0	0	0	0
	Vegetation Removal	Grazing	0	0	0	0	0	0	0	0	0	0
		Logging	12	1,650,492	681,103	22.6	9.3	6	825,246	545,584	11.3	7.5
		Shrub Removal	4	550,164	455,638	7.5	6.3	0	0	0	0	0
		Mowing	0	0	0	0	0	0	0	0	0	0
		Haying	0	0	0	0	0	0	0	0	0	0
		Herbicide	0	0	0	0	0	0	0	0	0	0
Mixed Wood Plains	Soil Modification	Prior Plowing	6	212,211	136,607	12.5	8.0	5	176,842	132,478	10.4	7.8
		Active Plowing	0			0	0	0	0	0	0	0
		Grading	2	70,737	84,159	4.2	5.0	0	0	0	0	0
		Vehicle Damage	6	212,211	135,473	12.5	8.0	0	0	0	0	0
		Filling	4	141,474	118,777	8.3	7.0	0	0	0	0	0
		Excavation	4	141,474	118,688	8.3	7.0	0	0	0	0	0
		Sedimentation	3	106,105	104,699	6.3	6.2	0	0	0	0	0
		Pipeline	0			0	0	0	0	0	0	0
	Vegetation Removal	Grazing	4	141,474	118,226	8.3	7.0	1	35,368	59,250	2.1	3.5
		Logging	1	35,368	62,812	2.1	3.7	1	35,368	62,812	2.1	3.7
		Shrub Removal	3	106,105	93,516	6.3	5.5	1	35,368	58,535	2.1	3.4
		Mowing	2	70,737	85,658	4.2	5.0	0	0	0	0	0
		Haying	2	70,737	82,489	4.2	4.9	1	35,368	59,281	2.1	3.5
		Herbicide	0	0	0	0	0	0	0	0	0	0
Temperate Prairies	Soil Modification	Prior Plowing	22	423,686	109,570	44.9	11.6	13	250,360	103,368	26.5	11.0
		Active Plowing	0			0	0	0	0	0	0	0
		Grading	3	57,775	54,673	6.1	5.8	0	0	0	0	0
		Vehicle Damage	8	154,068	87,347	16.3	9.3	2	38,517	44,296	4.1	4.7
		Filling	0	0	0	0	0	0	0	0	0	0
		Excavation	5	96,292	67,757	10.2	7.2	1	19,258	31,433	2.0	3.3
		Sedimentation	1	19,258	31,424	2.0	3.3	0	0	0	0	0
		Pipeline	0			0.0	0.0	0	0	0	0	0

Geographic Scale	Physical Alteration Category	Physical Alteration Type	Alteration Present					Alteration @ High Cover				
			n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)
	Vegetation Removal	Grazing	6	115,551	76,308	12.2	8.1	4	77,034	62,029	8.2	6.6
		Logging	2	38,517	47,987	4.1	5.1	0	0	0	0	0
		Shrub Removal	0	0	0	0	0	0	0	0	0	0
		Mowing	4	77,034	65,324	8.2	6.9	0	0	0	0	0
		Haying	4	77,034	63,462	8.2	6.7	3	57,775	54,101	6.1	5.7
		Herbicide	4	77,034	64,045	8.2	6.8	2	38,517	44,672	4.1	4.7

Table D-7. 2021 logging extent estimates in coniferous swamp wetland in the Mixed Wood Shield ecoregion when logging is present within a wetland acre and when at high-cover (i.e., > 25% of a sample site) and associated condition estimates. Recently logged describes conditions where regenerating trees are generally < 6' in height, whereas recovered/recovering describes expected trees are > 6' at expected cover. Altered conditions are where a sample site has clearly been harvested and significant time has past (e.g., > 10 years) but trees have not regenerated at expected cover. Error margins (±) represent 95% confidence intervals.

