Measuring what matters:

Assessing the full suite of benefits of OHF investments

Final Report January 8, 2021

This project is a collaborative effort among LSOHC staff and researchers at the University of Minnesota (Ryan Noe, Christina Locke, Eric Lonsdorf, Bonnie Keeler) and the Natural Resource Research Institute in Duluth, Minnesota (George Host, Jessica Gorzo, Lucinda Johnson, Alexis Grinde, Michael Joyce, Josh Bednar, Josh Dumke.)

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Executive Summary

In 2018-2020, researchers at the University of Minnesota and the Natural Resources Research Institute (NRRI) worked together to evaluate the portfolio of past Outdoor Heritage Fund (OHF) investments. In this document, we go beyond reporting "dollars and acres" to quantify specific environmental benefits provided by conservation acquisitions, which has not been previously done for OHF investments. Here, we present a comprehensive overview of the environmental benefits associated with the entire OHF fee and easement portfolio for the first 10 years of the program.

Using all relevant existing, and some newly created, statewide datasets, we created 21 metrics for conservation and environmental benefits and scored the OHF fee and easement portfolio across all metrics. We designed metrics to align with priorities outlined in the 2017 report, "Minnesota's Outdoor Heritage Fund: A Process to Define Outcomes and Impacts," which outlined primary outcomes of interest as fish habitat, wildlife habitat, and outdoor recreation, and a secondary focus on other benefits to people.[1] It should be noted that these metrics capture values beyond the OHF's mandate "to restore, protect, and enhance wetlands, prairies, forests, and habitat for fish, game, and wildlife" (Minnesota Constitution, Article XI). Thus, any 'low' scores for metrics not directly addressed in the constitutional language are not an indication of poor performance of the OHF. Rather, these metrics serve two purposes. First, using a broad suite of metrics better communicates the full extent of the benefits derived from OHF activities, and highlights areas in which the OHF is achieving more benefits than would otherwise be known. Second, it demonstrates the diversity of priorities espoused by managers of OHF lands, whose organizational missions range from expanding pheasant habitat to restoring trout streams, among many others.

Guiding questions and major findings include:

1. **How did OHF investments score on individual metrics?**
    - OHF parcels scored highly on habitat metrics for deer, pollinators, upland game birds, forest bird Species of Greatest Conservation Need (SGCN), trout, and pheasant.
    - OHF parcels scored relatively low on the metrics nearby population and birdwatching. This indicates that OHF lands, though open to the public, are less accessible and less often used for birdwatching than similar non-OHF lands.
2. **How did OHF investments score on overlapping co-benefits?**
    - Nearly all land in the OHF portfolio (98%) scored in the top 25% of statewide parcels on more than one metric.
    - 70% of OHF land scored highly on three, four, or five co-benefits, compared to 50% of non-urban land unprotected by any conservation program.

[1] Environmental Initiative, (2017) Minnesota's Outdoor Heritage Fund: A Process to Define Outcomes & Impacts. https://environmental-initiative.org/work/minnesotas-outdoor-heritage-fund-a-process-to-define-outcomes-impacts/

- 93% of the land that scored highly on 12 or more metrics is unprotected by any program.

3. **What were the highest scoring OHF parcels in each metric category?**
   - In each metric category, the highest scoring OHF parcel scored much higher than average; 12 examples are spotlighted in this report.
4. **What is the added conservation value of OHF investments?**
   - To contextualize the scale of benefits gleaned from OHF investments, we compared the acreage of high scoring OHF land to that of high scoring land in the longstanding Wildlife Management Area (WMA) program. This comparison illustrates the complementary strengths of the different conservation programs, and highlights OHF's important role in Minnesota's conservation portfolio.
   - OHF fee title and easement acquisitions doubled the protected area within a 66-foot buffer around trout streams relative to WMAs, even before accounting for improvements from restoration and enhancement activities.
   - OHF increased the protected area of highest quality habitat for game mammals, upland game birds, and forest bird SGCN by approximately 75%, and more than doubled the protected area of highest quality pollinator habitat, compared to areas protected by WMAs.
   - Acreage of OHF land in the catchment of lakes of outstanding biological significance or lakes was relatively small (12,600 acres) compared to the WMA portfolio (145,600 acres).

Challenges and Recommendations

Our analysis provides a helpful bird's eye view of benefits gleaned from the OHF program at the statewide level, but could be improved with more complete data, including a comprehensive cost-benefit analysis and an on-the-ground analysis of restoration impacts on wildlife and people. Below are several recommendations for achieving these products in future analyses:

- **Improvements in reporting**. When performing our analysis, we encountered inconsistencies in reported variables. One primary issue was a lack of a unique identifier that consistently linked a parcel's spatial boundaries to its project attributes. In the spatial database, parcels sometimes had overlapping or duplicated boundaries or parcel boundaries with a very different area than the acreage stated in the database. Another difficulty was determining the cost of acquisition and/or restoration activities for a given parcel or project. Many parcels had multiple database fields with inconsistent cost values, and some parcels noted as purchased lacked any purchase cost data at all. These inconsistencies limited the reliability of comparisons that required calculating per acre land values. Recommended data management practices include assigning a unique identifier to each OHF parcel, removing overlapping geometries among fee title or easement projects, ensuring the stated area of a parcel is similar to the area calculated from its boundaries, providing definitions for each column in the database, and ensuring component costs (purchase price, restoration costs, donated value, etc.) add up to

the total cost listed in the database.

- **Improvements to monitoring**. To fully capture changes in outcomes for fish and wildlife due to OHF activities, similar statewide analyses should be complemented with site-based assessments repeated over time. OHF already performs on-the-ground Technical Review Evaluations by independent experts on a subset of parcels to ensure OHF activities meet legal requirements and use current best practices. While these reviews offer a snapshot of select habitat and species information, they are not repeated consistently and do not offer a pre- and post-restoration comparison by which to track effects of restoration over time. A small sample of consistent surveys of fish, wildlife, and vegetation over time would aid in differentiating between the outcomes of OHF activities and natural variability. Beyond habitat assessments, data on outdoor recreation could be obtained via surveys, trail cameras,[2] or social media data,[3] to understand how OHF acquisition and restoration activities affect visitation and other social indicators. This type of research would likely require funding from sources outside of OHF.

[2] Miller, A.B., Leung, Y.-F., Kays, R., (2017) Coupling visitor and wildlife monitoring in protected areas using camera traps. Journal of Outdoor Recreation and Tourism 17, 44–53. https://doi.org/10.1016/j.jort.2016.09.007

[3] Wood, S.A., Winder, S.G., Lia, E.H., White, E.M., Crowley, C.S.L., Milnor, A.A., (2020) Next-generation visitation models using social media to estimate recreation on public lands. Scientific Reports. 10, 15419. https://doi.org/10.1038/s41598-020-70829-x

OHF portfolio overview

LANDCOVER	# ACRES
WETLANDS	130,023
FOREST	123,328
AGRICULTURE	57,751
PRAIRIE	36,398
OTHER	8,937
TOTAL	**356,438**

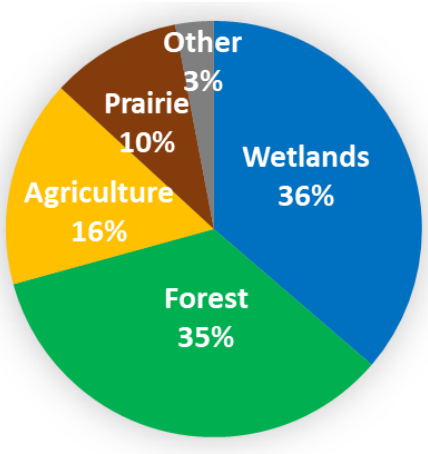


Figure 1. Land covers represented in OHF portfolio (fee and easement)

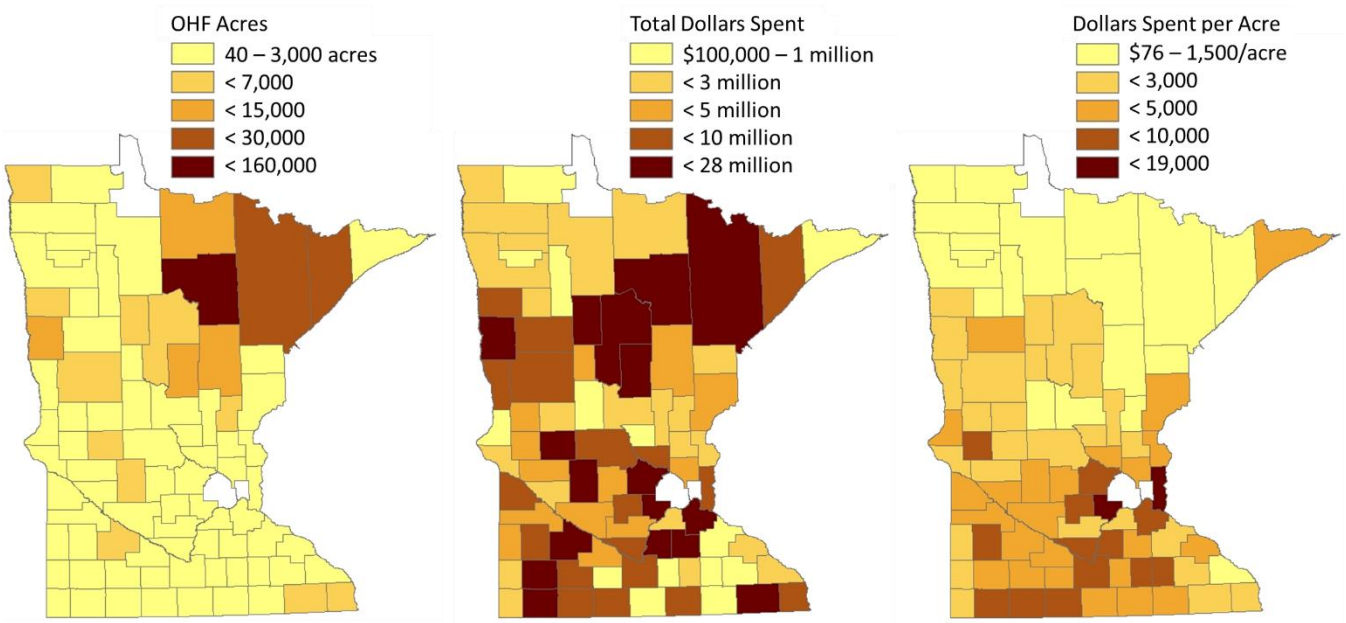


Figure 2. Acres and dollars spent in each county (fee and easement)

Metrics

We scored OHF investments (fee and easement) on 21 metrics (see table below and Appendix A for full metadata). Metrics were chosen to align with priorities outlined in the report, "Minnesota's Outdoor Heritage Fund: A Process to Define Outcomes and Impacts," which outlined primary outcomes of interest as fish habitat, wildlife habitat, and outdoor recreation, and a secondary focus on other benefits to people.[4] This broad suite of metrics goes beyond OHF's constitutional mandate to demonstrate opportunities for capturing intended and unintended co-benefits to people and wildlife.

Metric	Category	Description
Forest Bird Species in Greatest Conservation Need (SGCN) Habitat	Wildlife / Game Habitat	Breeding habitat quality for Species in Greatest Conservation Need (SGCN), derived from observations and modeling by the Minnesota Breeding Bird Atlas (MNBBA).
Grassland and Prairie Bird SGCN Habitat	Wildlife / Game Habitat	Breeding habitat quality for grassland SGCN, derived from observations and modeling by the MNBBA.
Wetland Bird SGCN Habitat	Wildlife / Game Habitat	Breeding habitat quality for wetland SGCN, derived from observations and modeling by the MNBBA.
Bird Species Richness	Wildlife / Game Habitat	Measure of the number of different bird species observed within a township.
Mammal SGCN Habitat	Wildlife / Game Habitat	Climate envelop modeling of SGCN mammals in the state.
Pollinator Habitat	Wildlife / Game Habitat	InVEST[5] Pollination model output of habitat quality for pollinator species.
Upland Game Bird Habitat	Wildlife / Game Habitat	Breeding habitat quality for American Woodcock, Wild Turkey, and Ruffed Grouse from observations and modeling by the MNBBA.
Pheasant Habitat	Wildlife / Game Habitat	Pheasant habitat suitability based on local land cover.
Waterfowl Habitat	Wildlife / Game Habitat	Breeding habitat quality for all waterfowl species from observations and modeling by MNBBA.
Mammal Game Species and Furbearers	Wildlife / Game Habitat	Climate envelop modeling of mammal game species and furbearers.

[4] Environmental Initiative, (2017) Minnesota's Outdoor Heritage Fund: A Process to Define Outcomes & Impacts. https://environmental-initiative.org/work/minnesotas-outdoor-heritage-fund-a-process-to-define-outcomes-impacts/

[5] Natural Capital Project. InVEST: Integrated Valuation of Ecosystem Services and Tradeoffs. https://naturalcapitalproject.stanford.edu/software/invest

Deer Abundance	Wildlife / Game Habitat	Climate envelop modeling supplemented by deer hunting permit data.
Risk of Development	Wildlife / Game Habitat	Risk of habitat loss to developed (built) uses.
Risk of Ag Conversion	Wildlife / Game Habitat	Risk of habitat loss to agriculture.
Lakes of Biological Significance	Fish Habitat	Department of Natural Resources (DNR) dataset combining data from biological sampling efforts at lakes throughout the state.
Trout Streams	Fish Habitat	Catchments and 66-foot buffers of legally designated trout streams.
Birdwatching	Outdoor Recreation	Bird watching activity concentration derived from eBird reports.
Lake Recreation	Outdoor Recreation	Lake catchments weighted by phosphorus sensitivity and recreation activity.
Trail Proximity	Outdoor Recreation	Within a 500-foot buffer of state and regional trails.
Wild Rice Sites	Outdoor Recreation	Within the catchment of a current wild rice site.
Nearby Population	Outdoor Recreation	Proportion of the state's population within 50 miles.
Wellhead Protection	Benefits to People	Land within a Drinking Water Supply Management Area, weighted by groundwater sensitivity.

Scoring OHF investments

- Each metric was scaled from 0 to 1, where 0 represents absent or lowest quality, and 1 is highest quality.
- A land scored "high" if it scored in the top half of land statewide for a given metric, and "low" if it scored in the bottom half. A parcel scored "highest" if it scored in the top quarter of land statewide.[6]

The remainder of this report is organized around answering the following questions:

1. How did OHF investments score on individual metrics?
2. How did OHF investments score on overlapping benefits?
3. What were the highest scoring OHF parcels in each metric category?

