2020 ARROWHEAD BIRD BANDING SUMMARY

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INTRODUCTION

The Institute for Bird Population's (IBP) Monitoring Avian Productivity and Survivorship (MAPS) program is a continent-wide collaborative effort among public agencies, non-profits, and individuals to assist in the conservation of birds and their habitats through demographic monitoring (http://www.birdpop.org/pages/maps.php). There are currently over 400 cooperating bird banding stations in this network and vital demographic rates are calculated by IBP at a continent scale.

There are presently five stations operating in northeastern Minnesota, an area bordered by Duluth to the south, International Falls and the Canadian border to the north, and Lake Superior to the east commonly referred to as the Arrowhead region. The Arrowhead stations include Wolf Ridge (Finland; 2 mi from Lake Superior), Weiss Creek (Isabella), Hawk Ridge (Duluth; 1 mi from Lake Superior), Sugarloaf Cove (Tofte; directly on Lake Superior), and Hubachek Wilderness Research Center (Ely; Figure 1).

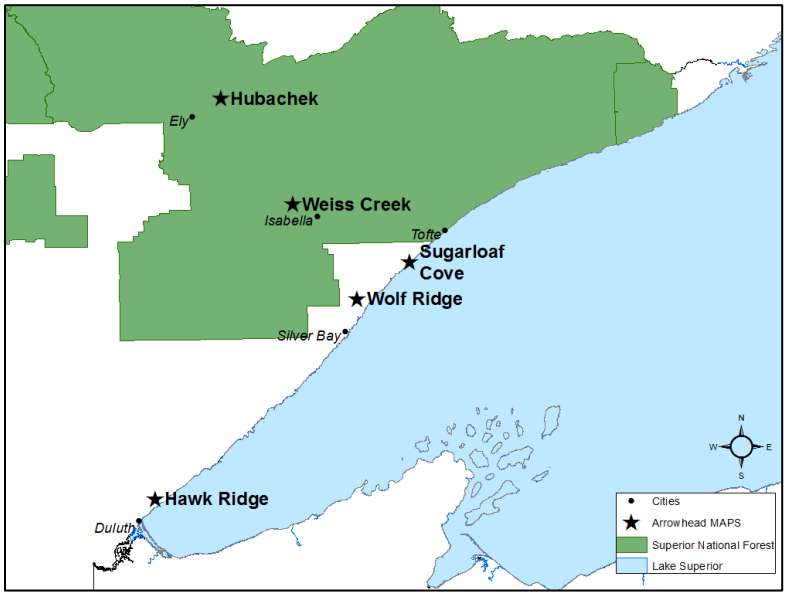


Figure 1. Location of MAPS bird banding stations in Minnesota's Arrowhead region.

METHODS

Although continent-wide species trends provided annually by IBP are available, there is a need to understand local trends of songbirds as environmental indicators to better inform management actions on the Superior National Forest. Our objectives for this report were to examine species diversity among the 5 Arrowhead stations, which helps us to understand the quality of habitat provided, and to track trends in abundance for the most common species. We compare avian trends with those obtained by other research methods in our study area.

Data from Wolf Ridge (WOLF), Weiss Creek (WECR), Hawk Ridge (HRBO), Sugarloaf Cove (SUGL), and Hubachek Wilderness Research Center (HWRC) are analyzed in this report. WOLF (UTMs 15N 635552, 5250062) operated since 1993. WECR (UTMs 15N 615649, 5279192) operated since 2007. HRBO (UTMs 15N 573289, 5188400) began in 2015. SUGL (UTMs 15N 651785, 5261290) began in 2018. HWRC (UTMs 15T 593436, 531184) began in 2018. WOLF, WECR, and HWRC stations are located in upland mixed boreal forest with lowland components, while HRBO and SUGL stations are located in upland deciduous forest with lowland components (Appendix A).