Logging Status	Vegetation Impact Sub-Category	n	Extent Estimates				Condition Estimates					
			Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
Logging Present	Recently Logged	2	275,082	359,434	10.5	13.8	50.0	73.0	50.0	73.0	0.0	0.0
	Recovered/Recovering	7	962,787	0	36.8	0.0	71.4	32.1	28.6	32.1	0.0	0.0
	Altered	1	137,541	269,575	5.3	10.3	100.0	0.0	0.0	0.0	0.0	0.0
	Sub-Total	10	1,375,410	546,145	52.6	20.9	70.0	25.6	30	26	0.0	0.0
Logging @ High Cover	Recently Logged	2	275,082	340,989	10.5	13.0	50.0	75.9	50.0	75.9	0.0	0.0
	Recovered/Recovering	4	550,164	318,063	21.1	12.2	75.0	41.9	25	42	0.0	0.0
	Altered	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sub-Total	6	825,246	510,016	31.6	19.5	66.7	37.1	33.3	37.1	0.0	0.0
No Logging		9	1,237,869	546,145	47.4	20.9	22.2	26.6	77.8	26.6	0.0	0.0
	Coniferous Swamp Total	19	2,613,279	673,774	100.0	0.0	47.4	21.8	52.6	21.8	0.0	0.0

Table D- 8. 2021 prior plowed wetland extent and associated vegetation condition estimates for the Mixed Wood Plains and Temperate Prairies ecoregions. Estimates have been generated when prior plowing was present within a wetland acre and when at high cover (i.e., > 25% of a sample site). Nonassessable wetland accounts for discrepancies with the condition estimates. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Ecoregion	Prior Plowing Status	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
MWP & TP Combined	Prior plow present	28	635,897	181,493	24.1	6.9	0.0	0.0	46.5	16.2	50.5	16.5
	Prior plow @ high cover	18	427,203	166,790	16.2	6.3	0.0	0.0	51.9	20.5	43.6	20.1
	No Prior Plow	69	2,005,456	191,323	75.9	6.9	32.1	8.9	36.1	9.7	30.1	9.1
Mixed Wood Plains	Prior plow present	6	212,211	136,607	12.5	8.0	0.0	0.0	66.7	33.9	33.3	33.9
	Prior plow @ high cover	5	176,842	132,478	10.4	7.8	0.0	0.0	60	36.7	40.0	36.7
	No Prior Plow	42	1,485,477	136,607	87.5	8.0	38.1	11.3	35.7	11.7	23.8	10.8
Temperate Prairies	Prior plow present	22	423,686	109,570	44.9	11.6	0.0	0.0	36.4	18.1	59.1	19.1
	Prior plow @ high cover	13	250,360	103,368	26.5	11.0	0.0	0.0	46.2	25.4	46.2	26.3
	No Prior Plow	27	519,979	109,570	55.1	11.6	14.8	11.5	37.0	15.7	48.1	15.9

Table D-9. 2021 statewide and regional hydrologic alteration rating extent estimates by severity level and associated vegetation condition estimates. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Scale	Hydrologic Alteration Rating	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
Statewide	Minimal	72	6,999,304	635,568	70.5	5.9	68.5	10.0	27.7	9.7	3.8	3.3
	Low	26	1,403,736	568,266	14.1	5.7	72.8	12.7	20.6	10.6	6.6	6.3
	Moderate	14	414,609	181,353	4.2	1.8	8.5	14.1	30.2	22.6	52.7	23.7
	Severe	38	1,113,377	361,066	11.2	3.5	1.7	2.9	40.6	16.9	55.9	16.9
Mixed Wood Shield	Minimal	45	6,189,344	563,416	84.9	7.7	71.1	11.1	26.7	10.8	2.2	3.6
	Low	6	825,246	546,874	11.3	7.5	100.0	0.0	0.0	0.0	0.0	0.0
	Moderate	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Severe	2	275,082	311,210	3.8	4.3	0.0	0.0	50.0	70.2	50.0	70.2
Mixed Wood Plains	Minimal	18	636,633	192,179	37.5	11.3	55.6	19.4	33.3	18.9	11.1	13.2
	Low	12	424,422	184,727	25.0	10.9	41.7	23.9	50.0	22.3	8.3	14.5
	Moderate	9	318,316	168,701	18.8	9.9	11.1	18.3	33.3	29.9	44.4	30.4
	Severe	9	318,316	157,531	18.8	9.3	0.0	0.0	44.4	30.7	55.6	30.7
Temperate Prairies	Minimal	9	173,326	85,054	18.4	9.0	22.2	24.4	44.4	30.7	33.3	24.0
	Low	8	154,068	84,545	16.3	9.0	12.5	22.0	50.0	31.5	37.5	32.3
	Moderate	5	96,292	60,296	10.2	6.4	0.0	0.0	20.0	32.1	80.0	32.1
	Severe	27	519,979	99,145	55.1	10.5	3.7	6.1	33.3	15.4	59.3	16.0