[6] Our analysis included five categorical metrics that do not conform to these scoring definitions. For these metrics, a parcel scored in the highest quality class if it met the following criteria: Trail Proximity: Present; Wild Rice: Present; Lakes of Biological Significance: 'High' or 'Outstanding; Trout Streams: All land located within a trout stream catchment; Wellhead Protection: 'High' or 'Very High' sensitivity categories. Full documentation available in Appendix A.

4. What is the added value of OHF investments on top of other conservation efforts?

1. OHF portfolio scores on individual metrics

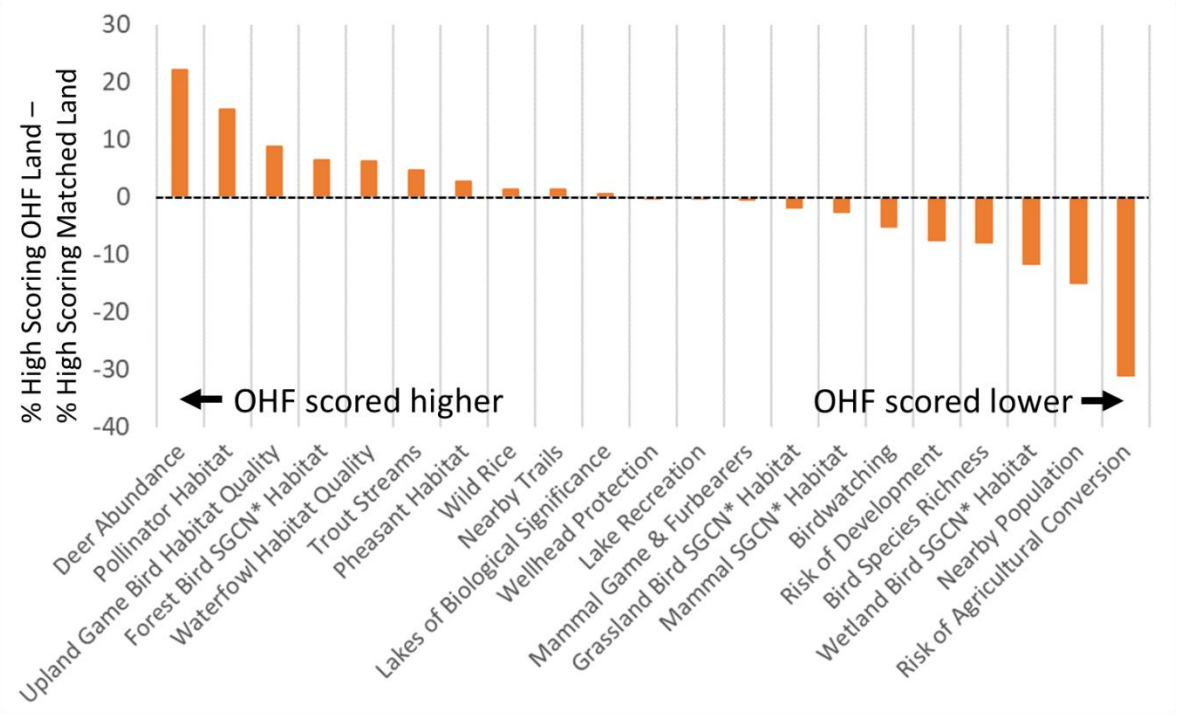


Figure 3. Scoring of OHF portfolio parcels compared to matched parcels.

This figure shows how the OHF portfolio scored compared to the other land parcels in Minnesota similar to OHF parcels in land value, size, shape, and region of the state ("matched parcels"). Matched parcels also represent land that could potentially be acquired under OHF in the future. Matching is a way to minimize bias that results from comparing two dissimilar groups. In other words, comparing OHF scores to scores of matched parcels is a fairer comparison than would be achieved comparing OHF parcels to dissimilar land that is unlikely to ever be considered for OHF protection. See Appendix B for full matching methods.

The OHF portfolio scored higher than matched parcels on a number of metrics reflecting the OHF's constitutional mandate, including habitat metrics for deer, pollinators, upland game birds, forest bird Species of Greatest Conservation Need (SGCN), trout, and pheasant. OHF parcels also scored well on wild rice, nearby trails, and the lake Index of Biological Integrity. However, OHF parcels scored no better than the matched parcels on wellhead protection, lake recreation, and furbearer habitat, and scored worse on habitat for SGCN wetland birds, SGCN grassland birds, SGCN mammals, and bird species richness.

OHF parcels undoubtedly increase the amount of land accessible to the public. Under mandate, OHF fee acquisitions "must be open to the public taking of fish and game during the open season unless otherwise provided by law" (Minnesota Constitution, Section 15). Additionally, the major OHF easement acquisition to date covering over 187,000 acres of northern forestland, is open to public access for hunting, fishing, and gathering. However, land designated as open to the public may not be used regularly by the public if it is remote or not easily accessed for other reasons. The indicator "nearby population" is a measure of remoteness, and "birdwatching" is a measure of recreational use; OHF parcels scored relatively low on both of these metrics.

OHF parcels also scored much lower than matched parcels on the risk of agricultural conversion and risk of development, meaning OHF investments to date have been at low risk of conversion in the absence of protection. The reason for the low score on the risk of development is related to the remoteness of OHF parcels discussed above, as the risk of development decreases with distance to population centers. One thing to note is that "risk of conversion" metrics can provide meaningful guidance when considering protection of existing habitat, but are less meaningful when considering the acquisition of degraded lands planned for restoration. For example, many OHF parcels are acquired as marginal agricultural lands (drained wetlands) under the premise that they will be restored to wildlife habitat, in which cases the "risk of agricultural conversion" is not of concern.

2. Multiple benefit scoring

The previous section describes the representation of individual benefits in the OHF portfolio, but does not examine overlapping benefits. The same piece of land may provide many benefits, such as deer and pheasant habitat, pollinator habitat, and wellhead protection. While creating a portfolio of parcels that excel at individual benefits is an effective strategy, selectively acquiring parcels that score well on multiple benefits is a complementary approach to maximize the benefits of the portfolio overall.

To test if the OHF portfolio preferentially includes land with multiple benefits, we reclassified all metrics as either the highest quality class or not. For continuous metrics, we defined the highest quality class as the top 25% of scores.[7] We then summed the number of highest quality class metrics found on non-urban land in the state (Figure 4).

[7] Categorical metrics were classified as described in the footnote on page 7.

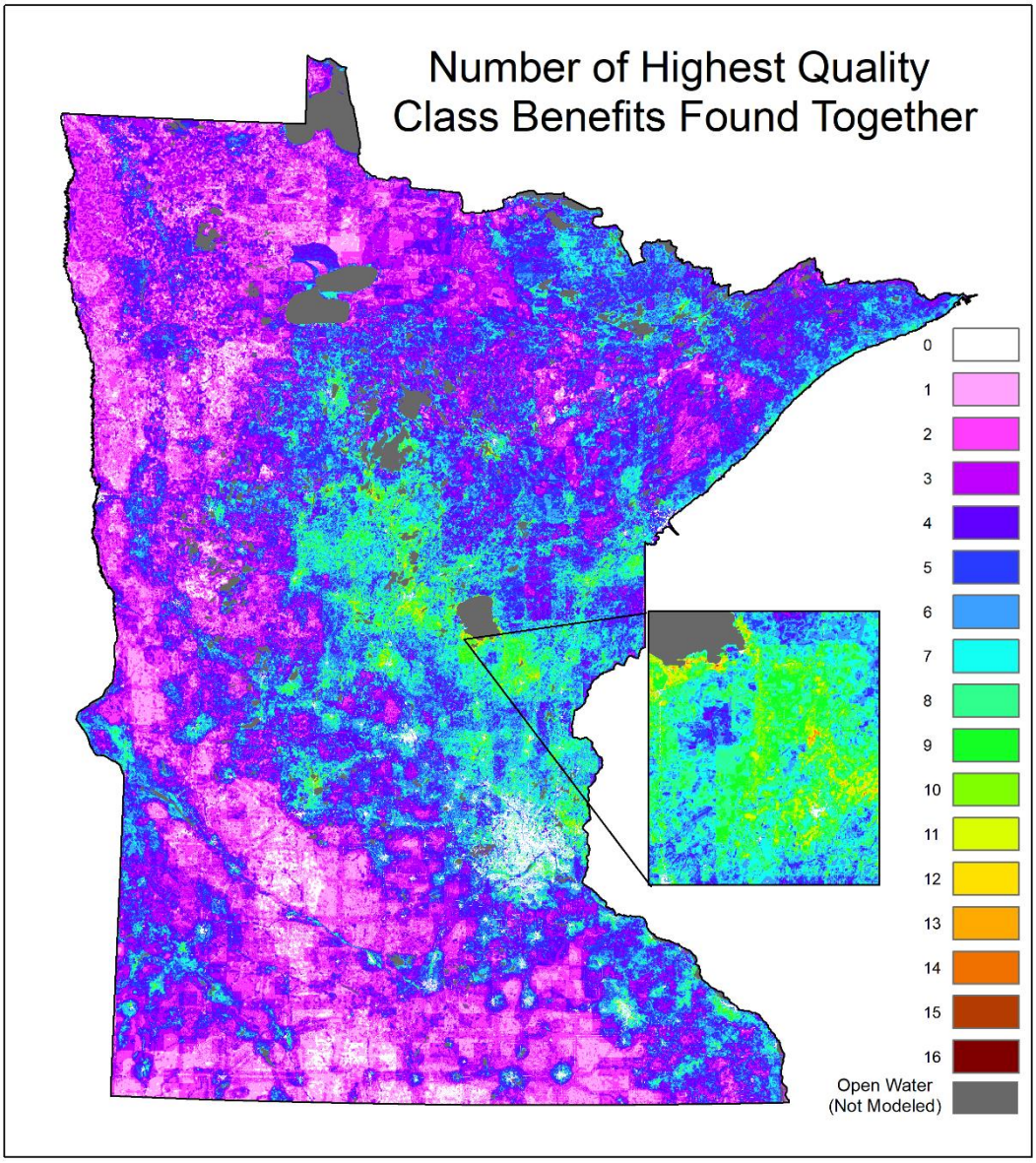


Figure 4. This map depicts the number of highest quality benefits co-incident in the same location. Of the 23,500 acres of land with 12 or more benefits in the highest quality class, 93% is unprotected by any conservation program.

We then calculated the distribution of multiple benefit counts for the OHF portfolio and a comparison group of non-urban land unprotected by any conservation program (Figure 5). If acquisitions in the OHF portfolio did not show a preference for land with multiple benefits, the distribution of orange bars would be similar to the purple bars. Instead, we see that OHF has disproportionately more land scoring highly on three to five metrics, compared to unprotected land. However, OHF has a slightly lower proportion of land scoring highly on seven or more metrics. While rare, there is land in Minnesota that scores in the highest quality class in up to 16 of the 21 metrics analyzed here. Because of

its rarity, land with this many benefits would need to be actively targeted to ensure representation in a conservation portfolio.

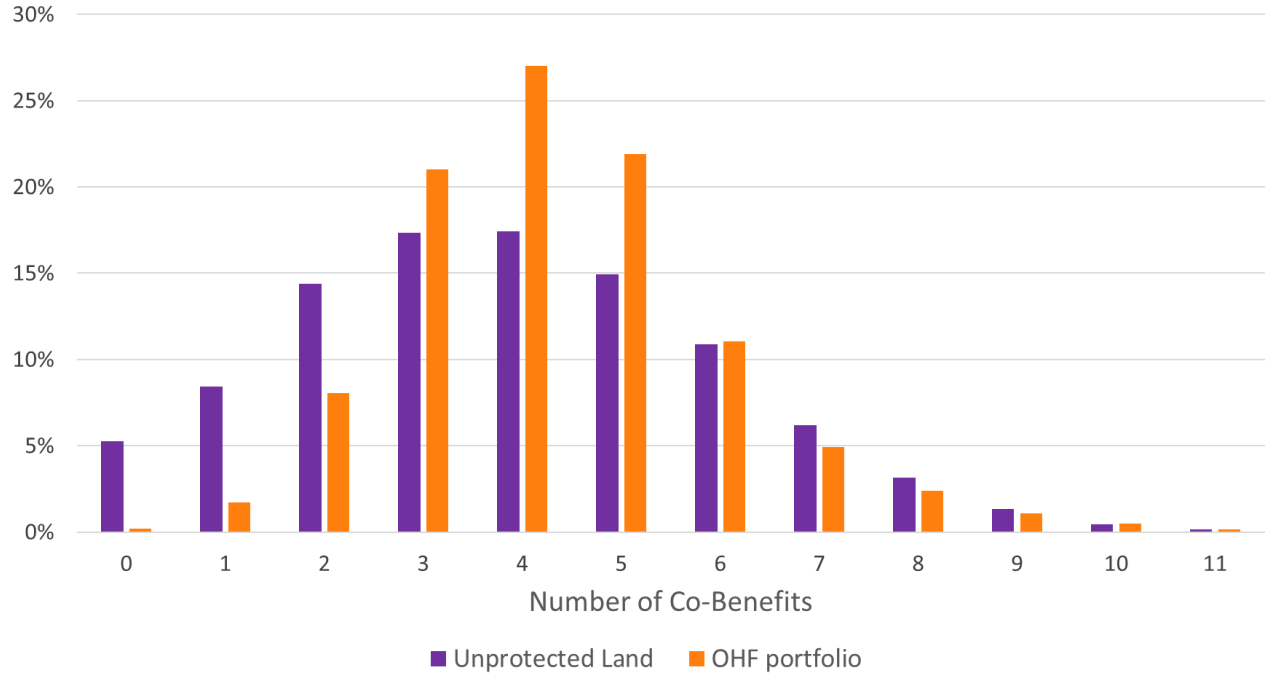


Figure 5. Percent of OHF portfolio with multiple benefits, relative to non-urban land unprotected by any conservation program.