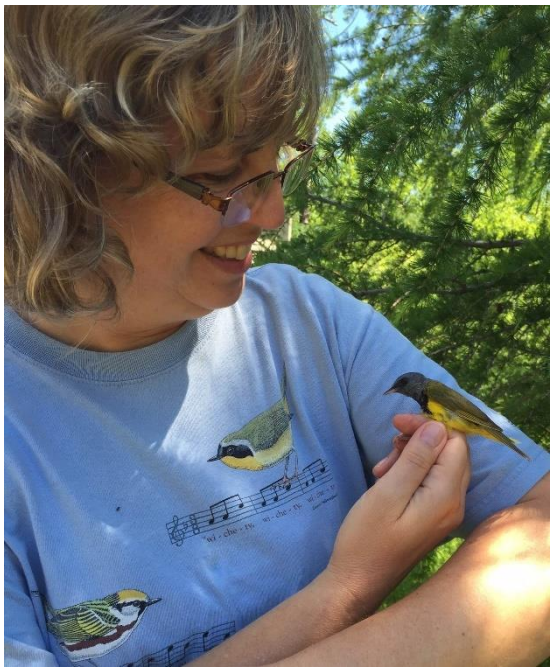
WOLF, WECR, HRBO and HWRC operates between ten and thirteen 12-m mist-nets on seven occasions for six hours, from June through early August, each year. The WECR station added one new net each year from 2013 to 2015 for a total of thirteen nets. The SUGL station operates eleven mist nets of various sizes ranging from 6-m to 18-m (but equivalent to ten 12-m nets) in length on eight to nine occasions for six hours, from June through early August, each year. Once a bird is captured, it is transported to the banding station and identified to species. We place an aluminum band on one leg with a unique identifying number, identify gender, take morphological and body condition measurements, and age the bird. Field protocols are explained in depth in the MAPS Manual 2018 Protocol (http://www.birdpop.org/docs/misc/MAPSManual20.pdf).

Composition of the passerine and near-passerine community is described for all five stations based on the years they were all in operation: 2018-2020. We used EcoSim700 (Gotelli and Entsminger 2010) to test whether avian diversity differed among stations. We treated individuals as sample units and set the number of individuals captured at each station equal to the number at the station with the fewest captures (WECR = 654). With this method, EcoSim rarefies the station with the greater number of captures down to the abundance level of the station with fewer captures. We examined species richness using the species richness option, which predicts the number of species that would be captured at each station if the number of captures were the same. We used Hurlbert's probability of interspecific encounters (PIE; Hurlbert 1971) to examine evenness. The number produced with this metric describes the probability that two randomly sampled individuals are different species. For both analyses we ran 1000 iterations with a random number seed 10. We considered stations different if 95% confidence intervals did not overlap.

We examined capture rates similar to Stake (2011), with some modifications. We performed a linear regression using program R (R Core Team 2020) on the number of birds of 10 selected species captured per 600 net hours for WOLF, WECR, and HRBO, the three stations for which we had more than five years of data. We chose the 10 species to compare trend lines based on either commonality within the top 15 species, Partners in Flight status and USGS Breeding Bird Survey (BBS; Sauer et. al 2020) national trends, or species that exhibited a marked decline at one or more Arrowhead MAPS stations.

We measured skewness and kurtosis of the data to determine the symmetry of data, and given the data were relatively normally distributed, we did not transform our data as in Stake (2011). Trends were compared between stations for years 2007-2020 for WOLF and WECR and 2015-2020 for HRBO. We also compared trends for those species to trends from 1995-2019 as identified with the BBS in Minnesota and the Natural Resource Research Institute (NRRI) Superior National Forest point count data (Grinde et al. 2019). We then calculated reproductive index (RI) for these same species by dividing the number of young by the number of adults (Nott et al. 2008) captured. This was done to get an index of post-fledging productivity and reported here as the average annual change between subsequent years, which can be used as a metric to understand trends.

We also examined species trends by guild following guild definitions identified by Niemi et al. (2016). Instead of analyzing species by each separate guild (e.g. nesting, habitat association, or migration strategy), we combined nesting *and* habitat association guilds given possible relationships between guilds and trends. The migration strategy guild was not used when combining guilds since a large majority of species used in the analysis were long-distance migrants. We report on guilds for which there was a minimum of three species captured during at least half of the years a station has operated, and we then combined all individuals together for those species in a guild to analyze as if it were a single class. We lumped guilds according to nesting strategy (ground or shrub/sub-canopy) and habitat association (early successional, lowland conifer, coniferous, deciduous, or mixed forest). We considered slopes of these lines (linear trend) significant where $p \leq 0.05$. We also report adjusted r^2 values to describe fit of trend lines to the data.