Table D-10. 2021 statewide and regional hydrologic alteration category extent estimates and associated condition estimates. The large majority of hydro-alterations when present were considered to affect an entire HDA-Assessment Area (i.e., occur at high cover). Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Scale	Hydro-Alteration Category	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Exceptional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
Statewide	Water Subtraction	39	1,331,468	447,200	13.4	4.4	31.3	16.9	23.4	10.7	43.9	15.9
	Water Addition	41	1,488,268	485,437	15.0	4.7	33.8	16.8	23.3	9.5	41.6	14.4
	Flow Obstruction	51	1,847,465	544,270	18.6	5.4	35.7	15.2	23.7	10.3	37.7	14.0
	No Hydro-Alteration Present	80	7,454,376	653,931	75.1	5.7	66.6	9.8	29.1	9.6	4.3	3.2
Mixed Wood Shield	Water Subtraction	3	412,623	383,566	5.7	5.3	66.7	54.0	0.0	0.0	33.3	54.0
	Flow Obstruction	5	687,705	478,708	9.4	6.6	80.0	32.1	0.0	0.0	20.0	32.1
	Water Addition	4	550,164	446,265	7.5	6.1	75.0	40.7	0.0	0.0	25.0	40.7
	No Hydro-Alteration Present	47	6,464,426	527,814	88.7	7.2	70.2	11.1	27.7	10.9	2.1	3.4
Mixed Wood Plains	Water Subtraction	14	495,159	202,772	29.2	11.9	28.6	19.3	35.7	14.8	35.7	15.8
	Water Addition	14	495,159	186,950	29.2	11.0	14.3	16.3	42.9	18.5	42.9	22.5
	Flow Obstruction	17	601,264	184,193	35.4	10.8	11.8	13.3	47.1	20.8	35.3	21.1
	No Hydro-Alteration Present	22	778,107	201,311	45.8	11.9	50.0	16.7	36.4	17.1	13.6	13.2
Temperate Prairies	Water Subtraction	22	423,686	109,815	44.9	11.6	0.0	0.0	31.8	16.3	63.6	17.8
	Water Addition	23	442,945	111,312	46.9	11.8	4.3	7.7	30.4	14.5	60.9	16.8
	Flow Obstruction	29	558,496	118,766	59.2	12.6	6.9	8.2	27.6	14.8	62.1	15.8
	No Hydro-Alteration Present	11	211,843	91,448	22.4	9.7	18.2	18.7	45.5	22.2	36.4	15.0

Table D-11. 2021 statewide and regional specific hydrologic alteration extent estimates. The large majority of hydro-alterations when present were considered to affect an entire HDA-Assessment Area (i.e., occur at high cover). Error margins (±) represent 95% confidence intervals.