3. Highest scoring OHF parcels

This section highlights the highest scoring OHF parcel for each of the 12 metrics. In each metric category, the highest scoring OHF parcel scored much higher than the average OHF parcel and the average matched parcel:

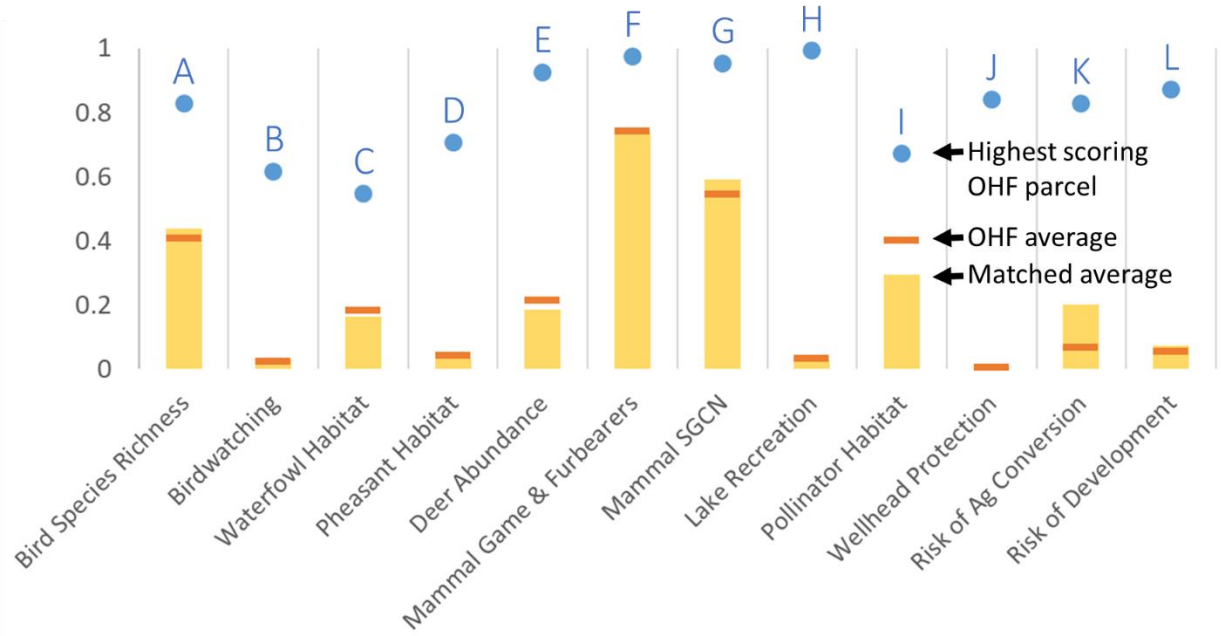
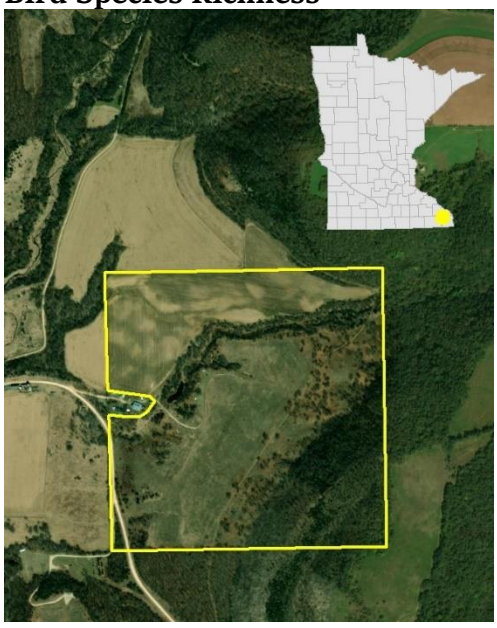


Figure 6. Highest scoring OHF parcel compared to the OHF average and "matched parcel" average for each metric.

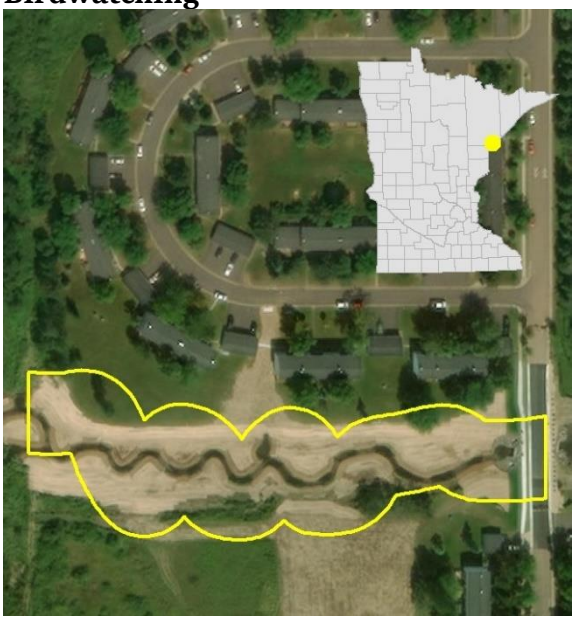
A, Root River Protection and Restoration, Houston County
B, MNDNR Aquatic Habitat Protection Phase VIII, St. Louis County
C, Accelerating the Wildlife Management Area Program, Phase III, Lac qui Parle County
D, RIM Wetlands Partnership Phase IV, Lincoln County
E, Southeast Minnesota Protection and Restoration Phase IV, Winona County
F, Metro Big Rivers Phase IV, Washington County
G, Critical Shoreland Habitat Protection Program: Phase II, St. Louis County
H, Accelerated Aquatic Management Area Acquisition, Phase II, Crow Wing County
I, Critical Shoreland Habitat Protection Program: Phase II, Lake County
J, Accelerating the Wildlife Management Area Program - Phase VI, Lyon County
K, MN Prairie Recovery Project - Phase VII, Marshall County
L, Dakota County Habitat Protection, Phase I, Dakota County

Bird Species Richness



Project: Root River Protection and Restoration
155-acre easement in Houston County
($120,000)

Birdwatching



Project: MNDNR Aquatic Habitat Protection Phase VIII
2-acre trout stream easement in St. Louis County ($8,400)

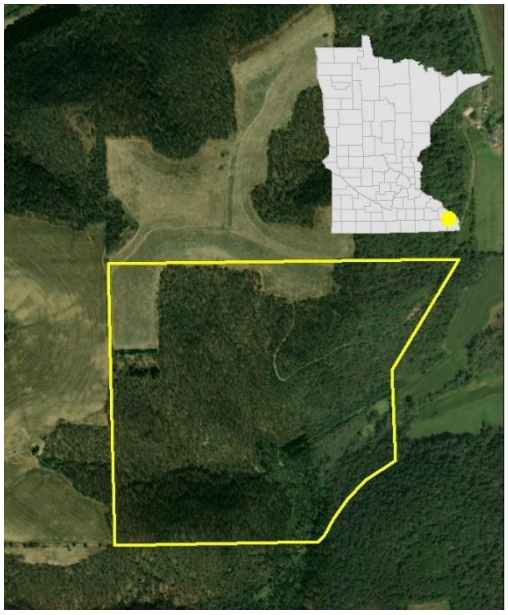
Waterfowl Habitat

Project: Accelerating the Wildlife Management Area Program, Phase III
67-acre fee purchase in Lac qui Parle County
($122,000)

Pheasant Production

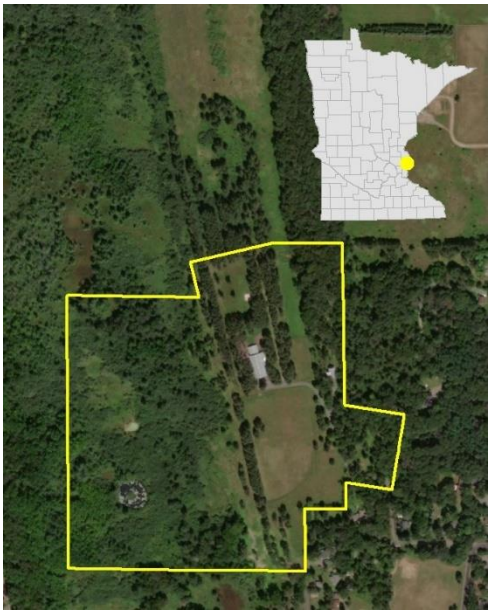
Project: RIM Wetlands Partnership Phase IV
19-acre easement in Lincoln County
($62,000)

Deer Abundance



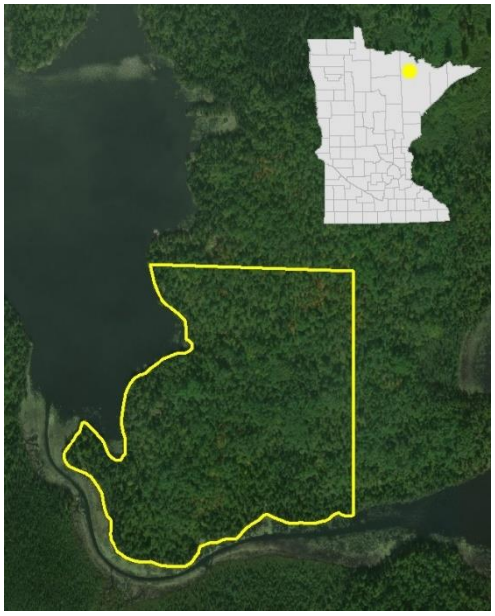
Project: Southeast Minnesota Protection and Restoration Phase IV
158-acre easement in Winona County
($175,000)

Mammal Game & Furbearers



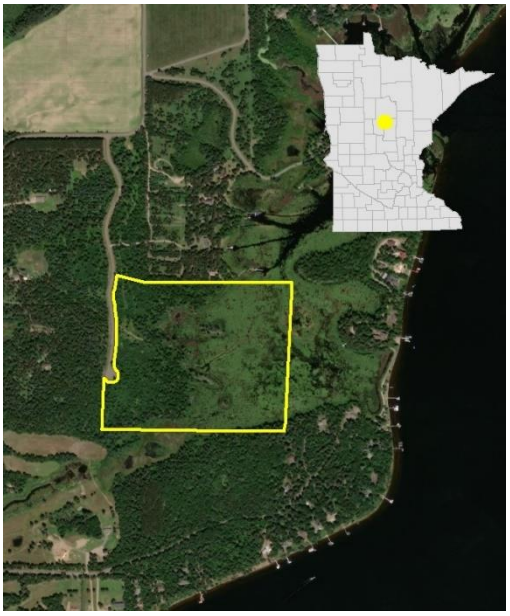
Project: Metro Big Rivers Phase IV
45-acre easement in Washington County
($313,000)

Mammal SGCN



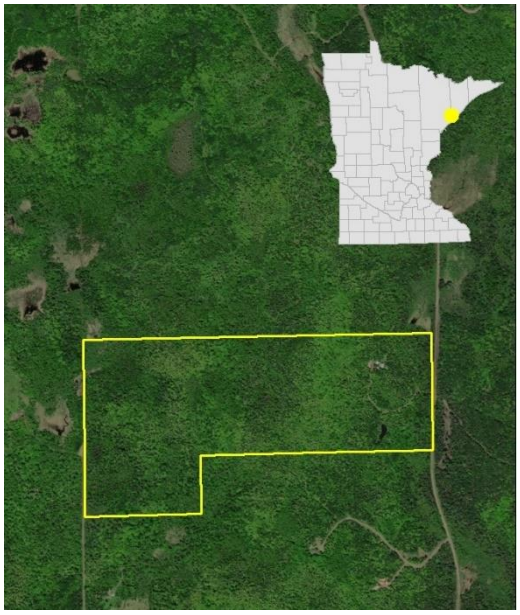
Project: Critical Shoreland Habitat Protection Program: Phase II
48-acre easement in St. Louis County
($50,000)

Lake Recreation



Project: Accelerated Aquatic Management Area Habitat Program, Phase III
50-acre fee purchase in Crow Wing County
($635,000)

Pollinator Habitat

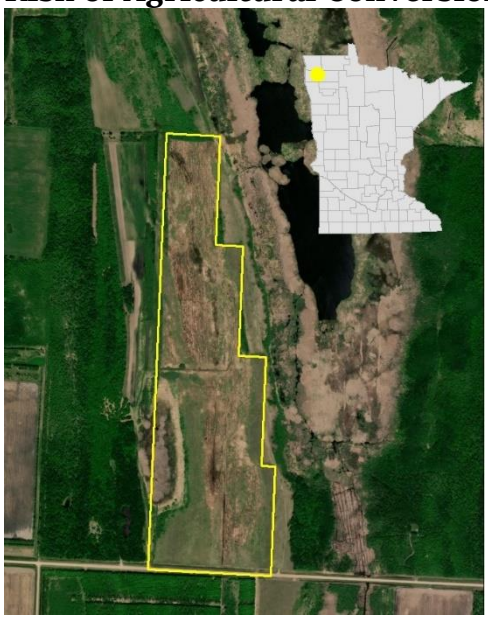


Project: Critical Shoreland Habitat Protection Program, Phase II
140-acre easement in Lake County ($50,000)

Wellhead Protection

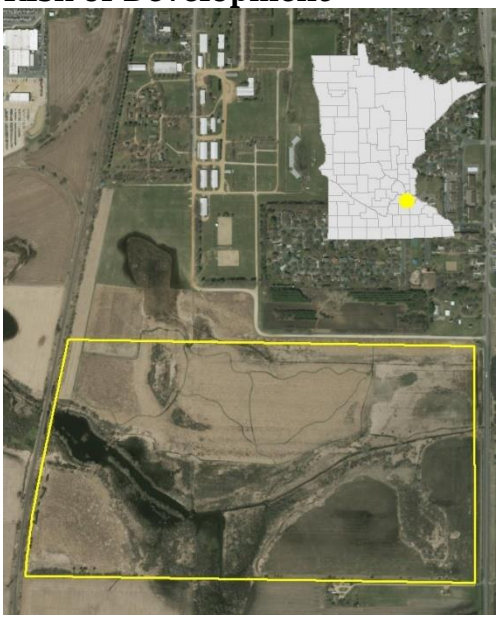
Project: Accelerating the Wildlife Management Area Program - Phase VI
Rolling Hills WMA Addition
2.5-acre fee purchase in Lyon County ($1 million)

Risk of Agricultural Conversion



Project: MN Prairie Recovery Project - Phase VII
Florian WMA Addition
135-acre fee purchase in Marshall County ($146,000)

Risk of Development

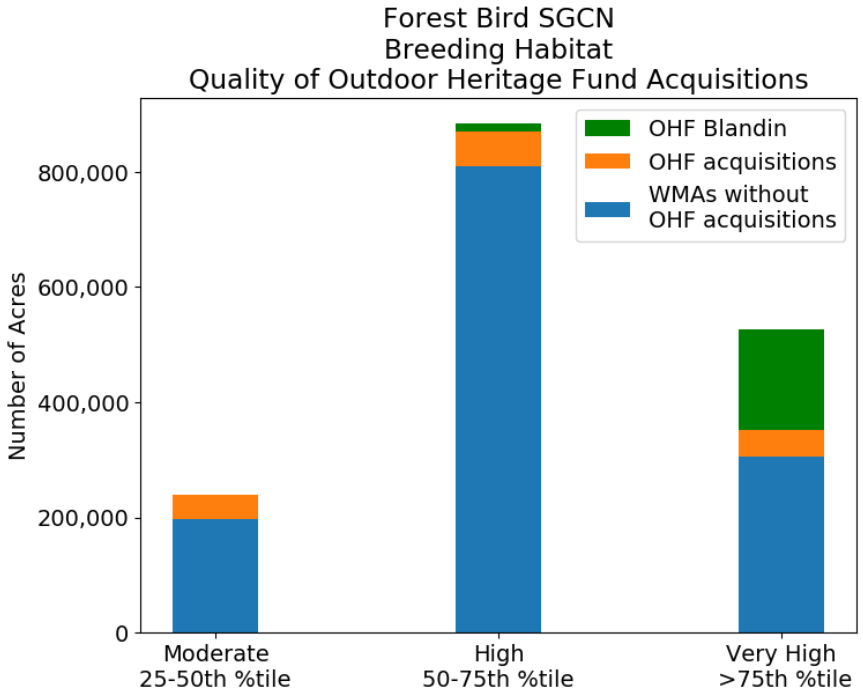


Project: Dakota County Habitat Protection, Phase I
193-acre easement in Dakota County ($750,000)