COMMUNITY CHARACTERISTICS

Wolf Ridge

The five most common species captured at WOLF between 2018-2020 were American redstart, chestnut-sided warbler, ovenbird, Nashville warbler, and Canada warbler (Figure 2). Total number of species captured at the site since 2007 was 37 with 679 birds captured between 2018-2020 (Table 1). There were 89 recaptures, birds originally banded in a previous year, between 2018-2020 with an annual average of 13.1 percent (Table 2). The model-based estimate for species richness for 2018-2020 was 37.67 (CI 36-38; Fig. 3) and 0.91 (CI 0.91-0.91; Fig. 4) for Hurlbert's PIE. Four-letter species codes, common names, and scientific names for all species covered in this report are listed in Appendix B.

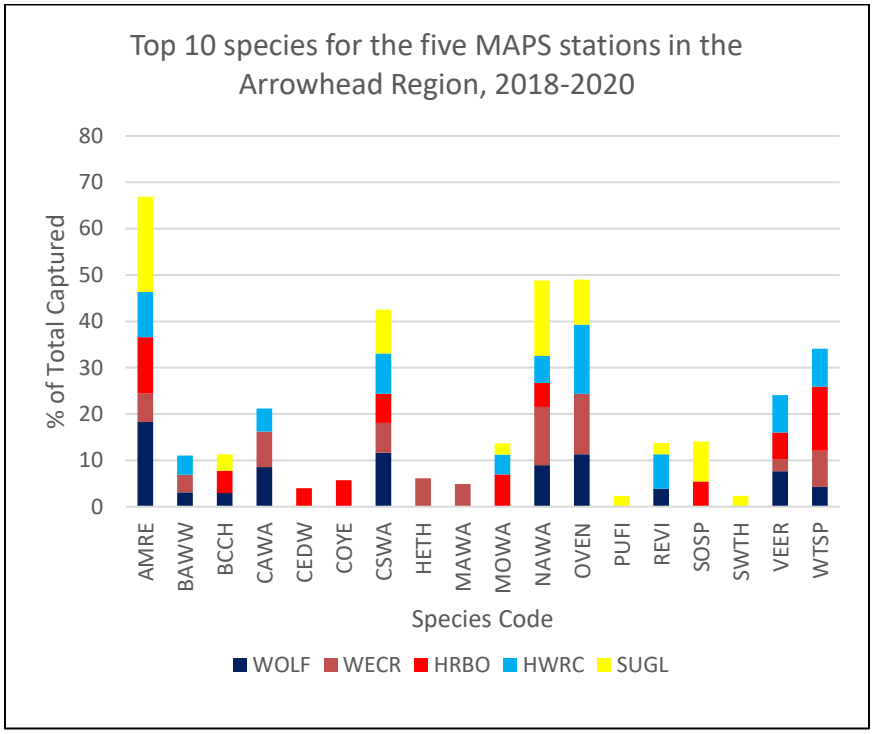


Figure 2. Most frequently captured birds between 2018-2020 at Wolf Ridge, Weiss Creek, Hawk Ridge Bird Observatory, Hubachek Wilderness Research Center, and Sugar Loaf, listed by American Ornithological Society species code (abbreviations identified in Appendix B). Percent of total captures are recorded for all stations if the species was among the top 10 captured at any one station, resulting in 18 reported here.

In 28 years of operation, the WOLF MAPS station had one recovery, a Canada warbler, banded at WOLF in 2003 and recaptured in Clear Lake, TX in 2004. During that time, there were two foreign captures, one a male Nashville warbler banded in Whitefish Point, MI in 1997, and recaptured at WOLF in 2000. The other was a female American redstart banded in Schroeder, MN and recaptured at WOLF in 2015.