Geographic Scale	Hydro-Alteration Category	Hydro-Alteration	n	Extent Estimates			
				Wetland Extent (ac)	Extent (±)	% Wetland	% (±)
Statewide	Water Subtraction	Ditch (outflow)	35	1,238,324	444,974	12.5	4.3
		Tile (drainage/outlet)	3	57,775	57,154	0.6	0.6
		Water Withdrawal	2	54,627	68,532	0.6	0.7
	Water Addition	Ditch (inflow)	39	1,433,641	483,920	14.4	4.7
		Tile (inflow)	1	19,258	32,846	0.2	0.3
		Point Source/Pipe	2	70,737	71,103	0.7	0.7
	Flow Obstruction	Dam/Dike/Control Structure	14	656,686	416,289	6.6	4.1
		Berm/levee	3	89,995	90,380	0.9	0.9
		Road/RR bed	27	831,582	302,450	8.4	3.1
		Excavation	8	320,680	247,225	3.2	2.5
		Incised channel	2	38,517	45,822	0.4	0.5
Mixed Wood Shield	Water Subtraction	Ditch (outflow)	3	412,623	383,566	5.7	5.3
		Tile (drainage/outlet)	0	0	0	0.0	0.0
		Water Withdrawal	0	0	0	0.0	0.0
	Water Addition	Ditch (inflow)	4	550,164	446,265	7.5	6.1
		Tile (inflow)	0	0	0	0.0	0.0
		Point Source/Pipe	0	0	0	0.0	0.0
		Dam/Dike/Control Structure	3	412,623	393,428	5.7	5.4
	Flow Obstruction	Berm/levee	0	0	0	0.0	0.0
		Road/RR bed	1	137,541	228,101	1.9	3.1
		Excavation	1	137,541	222,706	1.9	3.1
		Incised channel	0	0	0	0.0	0.0
Mixed Wood Plains	Water Subtraction	Ditch (outflow)	13	459,790	195,853	27.1	11.5
		Tile (drainage/outlet)	0	0	0	0.0	0.0
		Water Withdrawal	1	35,368	60,746	2.1	3.6
	Water Addition	Ditch (inflow)	13	459,790	182,803	27.1	10.8
		Tile (inflow)	0	0	0	0.0	0.0
		Point Source/Pipe	2	70,737	75,690	4.2	4.5
		Dam/Dike/Control Structure	2	70,737	80,959	4.2	4.8
	Flow Obstruction	Berm/levee	2	70,737	83,814	4.2	4.9
		Road/RR bed	12	424,422	172,451	25.0	10.2
		Excavation	3	106,105	102,924	6.3	6.1
		Incised channel	0	0	0	0.0	0.0

Geographic Scale	Hydro-Alteration Category	Hydro-Alteration	n	Extent Estimates: Wetland Extent (ac)	Extent (±)	% Wetland	% (±)
Temperate Prairies	Water Subtraction	Ditch (outflow)	19	365,911	112,729	38.8	11.9
		Tile (drainage/outlet)	3	57,775	57,185	6.1	6.1
		Water Withdrawal	1	19,258	30,800	2.0	3.3
	Water Addition	Ditch (inflow)	22	423,686	110,742	44.9	11.7
		Tile (inflow)	1	19,258	34,039	2.0	3.6
		Point Source/Pipe	0	0	0	0.0	0.0
		Dam/Dike/Control Structure	9	173,326	86,509	18.4	9.2
	Flow Obstruction	Berm/levee	1	19,258	30,964	2.0	3.3
		Road/RR bed	14	269,619	106,976	28.6	11.3
		Excavation	4	77,034	64,231	8.2	6.8
		Incised channel	2	38,517	44,207	4.1	4.7

Table D-12. 2021 statewide and regional water regime change rating extent estimates by severity level and associated vegetation condition estimates. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Scale	Water Regime Change Rating	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
Statewide	Minimal	77	7,278,319	671,101	73.3	6.0	66.3	10.0	29.5	9.7	4.1	3.3
	Low	64	2,242,815	529,773	22.6	5.2	34.1	14.8	25.9	9.6	37.5	12.3
	Moderate	1	19,258	31,582	0.2	0.3	0.0	0.0	100.0	NA	0.0	0.0
	Severe	1	19,258	32,846	0.2	0.3	0.0	0.0	100.0	NA	0.0	0.0
Mixed Wood Shield	Minimal	46	6,326,885	573,130	86.8	7.9	69.6	11.3	28.3	11.0	2.2	3.5
	Low	5	687,705	470,637	9.4	6.5	80.0	32.6	0.0	0.0	20.0	32.6
	Moderate	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Severe	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mixed Wood Plains	Minimal	22	778,107	201,311	45.8	11.9	50.0	16.7	36.4	17.1	13.6	13.2
	Low	26	919,581	201,311	54.2	11.9	19.2	12.9	42.3	15.5	34.6	14.9
	Moderate	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Severe	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperate Prairies	Minimal	9	173,326	86,551	18.4	9.2	22.2	24.1	44.4	27.5	33.3	15.8
	Low	33	635,529	104,247	67.3	11.0	6.1	7.1	30.3	12.5	60.6	13.8
	Moderate	1	19,258	30,800	2.0	3.3	0.0	0.0	100.0	NA	0.0	0.0
	Severe	1	19,258	34,039	2.0	3.6	0.0	0.0	100.0	NA	0.0	0.0

Table D-13. 2021 statewide and regional existence level hydro-alteration extent estimates and associated vegetation condition estimates. Existence level hydro-alterations are considered to occur when the pre-impact water regime is uninterpretable and is highly unlikely to change (examples include: diking, dredging, and drainage with subsequent restoration). The majority of existence level hydro-alteration wetland is rated "low" for water regime change as the activities resulting in the alteration are ignored as part of the HDA. Error margins (±) represent 95% confidence intervals.