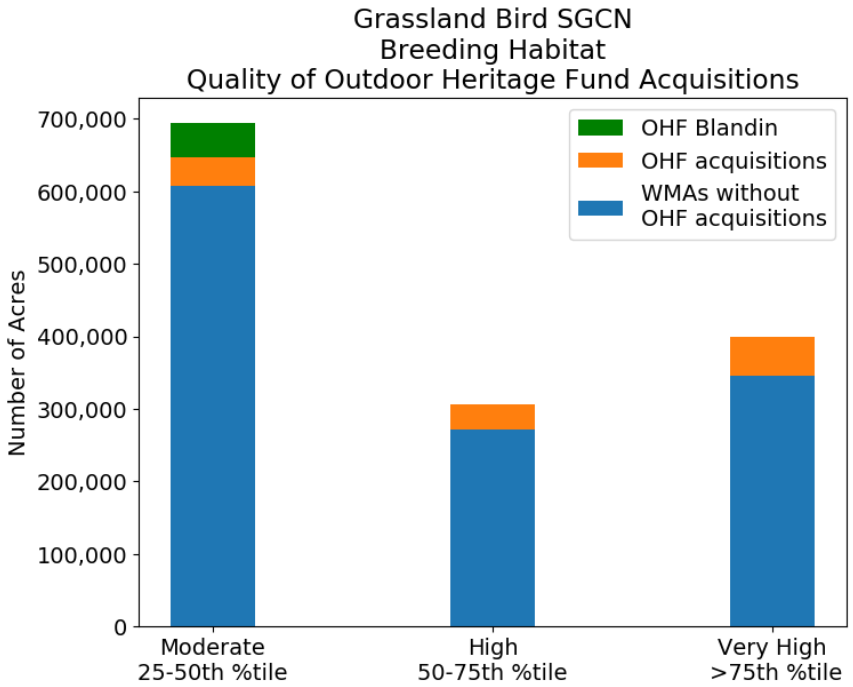
4. Added conservation value of OHF investments

OHF expenditures have funded over 350,000 acres of fee-title or easement acquisitions and associated restoration, but visualizing the impact of thousands of acres across the entire state is challenging. To put these numbers in context, we show them along with an established conservation program, Wildlife Management Areas (WMA). The WMA program has been protecting land since the 1950s, and has approximately 1.3 million acres in its portfolio, excluding OHF funded acquisitions. We focused on the WMA program because it is well-known and has similar objectives to OHF. In the figures below, the blue bars represent the acres of moderate, high, and highest quality land for each of the benefits added to the WMA portfolio over its nearly 70 years in existence. The orange and green bars represent what the OHF added to each of those benefits. The green bars parse out the contribution of the largest OHF investment, the over 187,000 acre UPM Blandin project. Given the high proportion of land represented by this project, we graphed it separately to demonstrate its influence on each metric.

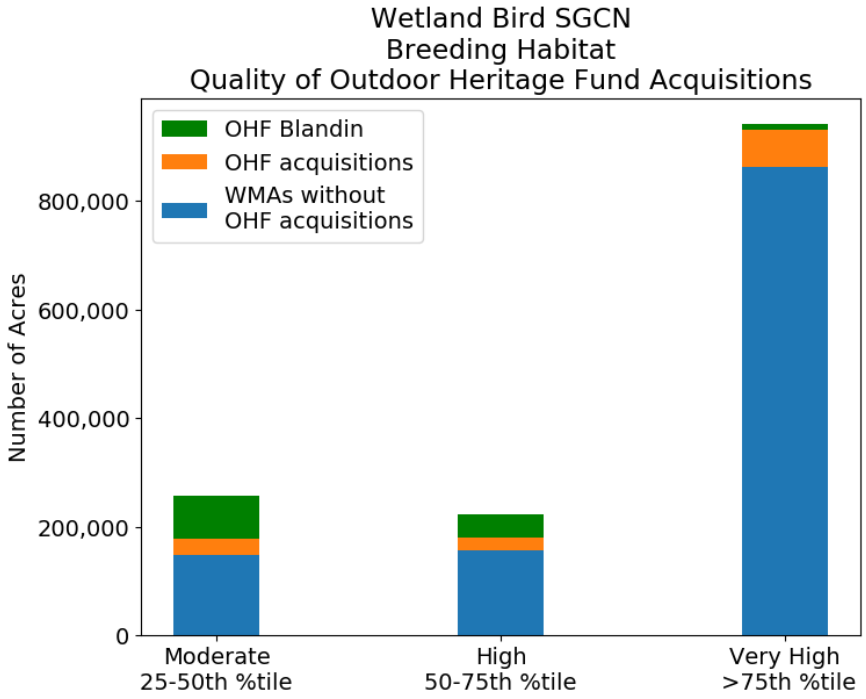
The orange and green bars in the figures below represent positive contributions to the respective benefits. For some metrics, the amount of moderate quality land is greater than the amount of very high-quality land, but this does not mean that performance was poor for that metric. The moderate quality category still provides important benefits, and more importantly, land in the moderate category for one benefit might score very high for another. Also note that some benefits are not distributed equally across the state. For example, there are fewer high-quality wellhead protection acres than there are high-quality waterfowl habitat areas, so the total acres of the benefits are not directly comparable between these figures. While our previous figures have focused on displaying the portfolio of highest quality benefits, these figures allow exploration of the amount and quality of individual benefits in the context of the added value to conservation efforts in the state.



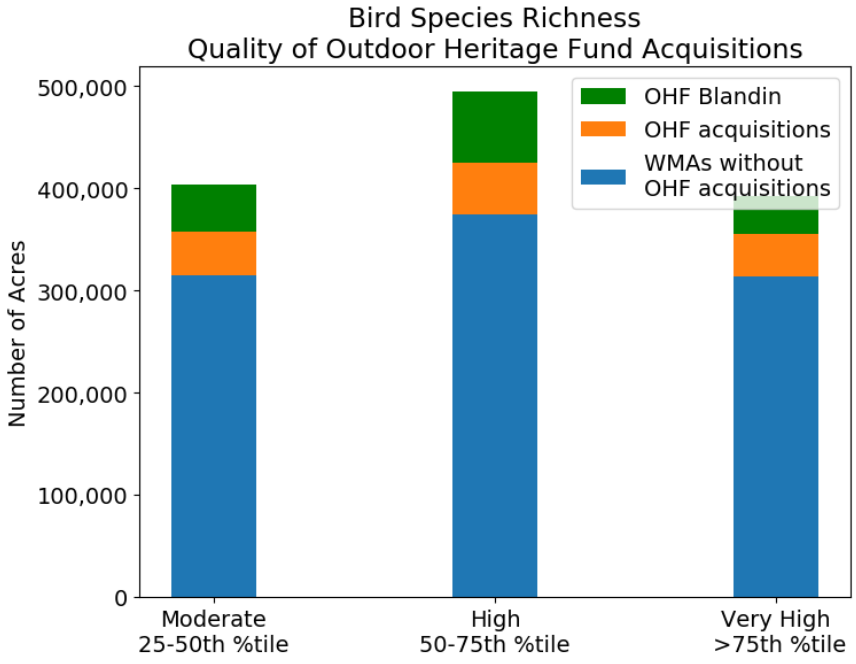
The OHF portfolio scored well for forest bird species of greatest conservation need (SGCN), likely due to large forest acquisitions in north-central Minnesota.



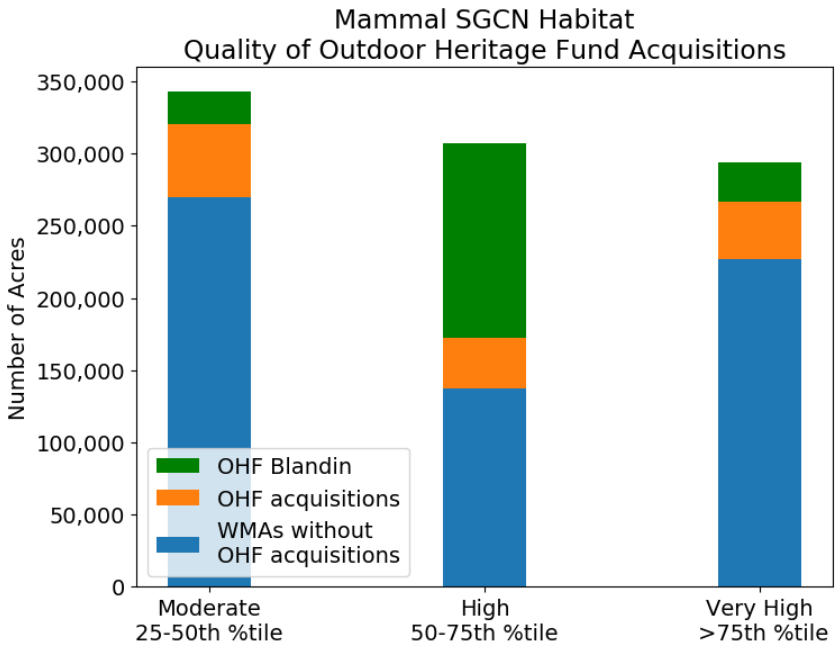
Grassland bird SGCN breeding habitat benefited from over 100,000 thousand acres of OHF acquisitions, with roughly half of this area in the moderate quality category.



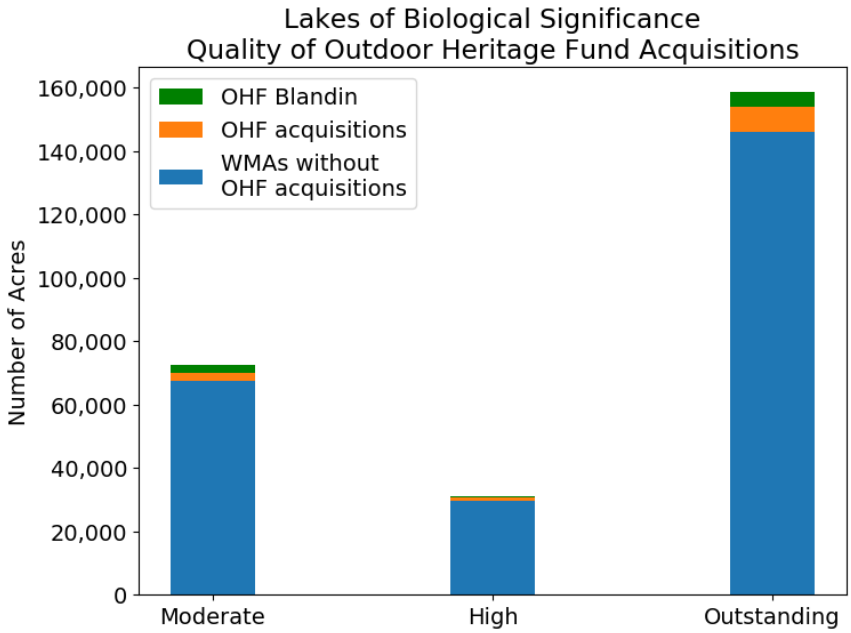
The distribution of OHF acquisitions contributing to wetland bird SGCN breeding habitat was similar to that of grassland bird SGCN. WMA acquisitions already provide a substantial amount of high-quality wetland bird SGCN breeding habitat.



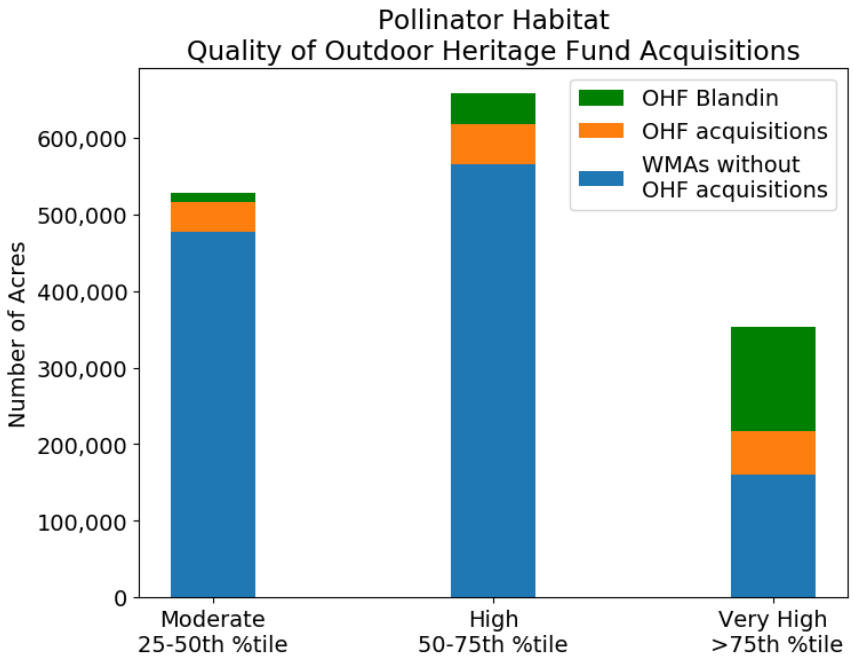
For bird species richness, OHF acquisitions add conservation value in all quality classes, with the most in the high-quality class.