Table 1. *Total # of species and # birds captured in 2018 - 2020 for the five MAPS stations in the Arrowhead region of northeastern Minnesota.*

Station	Total # species	2018	2019	2020	Overall total
		Total # birds	Total # birds	Total # birds	
WOLF	37	236	222	221	679
WECR	44	186	274	194	654
HRBO	43	317	281	307	905
HRWC	44	198	258	200	656
SUGL	41	270	228	274	772

Table 2. *Total # of recaptures and % of recaptures in 2018 – 2020 for the five MAPS stations in the Arrowhead region of northeastern Minnesota.*

Station	2018	2019	2020	Average
	Total recaps (%)[1]	Total recaps (%)[1]	Total recaps (%)[1]	Percent recaps
WOLF	27 (11.4)	25 (11.3)	37 (16.7)	13.1%
WECR	39 (20.9)	42 (15.3)	29 (14.9)	16.8%
HRBO	25 (7.9)	26 (9.3)	32 (10.4)	9.2%
HRWC	0 (0)[2]	32 (12.4)	34 (17.0)	14.4%
SUGL	0 (0)[2]	9 (3.9)	13 (4.7)	4.4%

[1] – Recaptures reported are only those birds originally banded in a previous year.
[2] – Stations with a "0" indicate the first year running as a MAPS station.

Weiss Creek

The five most common species captured at WECR between 2018-2020 were ovenbird, Nashville warbler, white-throated sparrow, Canada warbler, and chestnut-sided warbler (Fig. 2). Total number of species captured at the site since 2007 was 44 with 654 birds captured between 2018-2020 (Table 1). There were 110 recaptures, birds originally banded in a previous year, between 2018-2020 with an annual average of 16.8 percent (Table 2). Since WECR had the lowest number of captures among all stations, model-based estimates for species richness and evenness were equal to observed with a CI width of zero. Species richness for 2018-2020 was 44 (CI 44-44; Fig. 3). Hurlbert's PIE was estimated to be 0.94 (CI 0.94-0.94; Fig. 4). In 14 years of operation, WECR reported one recovery. A male red-eyed vireo banded at WECR in 2009 was recovered in Bogotá D.C., Columbia, in 2010.

Hawk Ridge Biological Observatory

The six most common species captured at HRBO between 2018-2020 were white-throated sparrow, American redstart, mourning warbler, veery, and common yellowthroat (6 species reported given veery and common yellowthroat had the same total; Fig 2.). Total number of species captured at the site since 2015 was 43 with 905 birds captured between

2018-2020 (Table 1). There were 83 recaptures, birds originally banded in a previous year, between 2018-2020 with an annual average of 9.2 percent (Table 2). Species richness for 2018-2020 was estimated at 40.9 (CI 38-43; Fig. 3) and Hurlbert's PIE was estimated to be 0.93 (CI 0.93-0.94; Fig. 4). No foreign recaptures or recoveries were reported at this station.

Hubachek Wilderness Research Center

The five most common species captured at HWRC between 2018-2020 were ovenbird, American redstart, chestnut-sided warbler, white-throated sparrow, and veery (Fig. 2). Total number of species captured at the site since 2018 was 44 with 656 birds captured between 2018-2020 (Table 1). There were 66 recaptures, birds originally banded in a previous year, between 2019-2020 (did not include 2018 because this was the first year of operation) with an annual average of 14.4 percent (Table 2). With HWRC's number of captures nearly identical to WECR, for which the richness and evenness modeling exercise was based on, the model estimates again equal the observed. Species richness for 2018-2020 was 44 (CI 44-44; Fig. 3) and Hurlbert's PIE was 0.93 (CI 0.93-0.93; Fig. 4). No foreign recaptures or recoveries were reported at this station.

Sugarloaf Cove

The five most common species captured at SUGL between 2018-2020 were American redstart, Nashville warbler, ovenbird, chestnut-sided warbler, and song sparrow (Fig. 2). Total number of species captured at the site since 2018 was 41 with 772 birds captured between 2018-2020 (Table 1). There were 22 recaptures, birds originally banded in a previous year, between 2019-2020 (did not include 2018 because this was the first year of operation) with an annual average of 4.4 percent (Table 2). Species richness model estimate for 2018-2020 was 39.2 (CI 37-41; Fig. 3) and Hurlbert's PIE was 0.90 (CI 0.90-0.90; Fig. 4). No foreign recaptures or recoveries were reported at this station.