		Extent Estimates				Condition Estimates					
Geographic Scale	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
Statewide	23	743,950	368,250	7.5	3.7	18.5	23.8	24.6	15.3	54.3	22.2
Mixed Wood Shield	2	275,082	326,630	3.8	4.5	50.0	70.9	0.0	0.0	50.0	70.9
Mixed Wood Plains	4	141,474	113,100	8.3	6.7	0.0	0.0	75.0	40.5	25.0	40.5
Temperate Prairies	17	327,394	107,437	34.7	11.4	0.0	0.0	23.5	16.6	70.6	17.6

Table D-14. 2021 statewide and regional seasonally semi-permanently flooded stabilization rating extent estimates and associated vegetation condition estimates. Seasonally semi-permanently flooded wetland that is diked or otherwise maintained by a control structure is considered severe. If the water regime is natural (i.e., no control structure) the rating is minimal. Wetland with a different water regime is not applicable. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Scale	Seasonally Semi-permanently Flooded Stabilization Rating	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Excep-tional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
Statewide	Minimal	40	1,732,282	487,984	17.4	4.9	47.9	11.8	18.6	9.4	31.5	10.5
	Severe	11	330,126	252,092	3.3	2.5	0.0	0.0	17.5	19.5	82.5	19.5
	Not Applicable	99	7,868,617	598,138	79.2	5.3	64.1	9.0	30.8	8.9	4.8	3.0
Mixed Wood Shield	Minimal	5	687,705	438,654	9.4	6.0	100.0	0.0	0.0	0.0	0.0	0.0
	Severe	1	137,541	222,706	1.9	3.1	0.0	0.0	0.0	0.0	100.0	0.0
	Not Applicable	47	6,464,426	491,951	88.7	6.7	70.2	10.9	27.7	10.8	2.1	3.4
Mixed Wood Plains	Minimal	23	813,475	181,232	47.9	10.7	17.4	13.7	34.8	15.9	43.5	17.5
	Severe	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not Applicable	25	884,212	181,232	52.1	10.7	48.0	14.6	44.0	15.7	8.0	9.8
Temperate Prairies	Minimal	12	231,102	96,831	24.5	10.3	0.0	0.0	16.7	18.8	83.3	18.8
	Severe	10	192,585	96,457	20.4	10.2	0.0	0.0	30.0	26.3	70.0	26.3
	Not Applicable	27	519,979	116,151	55.1	12.3	14.8	11.3	48.1	16.3	33.3	14.4

Table D-15. 2021 statewide and regional enhanced flashiness rating extent estimates and associated vegetation condition estimates. The enhanced flashiness rating is done by first summing the percent impervious surface and percent verified drained wetland within the immediate catchment. A severe level is reached at > 10% with moderate at >5 - 10%, low at >1 - 5%, and minimal at <1%. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Scale	Enhanced Flashiness Rating	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Exceptional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
Statewide	Minimal	93	7,989,632	546,506	80.5	4.4	68.5	9.1	26.6	8.8	5.0	3.1
	Low	12	666,499	424,119	6.7	4.2	51.9	27.2	24.6	20.8	23.5	26.3
	Moderate	13	395,350	178,582	4.0	1.8	8.9	15.0	26.8	23.7	55.3	24.6
	Severe	32	879,544	279,301	8.9	2.8	2.2	3.8	47.0	17.7	48.6	17.5
Mixed Wood Shield	Minimal	49	6,739,508	392,787	92.5	5.4	73.5	10.5	24.5	10.1	2.0	3.4
	Low	3	412,623	392,879	5.7	5.4	66.7	55.7	0.0	0.0	33.3	55.7
	Moderate	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Severe	1	137,541	217,379	1.9	3.0	0.0	0.0	100.0	0.0	0.0	0.0
Mixed Wood Plains	Minimal	25	884,212	201,263	52.1	11.9	52.0	16.7	36.0	15.0	12.0	11.6
	Low	5	176,842	132,244	10.4	7.8	40.0	42.3	60.0	42.3	0.0	0.0
	Moderate	9	318,316	168,701	18.8	9.9	11.1	18.3	33.3	29.9	44.4	30.4
	Severe	9	318,316	157,531	18.8	9.3	0.0	0.0	44.4	30.7	55.6	30.7
Temperate Prairies	Minimal	19	365,911	82,794	38.8	8.8	15.8	13.8	42.1	19.5	42.1	17.9
	Low	4	77,034	66,791	8.2	7.1	0.0	0.0	75.0	41.6	25.0	41.6
	Moderate	4	77,034	51,836	8.2	5.5	0.0	0.0	0.0	0.0	100.0	0.0
	Severe	22	423,686	86,958	44.9	9.2	4.5	7.7	31.8	16.3	59.1	17.7