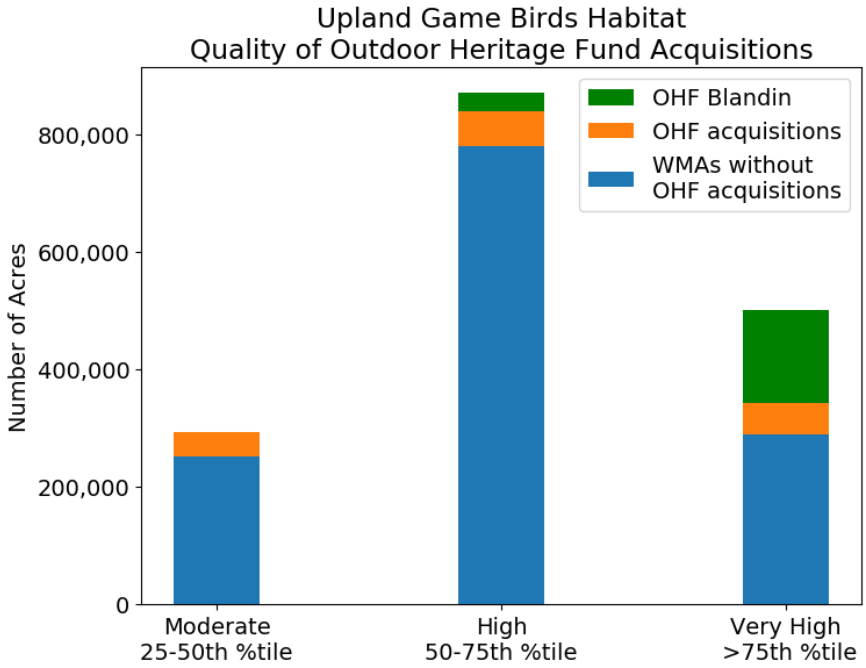
The OHF portfolio more than doubled the area of high-quality mammal SGCN habitat found in the WMA portfolio.



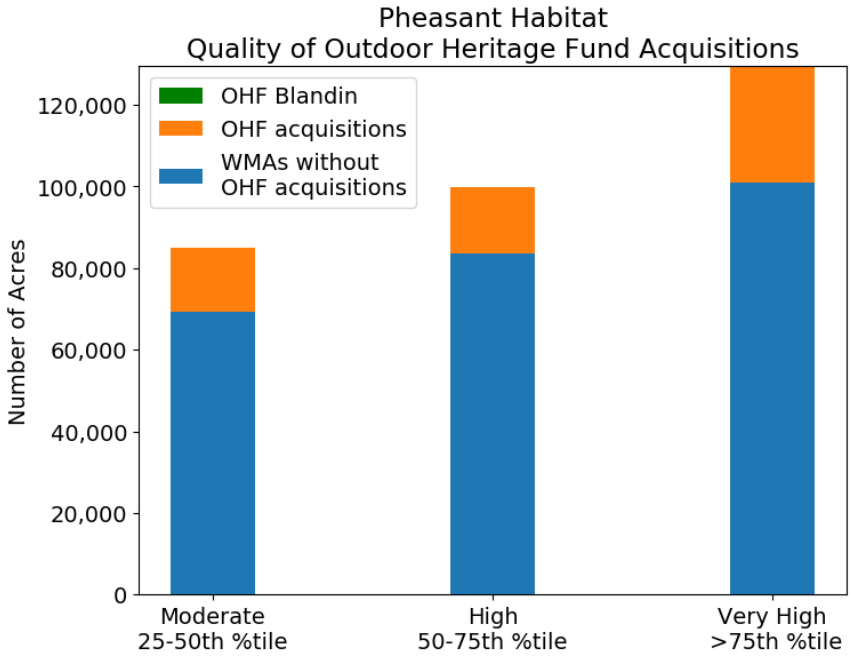
When compared to other metrics and to the WMA portfolio, the OHF portfolio had fewer acquisitions near lakes of biological significance. However, most of those acquisitions were around lakes classified by the DNR as ‘Outstanding’.



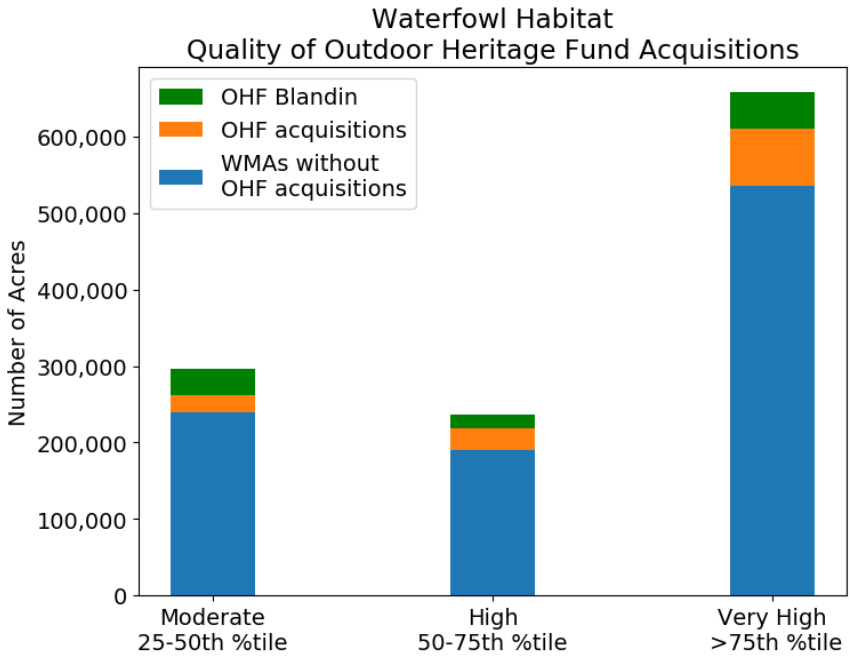
Very high-quality pollinator habitat was well represented in the OHF portfolio.



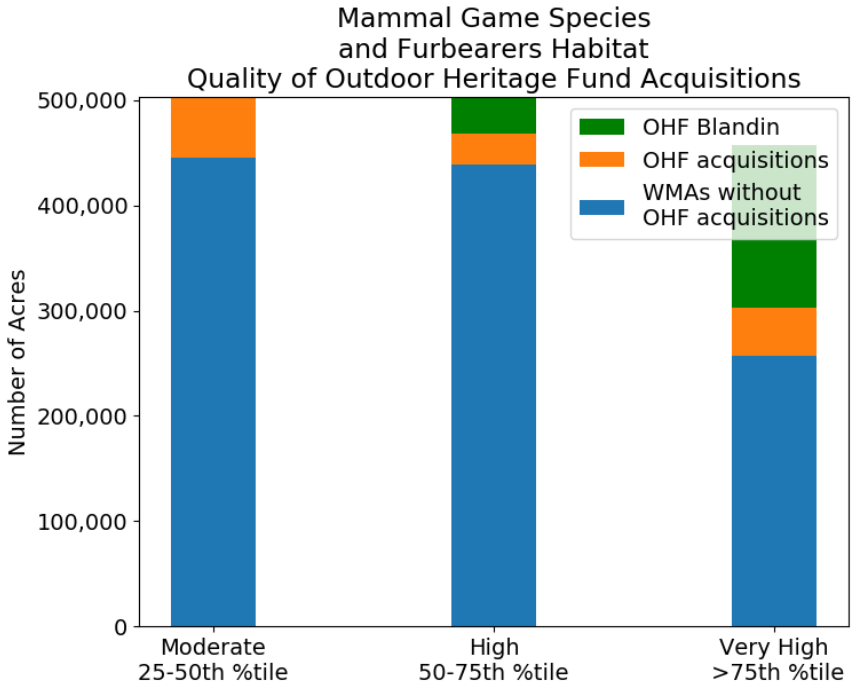
OHF acquisitions excelled in both the quantity and quality of breeding habitat for upland bird game species.



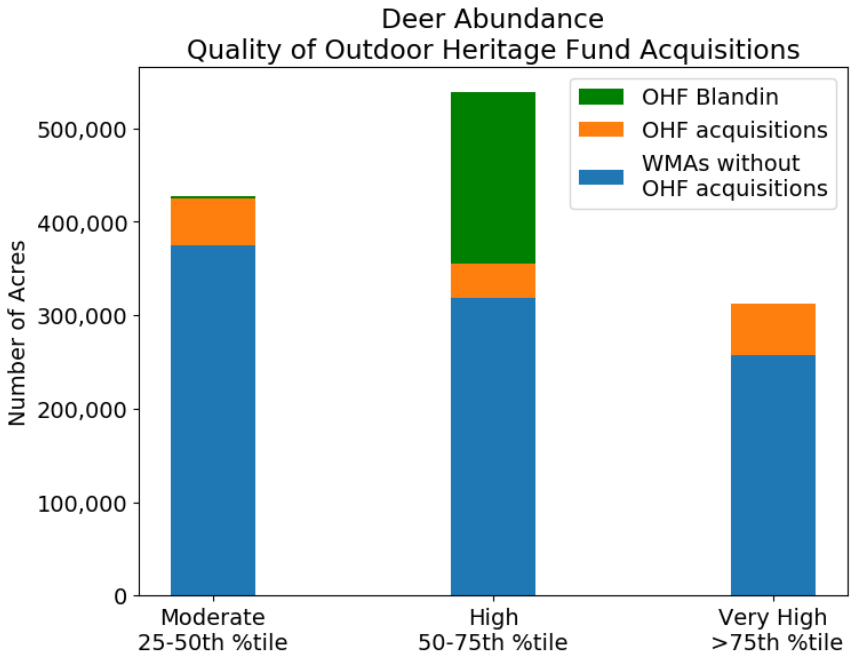
Most OHF acquisitions within the pheasant range (southern half of the state) were in the very high-quality class.



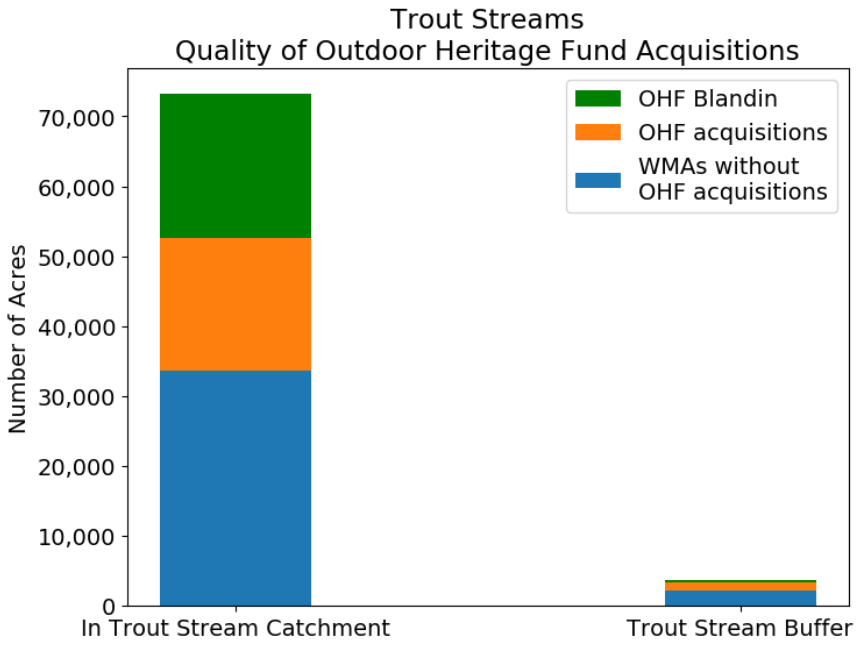
Very high-quality waterfowl breeding habitat was well represented in the OHF portfolio, increasing the number of acres in the WMA and OHF portfolios to over 600,000 acres.



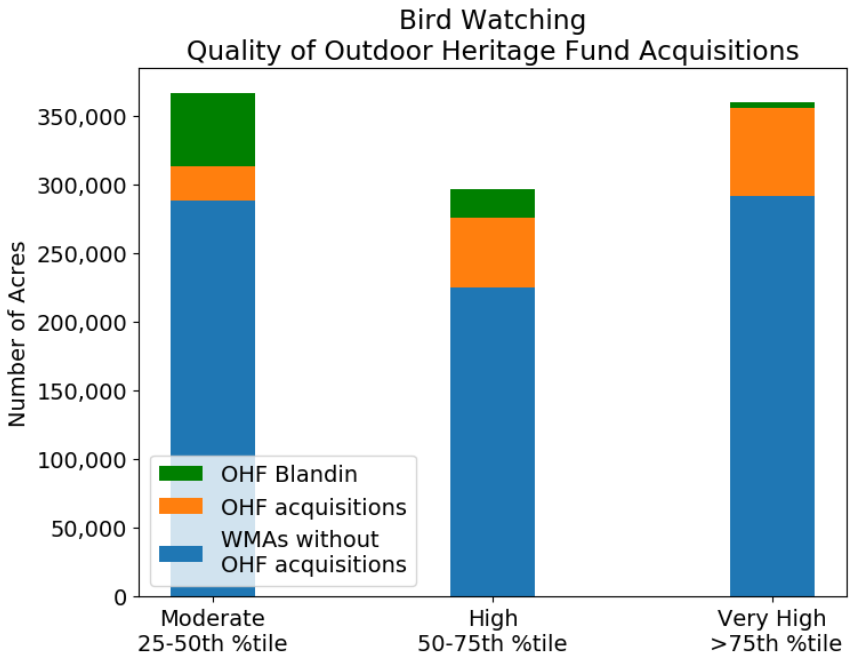
OHF acquisitions nearly doubled the amount of very high-quality mammal game species and furbearers habitat.



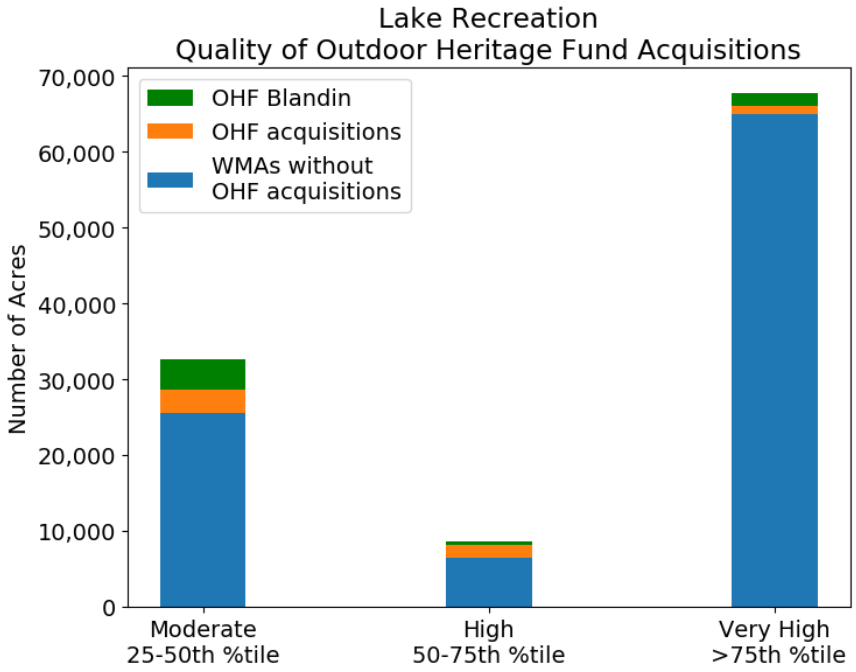
OHF acquisitions were concentrated in areas of high white-tailed deer abundance, making OHF acquisitions well positioned to support deer and hunting access.