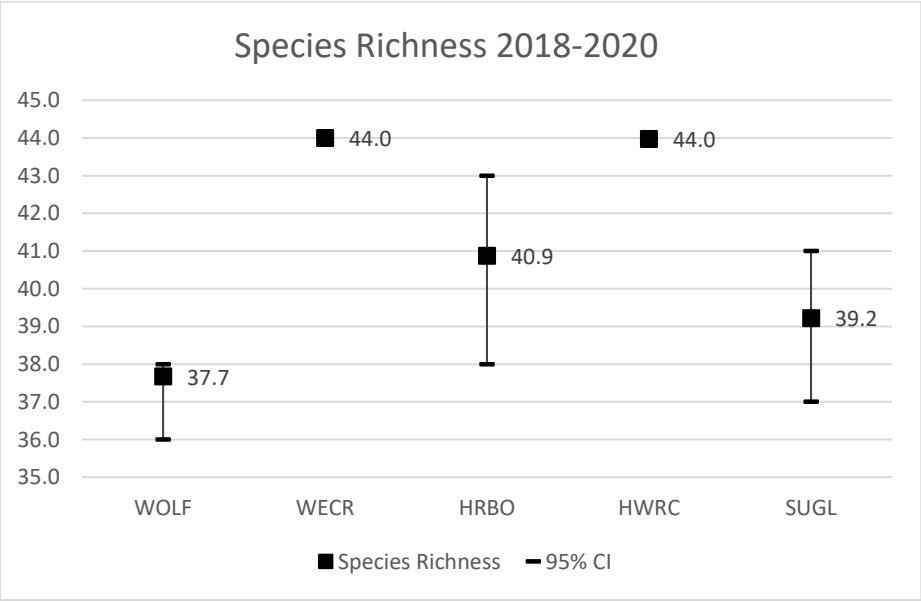


Figure 3. Species Richness and 95% Confidence Interval for five Arrowhead bird banding stations.

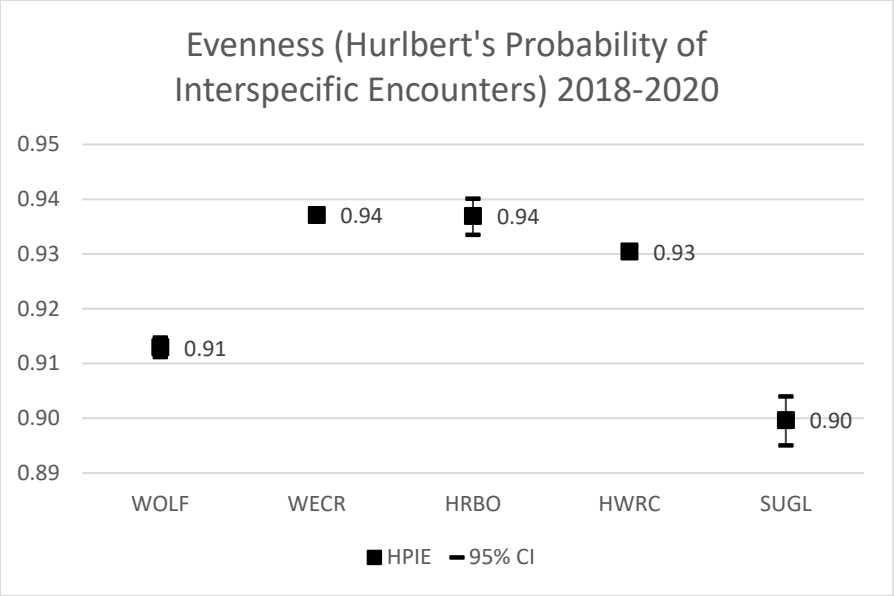


Figure 4. Hurlbert's PIE and 95% Confidence Interval for five Arrowhead bird banding stations.