Table D-16. 2021 statewide and regional non-native vegetation cover rating extent estimates and associated vegetation condition estimates. A severe level is reached at > 50% non-native cover, with moderate at >25 - 50%, low at >1 - 25%, and minimal at <1%. Error margins (±) represent 95% confidence intervals.

			Extent Estimates				Condition Estimates					
Geographic Scale	Non-native Vegetation Cover Rating	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)	% Exceptional/ Good	% (±)	% Fair	% (±)	% Poor/ Absent	% (±)
Statewide	Minimal	54	6,034,531	649,024	60.8	6.6	78.0	9.7	22.0	9.7	0.0	0.0
	Low	40	2,243,144	694,070	22.6	6.7	51.8	18.5	39.5	16.7	7.8	9.7
	Moderate	13	449,193	270,057	4.5	2.7	0.0	0.0	83.6	19.5	8.6	11.1
	Severe	43	1,204,157	331,630	12.1	3.3	0.0	0.0	18.1	11.2	81.9	11.2
Mixed Wood Shield	Minimal	41	5,639,180	650,634	77.4	8.9	78.0	10.4	22.0	10.4	0.0	0.0
	Low	10	1,375,410	627,374	18.9	8.6	60.0	26.3	30.0	23.3	10.0	17.6
	Moderate	1	137,541	222,582	1.9	3.1	0.0	0.0	100.0	0.0	0.0	0.0
	Severe	1	137,541	222,706	1.9	3.1	0.0	0.0	0.0	0.0	100.0	0.0
Mixed Wood Plains	Minimal	9	318,316	150,419	18.8	8.9	77.8	21.0	22.2	21.0	0.0	0.0
	Low	18	636,633	198,167	37.5	11.7	50.0	17.0	50.0	17.0	0.0	0.0
	Moderate	5	176,842	132,465	10.4	7.8	0.0	0.0	80.0	34.0	0.0	0.0
	Severe	16	565,896	202,891	33.3	12.0	0.0	0.0	25.0	19.0	75.0	19.0
Temperate Prairies	Minimal	4	77,034	59,787	8.2	6.3	75.0	40.5	25.0	40.5	0.0	0.0
	Low	12	231,102	96,474	24.5	10.2	8.3	13.5	66.7	25.5	16.7	18.4
	Moderate	7	134,809	80,642	14.3	8.5	0.0	0.0	71.4	32.8	28.6	32.8
	Severe	26	500,720	112,122	53.1	11.9	0.0	0.0	15.4	12.4	84.6	12.4

Table D-17. 2021 statewide extent estimates when live or dead Ash trees ≥ 1" diameter breast height (DBH) are present and at significant cover (≥ 15%), and when Emerald Ash Borer (EAB) was observed. This includes black and green ash regardless of plant community type. Error margins (±) represent 95% confidence intervals.

Ash & EAB Categories	n	Wetland Extent (ac)	Extent (±)	% Wetland	% (±)
Wetland w/Ash Present	48	3,257,410	827,621	32.8	8.1
Wetland w/Significant Ash Cover	19	1,290,549	576,245	13.0	5.7
Wetland w/EAB Present	6	163,881	114,267	1.7	1.2
Significant Ash Cover Wetland w/EAB Present	3	73,885	73,518	0.7	0.7