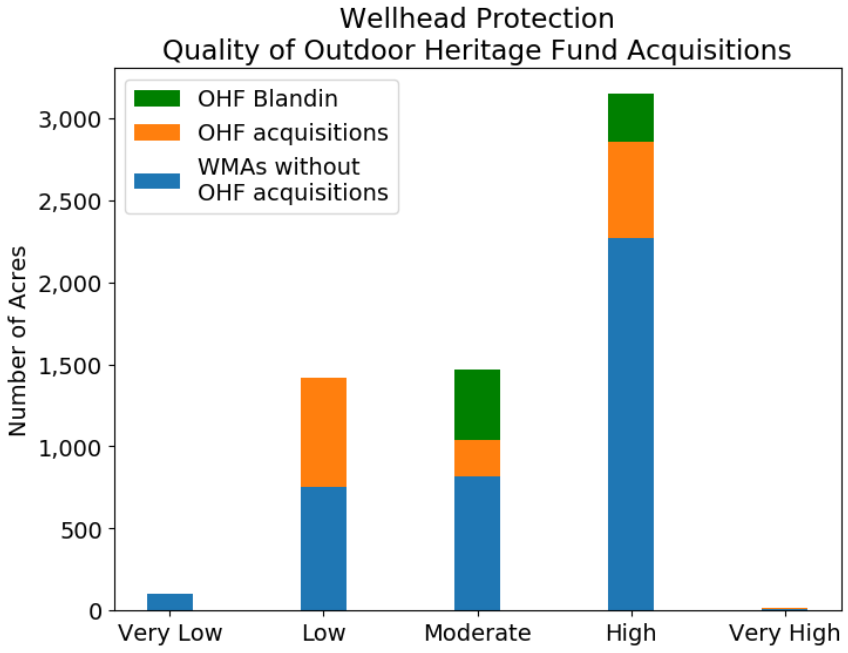
OHF acquisitions more than double the area protected by WMAs in catchments of legally designated trout streams. They also increased the amount of access to trout streams through acquisitions within a narrow 66-foot buffer of the streams.



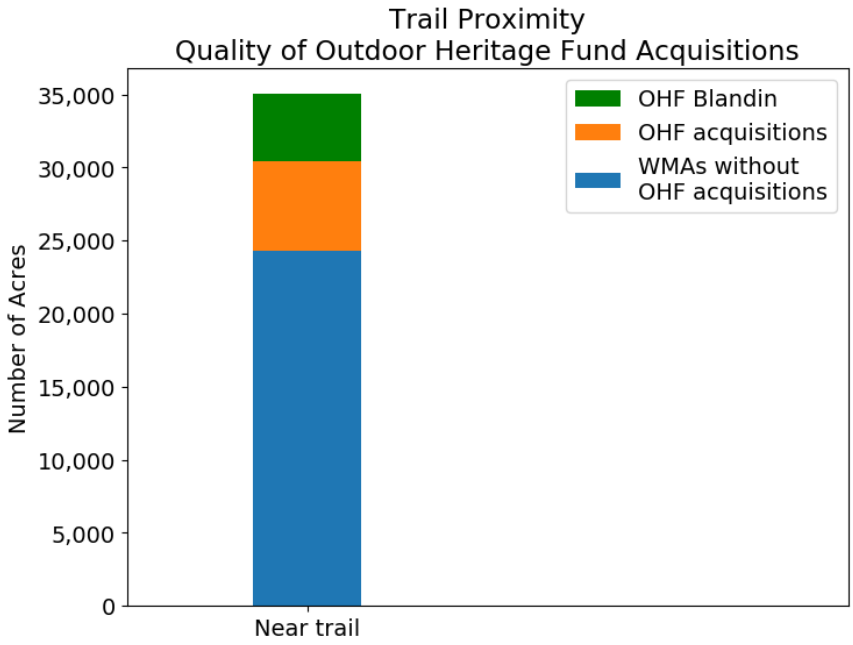
OHF acquisitions added to birdwatching opportunities throughout the state evenly in all quality classes.



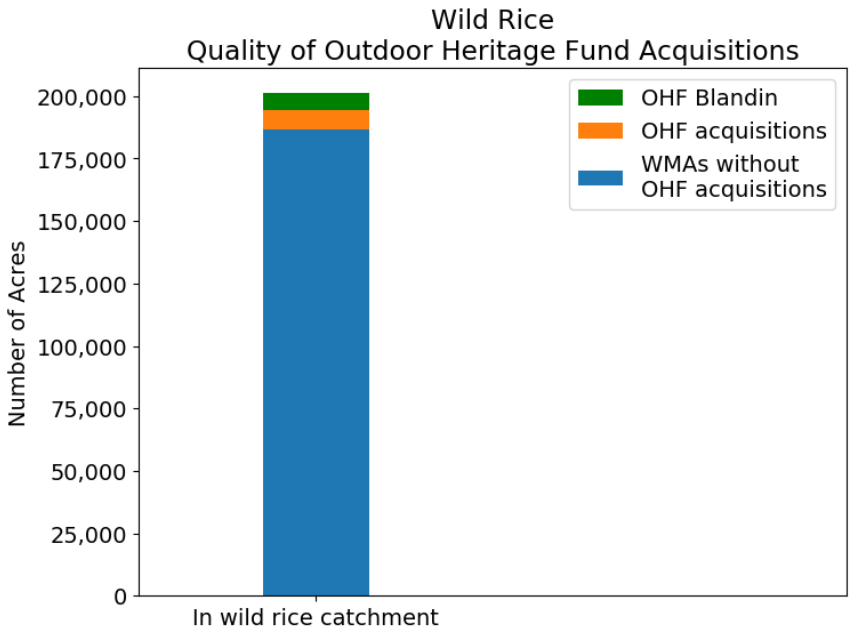
The OHF portfolio had a relatively small area of acquisitions in catchments of lakes with public access.



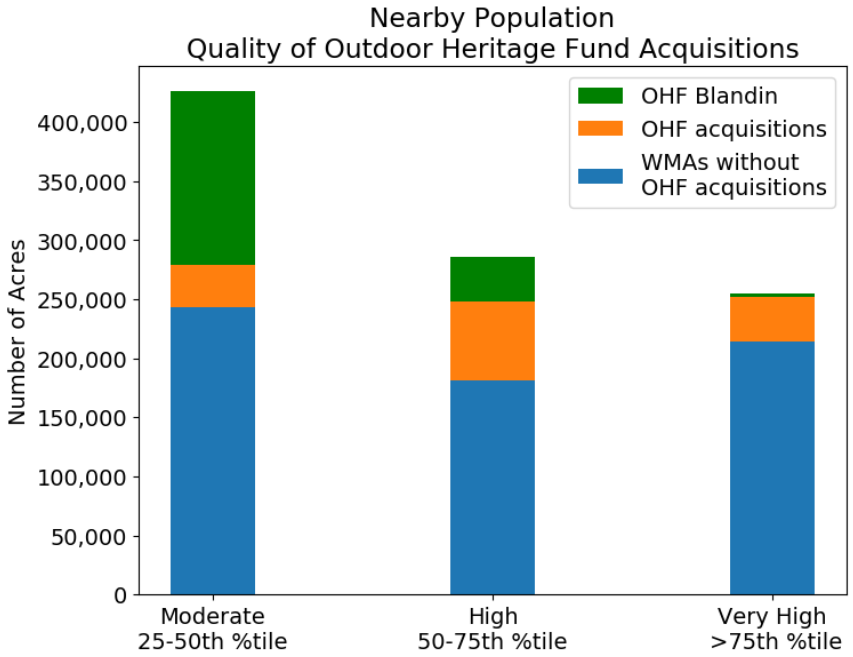
While OHF acquisitions have substantially added to the protection of drinking water supplies found in WMAs, both programs had almost no protection or restoration in the highest risk drinking water supplies.



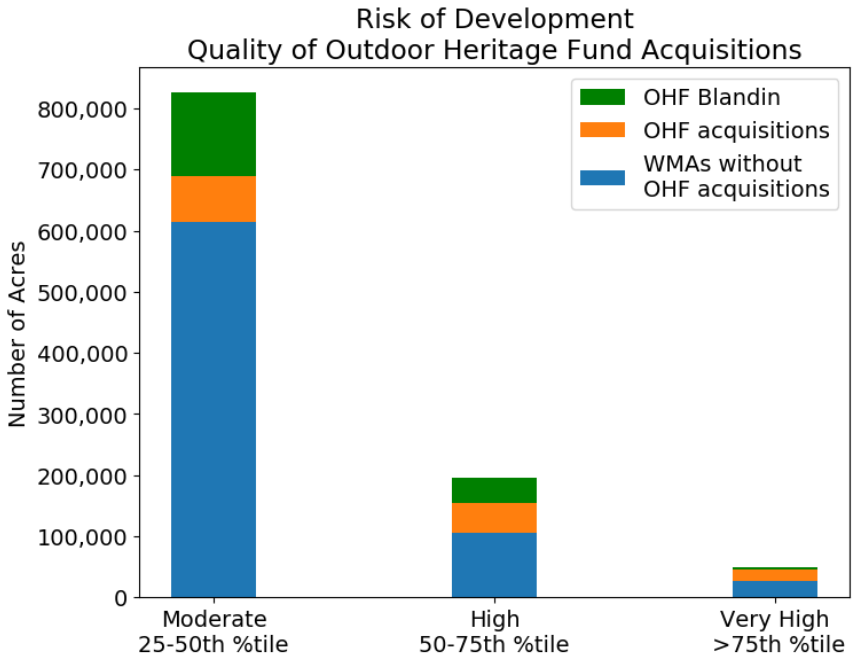
Approximately 10,000 acres of OHF acquisitions were in a relatively narrow 500-foot buffer of state and regional trails. While narrow, 500-feet is enough to improve the aesthetic experience and provide noise attenuation benefits from nearby roads.



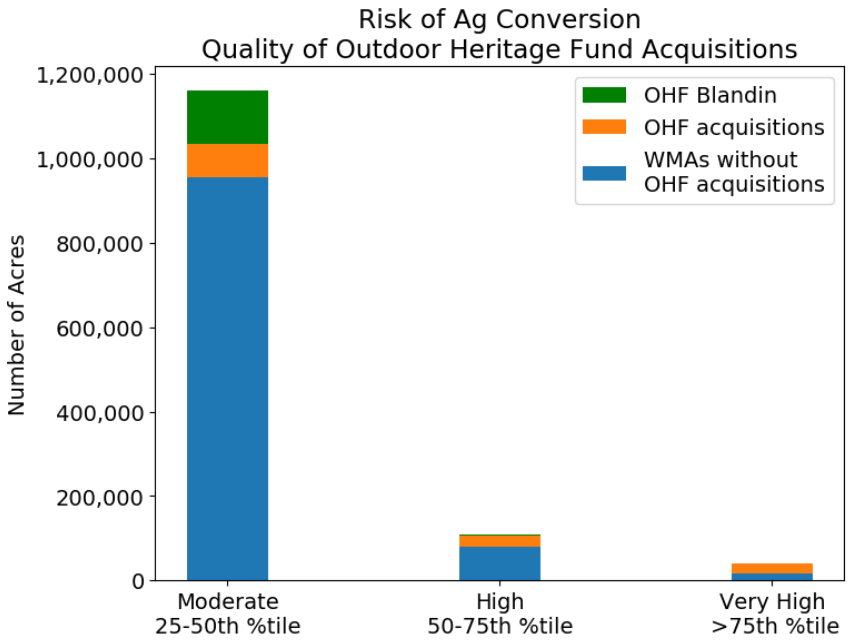
Consistent with our other lake related metrics, OHF acquisitions were less prevalent in the catchments of wild rice sites.



Population served scores land based on how many people are within 50 miles (a typical day trip). OHF acquisitions tend to be more remote than WMAs.



Similar to the nearby population metric, but from the perspective of future built/urban development, the risk of development metric indicates that OHF acquisitions were often not at high risk of development. While this provides less protection to high-risk land, it also typically enables less expensive, and thus larger, acquisitions.



It is important to note the scale on the y-axis goes to 1.2 million, making large numbers of acres represented by the orange bars appear small. Most of the OHF portfolio is providing some level of protection against conversion to agriculture. However, large acquisitions in the northern low ag risk region of the state make the smaller, but still substantial, acquisitions in high ag risk regions difficult to visualize.

Appendix A. Metric metadata

Bird metrics

The Minnesota Breeding Bird Atlas (MNBBA) was designed to assess the distribution and abundance of breeding birds in Minnesota. Data from the MNBBA documented the statewide distribution of breeding birds, provided a metric of abundance for many species, and to investigate habitat relationships of breeding birds. These data provide a valuable source of information for conservation planning.

The MNBBA was completed over a five-year period (2009-2013), the data for this project was collected using two complementary methods; volunteer-based sampling and systematic point counts.[8] Point counts were used to survey breeding birds across the state. Dominant and subdominant cover types of the survey locations were determined using the National Land Cover Database (2001).[9] Primary habitat types were identified at a scale of 30 m resolution. Habitat suitability models were developed using one of three modeling approaches (MaxEnt, glms, glms with QPAD offset)[10] for all breeding bird species[11,12,13] and can be viewed online at mnbirdatlas.org.

We developed a variety of bird habitat suitability metrics by identifying ecologically important groups of birds. We combined the individual species habitat models that were developed for the MNBBA and standardized the model output to calculate a combined raster output for each bird group. The rasters were valued from ~0 to 1, 1 being the highest "habitat suitability" value.

Upland game birds

Upland game birds are non-waterfowl game birds that use a variety of habitats from prairie to agricultural fields to forests. The upland game bird data in this report is a combination of breeding habitat suitability models for American Woodcock, Wild Turkey, and Ruffed Grouse. Note that several upland game bird species such as Ring-necked Pheasant, Sharp-tailed Grouse, and Greater Prairie-Chicken did not have the adequate

[8] Pfannmuller, L., et al., (2017) The First Minnesota Breeding Bird Atlas (2009-2013). Available at mnbirdatlas.org

[9] Homer, C., et al., (2004) "Development of a 2001 National Land-Cover Database for the United States." Photogrammetric Engineering and Remote Sensing 70: 829–840.

[10] Minnesota Bird Breeding Atlas. Methods of Analysis. https://mnbirdatlas.org/data-and-methods/methods-of-analysis/

[11] Miller, A.B., Leung, Y.-F., Kays, R., (2017) Coupling visitor and wildlife monitoring in protected areas using camera traps. Journal of Outdoor Recreation and Tourism 17, 44–53. https://doi.org/10.1016/j.jort.2016.09.007

[12] Walton, N., G. Niemi, E. Zlonis, P. Sólymos, A. Grinde. (In review). Getting the most out of breeding bird atlas data: multiple methods for modelling species' distributions.