While half of the top ten species were in common between most stations (WOLF, WECR, HRBO, and HWRC), it is evident the avian community differs among them. Taken together, WECR and HWRC scored highest in species richness and evenness among the five stations, whereas SUGL and WOLF ranked lowest. WECR and HWRC were the only stations with both conifer and deciduous components (Habitat Structure Assessment Appendix A), which provided a wider variety of habitat than the others. The three stations lacking conifer forest were also closest to the Lake Superior shoreline, so soil and climate conditions contribute to the composition of the tree community. Where possible our results suggest the importance of maintaining conifer on the landscape in future management practices to realize benefits to biodiversity.

Recapturing banded birds in subsequent years provides information on overwinter survival. Although our birds, with few exceptions, have not been recovered during migration or at their wintering areas, we can still gain valuable information regarding the stresses they face during those portions of their life cycle. Average annual recapture rates for all birds at Arrowhead stations ranged from 4-17%. In an effort to put our recapture rates in context, we examined recapture rates for a select group of species at MAPS stations continent-wide. These data were available for 1992-2006 reported by DeSante et al. (2015). Since our recapture rates were heavily influenced by the 10 most frequently captured species at each station (Figure 2), we averaged the recapture rate for those species in DeSante et al.'s data and found they had an average 18% recapture rate. The observed recapture rate range appears relatively low for the

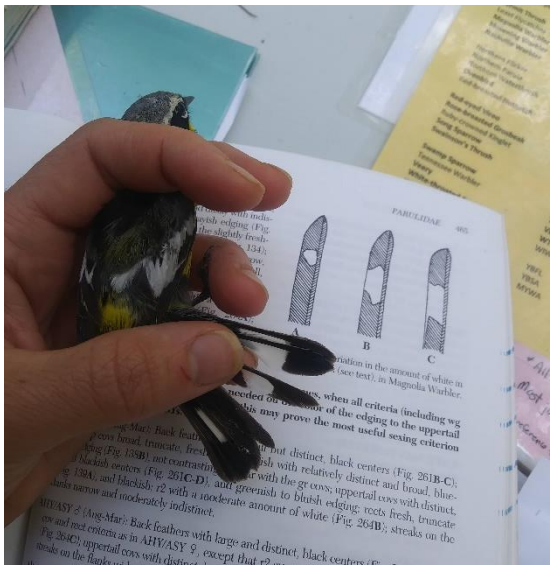
Arrowhead stations (Table 2) in comparison; however, based on our recapture rates, the overwinter survival of adults at our stations are not a cause for alarm.

INTER-ANNUAL TRENDS IN CAPTURE RATE

With so few foreign recaptures or recoveries at other stations, even within the Arrowhead region, the benefits of this banding effort are primarily realized by examining species and guild trends at each station. We selected 10 species for trend analysis: eight species were in common within the top 15 most frequently captured at WOLF, WECR, and HRBO stations. These common species analyzed were Nashville warbler, chestnut-sided warbler, American redstart, mourning warbler, ovenbird, red-eyed vireo, white-throated sparrow, and veery. Of the remaining species captured frequently at one or more station, we selected Canada warbler for further analysis because Breeding Bird Survey data across the country show a marked decline, and the Swainson's thrush due to a marked decline observed at one of the stations.

Trends in captures per 600 net hours for these species at three stations with greater than five years in operation are displayed in Table 3. Overall, trends were not consistent across stations. Chestnut-sided warblers were the only species that exhibited significant trends at more than one station, with an increase at both WECR and HRBO. In most cases, significant positive trends were matched by positive reproductive indices, and vice versa, with the exception of CAWA at WECR. A positive trend in captures for this species at WECR is likely due to adult survival and possibly immigration rather than productivity. Though, the low productivity measure could be a function of CAWA adults taking fledglings off-site for rearing to independence, and therefore, young birds are simply underrepresented in the data. More species demonstrated positive trends in captures (6) than negative (4). There was only one species for which significant trends were noted at multiple stations in the opposite direction, with SWTH decreasing at WECR and increasing at WOLF.