[13] Pfannmuller, L., G. Niemi, J. Green, K. Rewinkel (editor). (In review). Breeding Birds of Minnesota (2009-2014) - their history, ecology, and conservation. University of Minnesota Press.

sample sizes to develop habitat suitability models for the MNBBA, thus were not included in this analysis.

Waterfowl

Waterfowl are ducks, geese, and swans that depend on wetland habitat for breeding and migration. Waterfowl hunting occurs in the fall during migration, however, waterfowl distribution during the breeding season highlights important habitat for these species. The breeding habitat suitability for common waterfowl in the state included: Canada Goose, Mallard, Wood Duck, Blue-winged Teal, Ring-necked Duck, Hooded Merganser, Common Merganser.

Non-game Species of Greatest Conservation Need

Minnesota is home to over 2,000 known native wildlife species, however, almost 16% of these species are identified as Species in Greatest Conservation Need (SGCN) by the Minnesota Department of Natural Resources (DNR) because they are rare, have populations that are declining, or are under threats that may cause them to decline[14]. We developed metrics for SGCN species for each major habitat type (wetlands, grasslands and prairies, and forests) in the state.

Forest Bird SGCN Habitat. Habitat suitability metric for breeding forest birds, these species use a wide variety of forest types, but all require forest habitat for breeding. The following species were included: Boreal Chickadee, American Woodcock, Black-billed Cuckoo, Black-throated Green Warbler, Brown Creeper, Connecticut Warbler, Golden-winged Warbler, Olive-sided Flycatcher, Veery, Winter Wren, and Wood Thrush. High values likely indicate quality forest habitat.

Grassland and Prairie Bird SGCN Habitat. Habitat suitability metric for breeding bird SGCNs that require grassland or prairie habitat. The following species were included: Upland Sandpiper, American Kestrel, Northern Harrier, Lark Sparrow, Bobolink, Dickcissel, Eastern Meadowlark, Field Sparrow, Grasshopper Sparrow, LeConte's Sparrow, and Western Meadowlark. High values likely indicate quality grassland or prairie habitat.

Wetland Bird SGCN Habitat. Habitat suitability metric for SGCN that depend on wetland habitat for breeding. The following species were included: American Bittern, Black Tern, Sedge Wren, and Yellow-headed Blackbird. High values likely indicate quality wetland habitat.

Species richness

A total of 249 birds were documented during the MNBBA project. This metric summarizes the species richness (number of species) documented by block across the state. High values likely indicate important areas for conserving biodiversity.

[14] Minnesota Department of Natural Resources, (2015) Minnesota's Wildlife Action Plan, 2015 – 2025. http://www.dnr.state.mn.us/cwcs/index.html

Mammal metrics

We used bioclimatic envelop models developed for all mammal species currently living in Minnesota[15] as a proxy for species distribution and habitat quality in Minnesota. Bioclimatic envelop models characterize the climatic niche space of a species by combining species occurrence data with climatic data.[16,17] We used bioclimatic envelop models for this project because they are a powerful tool conservation planning,[18] models were available for all extant mammals living in Minnesota, and because no comparable data were available for non-game species. We used 2010 projections of species-specific bioclimatic envelop models to represent current distribution and relative habitat quality in Minnesota. Estimates of current distribution from 2010 projects accurately reflected IUCN-defined ranges of mammal species.[19]

Bioclimatic envelop models for individual species were clipped to the boundary of Minnesota and output values standardized so values ranged from 0 (no presence) to 1 (best likelihood of presence). The resulting models over-predicted the current distribution for 7 species: black bear, bobcat, Canada lynx, gray wolf, fisher, American marten, and moose. For these species, we reclassified cells outside of the current range to zero.

Finally, we combined individual species models to create three outputs that were used in our analysis: 1) deer, 2) furbearers + game species, and 3) species of greatest conservation need (SGCN). We distinguished furbearers from game species based on whether species were trapped (furbearers), hunted (game species), or both (included with both groups). To create the deer model, we multiplied the standardized bioclimatic model output with deer permit area (DPA)-specific estimates of deer density (Norton and Giudice 2017)[20] to weight the output by actual deer density. For the other mammal variables, we took the average value of the corresponding species-specific models (Table 1).

[15] Moen, R., L. Frelich, S. Windels, K. Hennig, S. Baker, J. Bollinger, M. Galey, M. Swingen, B. Houck. (In preparation). Climate change effects on mammals in Voyageurs National Park.

[16] Watling, J., L. Brandt, F. Mazzotti, and S. Romanach, (2013) Use and Interpretation of Climate Envelope Models: A Practical Guide. book, University of Florida.

[17] Watling, J., et al., (2012) Do bioclimate variables improve performance of climate envelope models? Ecological Modelling 246:79–85.

[18] Porfirio, L. L., R. M. B. Harris, E. C. Lefroy, and S. Hugh, (2014) Improving the Use of Species Distribution Models in Conservation Planning and Management under Climate Change. PLoS ONE 9:1–21.

[19] Moen, et al. Climate change effects on mammals.

[20] Norton, A., & J.H. Giudice, (2017) Monitoring population trends of white-tailed deer in Minnesota – 2017. Minnesota Department of Natural Resources, Summaries of wildlife research findings, St. Paul, Minnesota.

Table 1. Mammal species included in our combined spatial distribution. All mammals listed were included in the "all mammals" output. Columns designate which mammals were considered furbearers, game species, and species of greatest conservation need (SGCN).

Group	Common	Furbearer	Game	SGCN
Bats	Big brown bat			Yes
	Silver-haired bat			
	Eastern red bat			
	Hoary bat			
	Little brown bat			Yes
	Northern long-eared bat			Yes
	Tri-colored bat			Yes
Carnivores	Northern raccoon	Yes	Yes	
	Black bear		Yes	
	Coyote	Yes	Yes	
	Gray wolf			Yes
	Gray fox	Yes	Yes	
	Red fox	Yes	Yes	
	Northern river otter	Yes		
	American marten	Yes		
	Short-tailed weasel	Yes		
	Long-tailed weasel	Yes		
	Least weasel	Yes		Yes
	American mink	Yes		
	Fisher	Yes		
	American badger	Yes		
	Eastern striped skunk	Yes		
	Canada lynx			Yes
	Bobcat	Yes	Yes	
Lagomorphs	Snowshoe hare		Yes	
	White-tailed jackrabbit		Yes	
	Eastern cottontail		Yes	
Marsupials	Virginia opossum	Yes		
Rodents	American beaver	Yes		
	North American porcupine			
	Rock vole			
	Prairie vole			Yes
	Meadow vole			
	Woodland vole			Yes
	Southern red-backed vole			
	Woodland jumping mouse			
	Muskrat	Yes		
	Northern grasshopper mouse			Yes
Rodents	Plains pocket mouse			Yes
	White-footed mouse			
	Deer mouse			
	Eastern heather vole			Yes
	Western harvest mouse			Yes
	Northern bog lemming			Yes
	Southern bog lemming			

	Meadow jumping mouse			
	Plains pocket gopher			
	Northern pocket gopher			Yes
	Northern flying squirrel			
	Southern flying squirrel			
	Thirteen-lined ground squirrel			
	Woodchuck			
	Franklin's ground squirrel			
	Eastern gray squirrel		Yes	
	Eastern fox squirrel		Yes	
	Least chipmunk			
	Eastern chipmunk			
	Red squirrel		Yes	
	Richardson's ground squirrel			Yes
Shrews & moles	Northern short-tailed shrew			
	Star-nosed mole			
	Least shrew			Yes
	Eastern prairie mole			
	Arctic shrew			
	Masked shrew			
	Smoky shrew			Yes
	Pygmy shrew			
	Water shrew			
Deer	Moose			Yes
	White-tailed deer		Yes	

Other benefit metrics

Metric descriptions below are taken from the Parcel Environmental Benefits Assessment Tool (PEBAT)[21], which provided the foundational data for a subset of the benefits analyzed here. Some metrics have been modified for better application to this project and their descriptions have been updated below.

Bird watching

Our metric uses data on the behavior of bird watchers to identify where hot spots for birdwatching in the state are. To estimate the intensity and location of bird watching, we used the Cornell Lab of Ornithology's citizen science initiative, eBird.[22] The eBird database allows bird watchers to report when and where they engaged in bird watching. We interpolated the data to create a statewide layer with high scores for bird watching hot spots and declining scores with low reported visits. High scores for bird watching are found on land that has high reported visitation.

[21] Noe, R., Keeler B., Johnson J., Kilgore M., Taff S., Polasky S., (2018) Parcel Environmental Benefit Assessment Tool, version 1.2. Minneapolis, MN: University of Minnesota. http://pebat.umn.edu/metrics

[22] Cornell Lab of Ornithology, (2020) eBird Basic Dataset. Version: EBD_relMar-2020.

Nearby population

The nearby population metric represents the proportion of the state's population that can easily access the benefits of an acquisition. We assumed the nearby population to be the people residing within a radius of 50 miles of a given piece of land. This distance is based on the US National Tourism Resources Review Commission's definition of a "day trip". The population within 50 miles was calculated using the Environmental Protection Agency's 30 meter population map.[23] Higher scoring land is that with a larger nearby human population.

Lakes of biological significance

Assessing the quality of fish and other aquatic resources statewide poses a challenge due to the lack of remotely sensed or comprehensive datasets. We explored many of the datasets collected by the DNR, but concluded that its compilation of Lakes of Biological Significance[24] represents the most comprehensive aquatic biodiversity data in the state, even though not all lakes have been sampled. The DNR dataset classifies lakes of biological significance as moderate, high, or outstanding based on a sampling of aquatic plants, fish, birds, and amphibians.[25] We used this classification to make a categorical metric where land in the catchment of a lake is assigned to a quality category corresponding to the DNR rating of the lake. Both 'Outstanding' and 'High' categories are considered to be the highest quality class for the purposes of the multiple benefit analysis.

Lake recreation

The lake recreation metric prioritizes the protection of land that influences the water quality of lakes important for public recreation. It applies to the catchments of lakes with a publicly accessible water access site. Land outside of these catchments receives a score of zero for lake recreation. Among lakes with public access, prioritization is based on three attributes; the sensitivity of the lake's clarity to additional phosphorus runoff,[26] the public amenities (e.g., dock, boat ramp, restrooms) of the lake,[27] and a proxy for lake visitation.[28] Catchments with publicly accessible lakes receive a minimum score of 0.2. The rest of the score is equally divided between a physical measure of the lake's sensitivity to phosphorus, and measures of the social benefit of the lake as measured by access amenities and a proxy for visitation. High scoring land is within a catchment of a

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[23] United States Environmental Protection Agency. EnviroAtlas. Dasymetric Allocation of Population. https://enviroatlas.epa.gov/enviroatlas/DataFactSheets/pdf/Supplemental/DasymetricAllocationofPopulation.pdf

[24] Minnesota Department of Natural Resources, (2020) Lakes of Biological Significance: A list of high quality lakes based on dedicated biological sampling that can be used to focus protection efforts. GIS shapefile. https://resources.gisdata.mn.gov/pub/gdrs/data/pub/us_mn_state_dnr/env_lakes_of_biological_signific/metadata/Lakes%20of%20Biological%20Significance_20200707.pdf

[25] Ibid.

[26] Minnesota Department of Natural Resources. Lakes of Phosphorus Sensitivity Significance GIS shapefile. https://gisdata.mn.gov/dataset/env-lakes-phosphorus-sensitivity

[27] Minnesota Department of Natural Resources. Public Water Access Sites in Minnesota GIS shapefile. https://gisdata.mn.gov/dataset/loc-water-access-sites

[28] Sharp, R. et al. (2018) InVEST User's Guide: Visitation. http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/recreation.html

publicly accessible lake highly sensitive to additional phosphorus, which has public amenities and high scores for visitation.

Pheasant habitat quality

Abundant pheasant populations support pheasant hunters and related industries. Our metric is based on pheasant production models first published in Jorgensen (2014)[29] and then refined in Wszola (2017).[30] In brief, the metric uses relationships between the amount of grass, agriculture, small grains, trees, and wetlands in one- or five-kilometer buffers around a parcel to estimate relative pheasant abundance. We used an aggregated version 2019 Cropland Data Layer[31] to define land cover. Higher scores are given to land with greater potential pheasant abundance.

Pollinator habitat

This metric uses the output from the InVEST pollination model[32] with the 2019 Cropland Data Layer.[33] The InVEST pollination model uses data on land cover and the foraging habits of bees to produce a bee abundance index. The model output used in this metric is described in Koh (2016).[34]

Trails proximity

Trails in the state provide a wide range of recreation activities, such as hiking and biking on non-motorized trails, ATV and snowmobile use on motorized trails, and boating on water trails. Conservation acquisitions can protect the aesthetic experience around trails by providing scenic beauty and noise attenuation for trail users. Our metric assigns a score of 1 to land within a 500-foot buffer of existing recreation trails, as designated by the Minnesota DNR[35] and Metropolitan Council,[36] and 0 to land outside this buffer.

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[29] Jorgensen CF, Powell LA, Lusk JJ, Bishop AA, Fontaine JJ, (2014) Assessing Landscape Constraints on Species Abundance: Does the Neighborhood Limit Species Response to Local Habitat Conservation Programs? PLoS ONE 9(6): e99339. https://doi.org/10.1371/journal.pone.0099339

[30] Wszola LS, Simonsen VL, Stuber EF, Gillespie CR, Messinger LN, Decker KL, et al. (2017) Translating statistical species-habitat models to interactive decision support tools. PLoS ONE 12(12): e0188244. https://doi.org/10.1371/journal.pone.0188244

[31] USDA National Agricultural Statistics Service Cropland Data Layer. (2019) Published crop-specific data layer.
USDA-NASS, Washington, DC.

[32] Sharp, R. et al. (2018) InVEST User's Guide: Pollinator Abundance.
http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/croppollination.html

[33] USDA National Agricultural Statistics Service Cropland Data Layer, (2019) Published crop-specific data layer.
USDA-NASS, Washington, DC.

[34] Koh, I., Lonsdorf, E. V., Williams, N. M., Brittain, C., Isaacs, R., Gibbs, J., & Ricketts, T. H. (2016). Modeling the status, trends, and impacts of wild bee abundance in the United States. *Proceedings of the National Academy of Sciences*, *113*(1), 140-145.

[35] Minnesota Department of Natural Resources. State Trails of Minnesota GIS shapefile.
https://gisdata.mn.gov/dataset/trans-state-trails-minnesota

[36] Metropolitan Council. Regional Trails GIS shapefile. https://gisdata.mn.gov/dataset/us-mn-state-metc-trans-regional-trails-exst-plan

Trout streams

The trout streams metric is categorical with three classes. It receives a score of 0 if it is outside of the catchments of legally designated trout streams[37] and a score of 1 if it is within a catchment. Additionally, it receives a score of 2 if it is within 66 feet (the buffer size often used in Aquatic Management Area acquisitions), of trout streams. For the purposes of multiple benefit analysis, acquisitions within catchments and within buffers are both treated as the highest quality class.

Wellhead protection

Nitrate in groundwater poses a threat to human health and increases water treatment costs. Our metric assumes that land located within identified Drinking Water Supply Management Areas (DWSMA)[38] as mapped by the Minnesota Department of Health (MDH) are more likely to contribute to drinking water protection than land outside DWSMAs. We used the five categorical definitions of vulnerability created by the MDH to define the quality of protection within DWSMAs. Both 'Very High' and 'High' vulnerability categories are considered to be the highest quality class for the purposes of the multiple benefit analysis.

Wild rice sites

For this metric, land within the catchment of a wild rice site receives a score of 1 and land outside receives a score of 0. Wild rice sites were defined as current (i.e., not pre-historic) wild rice sites identified by the DNR.[39] We do not differentiate among wild rice sites, nor does the metric account for the impact of management on wild rice habitat or water quality. We also do not capture newly created wild rice sites from restoration and enhancement activities.

Risk of habitat loss

We created indicators for the probability of land conversion to developed or agricultural uses by developing two spatial logistic regression models using Maxent.[40] The dependent variables of these models were observed land use changes between 2006 and 2011 in the National Land Cover Datasets (NLCD),[41] which were checked for accuracy by referencing historical aerial imagery via Google Earth.[42] We validated 1,885 observations of change

[37] Minnesota Department of Natural Resources. State Designated Trout Streams, Minnesota GIS shapefile. https://gisdata.mn.gov/dataset/env-trout-stream-designations

[38] Minnesota Health Department. Drinking Water Supply Management Areas GIS shapefile. https://gisdata.mn.gov/dataset/water-drinking-water-supply

[39] Minnesota Department of Transportation. MnModel Wild Rice Locations, Minnesota GIS shapefile. https://gisdata.mn.gov/dataset/biota-wild-rice

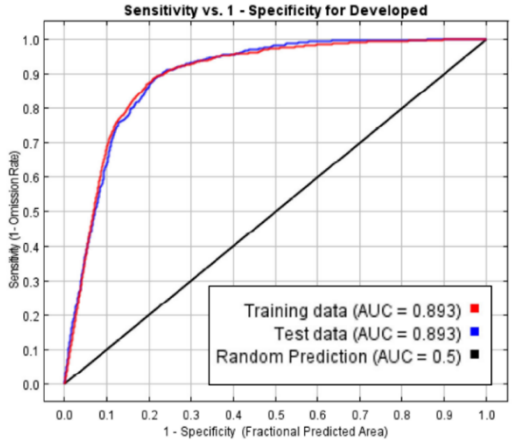
[40] Steven J. Phillips, Miroslav Dudík, Robert E. Schapire. Maxent software for modeling species niches and distributions (Version 3.4.1). http://biodiversityinformatics.amnh.org/open_source/maxent/

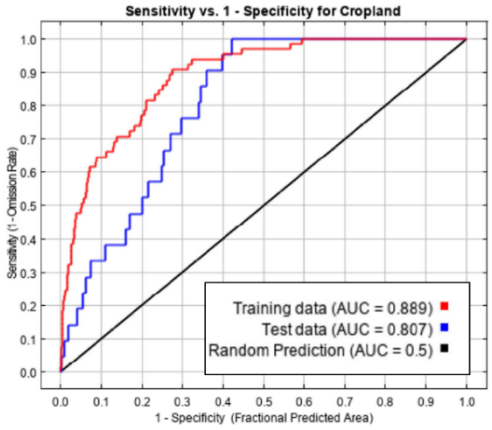
[41] Homer, C., et al., (2004) "Development of a 2001 National Land-Cover Database for the United States." Photogrammetric Engineering and Remote Sensing 70: 829–840.

[42] Google Earth. Google Earth Pro on Desktop. https://www.google.com/earth/

from non-developed to developed uses, and 87 observations of change from non-agricultural to agricultural uses. Predictor variables in the development risk model were: distance to urban area,[43] distance to lake,[44] floodplain status,[45] slope,[46] protected area status,[47] crop productivity,[48] soil suitability for dwellings without basements,[49] soil suitability for septic tanks,[50] distance to primary road,[51] and NLCD land cover in 2006. Predictor variables in the agricultural risk model were: soil and crop productivity, slope, protected area status, farmland value,[52] frost-free days,[53] average precipitation,[54] distance to urban area, and NLCD land cover in 2006.

During modeling, 25% of observations were withheld to test model performance. The figures below show model performance of the development risk model (left) and the agricultural conversion risk model (right) based on the Area Under the ROC Curve (AUC). AUC values range from 0.5 (random prediction) to 1, with higher values indicating better model performance.





[43] U.S. Census Bureau, (2000) U.S. Census 2000 Summary File 1 (SF 1) 100% Data.

[44] U.S. Geological Survey. USGS Small-scale Dataset - 1:1,000,000-Scale Hydrographic Geodatabase of the United States - Conterminous United States 201403 FileGDB 10.1:

[45] 100-year flood zone delineations derived from LISFLOOD-FP data. http://www.bristol.ac.uk/geography/research/hydrology/models/lisflood/

[46] Minnesota Department of Natural Resources. Digital Elevation Model - 30 Meter Resolution. From USGS 1:24,000 scale Level 2 DEMs for the State. GIS shapefile. https://gisdata.mn.gov/dataset/elev-30m-digital-elevation-model

[47] Noe, R., Keeler, B., Johnson J., Kilgore, M., Taff, S., Polasky, S., (2018) Parcel Environmental Benefit Assessment Tool Expanded Documentation. Pages 5-7. https://z.umn.edu/pebat-documentation

[48] Soil Survey Staff. Gridded Soil Survey Geographic (gSSURGO) Database for Minnesota. United States Department of Agriculture, Natural Resources Conservation Service. https://gdg.sc.egov.usda.gov/.

[49] Ibid.

[50] Ibid.

[51] TIGER/Line Shapefile, (2018) Minnesota Primary and Secondary Roads State-based GIS Shapefile. https://catalog.data.gov/dataset/tiger-line-shapefile-2018-state-minnesota-primary-and-secondary-roads-state-based-shapefile

[52] Minnesota Land Economics. Estimated Land Values for counties, 2005. https://landeconomics.umn.edu/landdata/LandValue/RunReport.aspx?RI=1491041

[53] High Plains Regional Climate Center database. Percent frost-free days 2001-2005 for counties. http://www.hprcc.unl.edu/.

[54] Ibid.

Appendix B. Matching methods

This analysis is meant to answer the question: How did scores of OHF parcels compare to non-OHF land parcels similar in value, size, shape, and region of the state?

Data preparation

Because this analysis is meant to mimic purchasing decisions made with OHF dollars and because purchasing decisions are made at the level of tax parcel boundaries, we used tax parcel boundaries as the unit of analysis rather than the OHF project boundaries. This required intersecting the OHF project boundary spatial layer with a tax parcel boundary layer using GIS. Because OHF project boundaries did not align perfectly with tax parcel boundaries, this step resulted in producing tiny sliver polygons around the edges of the OHF boundaries. We therefore removed all polygons under 1 acre from further analysis. Because the unit of analysis was tax parcels (the unit at which land sales occur) and not OHF project boundaries, the number of OHF parcels considered in this analysis (n=18,592) was greater than the number of OHF projects (i.e., each OHF project consists of multiple tax parcels).

Matching

We matched[55] OHF tax parcel polygons to non-OHF, unprotected tax parcel polygons on the following variables: OHF planning section ("region"), market value (based on estimated market value for non-OHF parcels, and estimate cost for OHF parcels), area (size in acres), and shape index (a measure of how square or elongated is a polygon calculated as the area divided by one-sixteenth of the perimeter squared). Regions of the state included Northern Forest, Forest/Prairie Transition, Prairie, Metropolitan Urbanizing Area, and Southeast Forest. The following procedure in statistical program R was used to perform the matching:

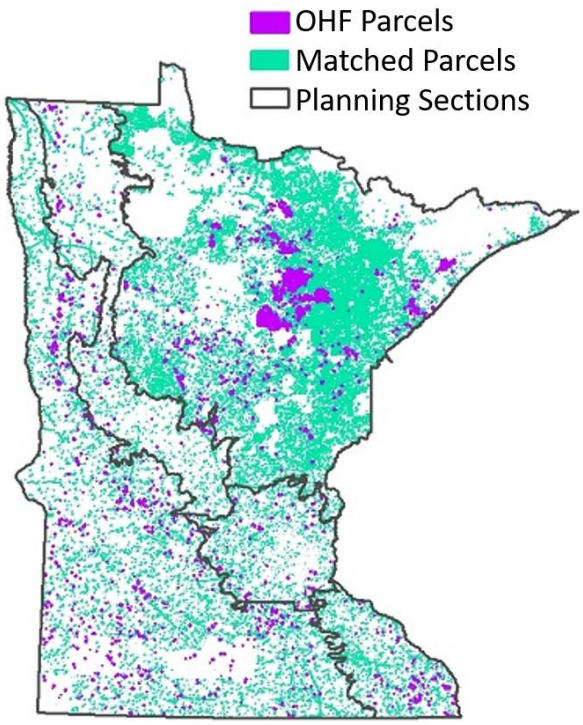
1. Installed R package 'MatchIt'[56]
2. Compiled data so that parcels identified as OHF and non-OHF, and their associated variables, were in the same long-form data table.
3. Performed the match using the following code ():
   m.out <- matchit(GROUP~Shape_Area+Shape_Index+value, data, method = "nearest", ratio = 5)
   Because it was computationally challenging to run the match for the whole state, we ran the match for each of the five regions separately. The "nearest" method matched non-OHF parcels to OHF parcels, one at a time, based on closest similarity of propensity score. The propensity score was the probability of a parcel being

[55] Ho et al., (2007) "Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference." Political Analysis, 15, Pp. 199–236. Copy at https://j.mp/20D70EE

[56] Stuart et al., (2011) MatchIt: nonparametric preprocessing for parametric causal inference. Journal of statistical software.

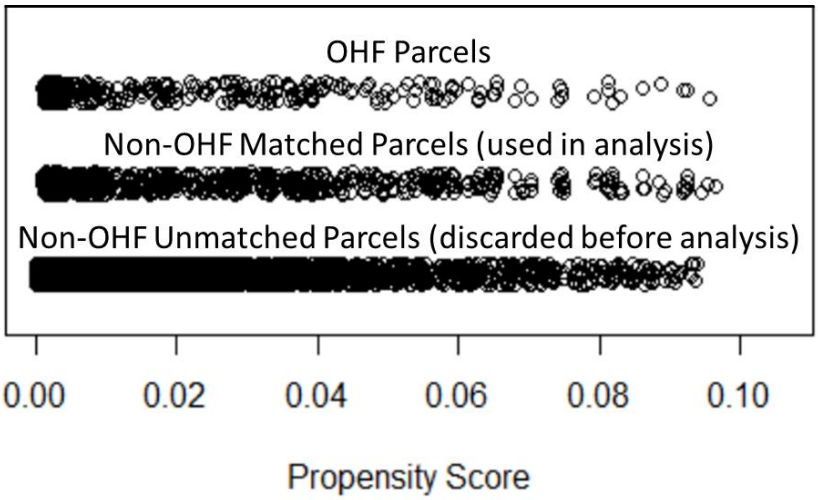
designated OHF versus non-OHF ("GROUP" is binary and the dependent variable in the logit model) based on the values of the three covariates (independent variables in the logit model). The "ratio = 5" specification resulted in five matches per OHF parcel.

4. Assessed performance of each match by comparing the means and distributions of the OHF and non-OHF groups, pre- and post-match, for each covariate. Matching results showed standardized means to be significantly closer post-match versus pre-match – see below for example.
5. Compiled matched data for further analysis. This required assigning each parcel in the full dataset (created in Step 2) a code of "matched" or "unmatched" so that further analysis could be focused on just the matched data, n = 18,592 OHF parcels and n = 92,960 non-OHF matched parcels.
6. Scored all matched parcels (see "Scoring OHF Investments" for methods) and compared scores of the OHF portfolio to scores of the matched portfolio on 21 metrics. Results are presented in the body of this report in the section "OHF scores on individual metrics."

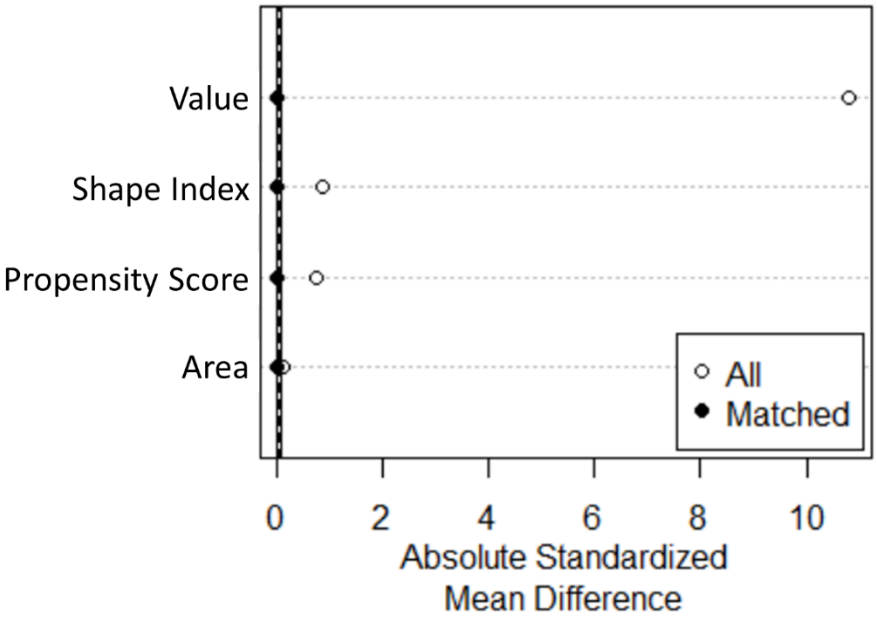


Map of OHF parcels and matched parcels (five per OHF parcel).

The below figures show the improvement in similarity between OHF and the comparison group of non-OHF parcels after matching. This example shows results for parcels in the Southeast Forest region only (for data management purposes, we matched each region separately):



This figure shows the similarity in propensity scores between the group of OHF parcels and the matched set of non-OHF parcels.



This figure shows the increased similarity in individual attributes of the two parcel groups post-match ("Matched") versus pre-match ("All"). The closer to zero on the x-axis, the more similar the two groups are on a particular variable.