The fact that consistent trends were not observed across all stations is likely due to the differences in local habitat conditions at each station, and it is particularly encouraging that no declines were observed region wide. Interestingly, WECR and HRBO both had significant trends observed in roughly half of the ten species analyzed, while WOLF only had one species with a significant trend. Perhaps the habitat conditions at WOLF have remained more constant than WECR and HRBO. WECR experienced a spruce budworm (*Choristoneura spp.*) outbreak between 2014-2018 with much of the balsam fir understory/subcanopy trees dying. This reduction in conifer cover may explain the local decline in SWTH at that station.



To better understand species dynamics over time, we also performed a linear regression on captures per 600 net hours by species guild for the period of 2007-2020 for WOLF and WECR, and 2015-2020 for HRBO (Table 4). Species that were captured in less than half the years a station had been operating were not included in the guild analysis. In total, there were 28 species that could be grouped into nesting and habitat association guilds with at least three species representing each guild (WOLF = 9 spp. representing 3 guilds, WECR = 19 spp. representing 5 guilds, and HRBO = 17 spp. representing 5 guilds; Appendix B). Similar to the selected individual species analysis discussed above, trends were generally not consistent across all stations. There were two guild combinations that exhibited opposite significant trends, ground nesters in early successional habitat and ground nesters in lowland coniferous forest habitat. Ground nesters in early successional habitat demonstrated a significant decrease at WOLF and significant increase at HRBO, with a non-significant decrease at WECR. Ground nesters in lowland coniferous forest demonstrated a significant decrease at HRBO and significant increase at WECR, with a non-significant decrease at WOLF. Again, these inconsistencies in trends are likely a function of local habitat conditions rather than region-wide conditions or conditions encountered during migration or in wintering areas since they were not observed throughout.

Our comparison of linear trends from the three stations to point count data from NRRI across the study area and BBS across Minnesota may not be very useful as few trends were in agreement, even between the NRRI and BBS data (Table 5). However, it is notable that American redstarts had a significant increasing trend using the NRRI, BBS, and HRBO station data, and mourning warbler had a significant decreasing trend in the NRRI, BBS, and WECR station data, as well as a non-significant decline at the WOLF station.

The agreement of these three sets of data indicating a decline in mourning warbler suggest the importance of continued monitoring for this species. Interestingly, there was a significant decrease at WOLF and a nearly significant decrease at WECR in ground nesters in

early successional habitat guild, with the mourning warbler in that guild. Therefore, the quality of nesting habitat may be one factor to consider monitoring at stations. The reproductive index for mourning warbler was shown to be neither increasing nor decreasing (0.0) at all three stations, so low productivity may be a contributing factor in the decline. Fortunately, productivity is a factor that land managers may be able to influence through habitat manipulation on the breeding grounds. Wildlife managers should consider not only the availability of ground nester habitat in early successional forest, but also the habitat structure as it relates to this species in future vegetation management projects.

Table 3. *Estimated linear trends (captures per 600 net hours) and reproductive index (RI; # juveniles/# adults) for ten species (AMRE, CAWA, CSWA, MOWA, NAWA, OVEN, REVI, SWTH, VEER, WTSP) at Wolf Ridge (WOLF) and Weiss Creek (WECR) 2007-2020 and Hawk Ridge Biological Observatory (HRBO) 2015-2020. Significant relationships are indicated by green (positive) and orange (negative) shading.*

Species	WOLF				WECR				HRBO			
	Linear trend	Adjusted R^2	*P*	RI	Linear trend	Adjusted R^2	*P*	RI	Linear trend	Adjusted R^2	*P*	RI
AMRE	0.09	-0.08	0.89	0.01	0.58	0.11	0.13	0.01	5.89	0.67	0.03	0.00
CAWA	0.35	0.03	0.25	0.03	0.64	0.44	0.01	-0.08	NA	NA	NA	0.00
CSWA	-0.58	0.04	0.24	-0.01	0.66	0.37	0.01	0.01	1.88	0.80	0.01	0.09
MOWA	-0.50	0.18	0.07	0.00	-0.48	0.25	0.04	0.00	1.96	0.01	0.36	0.00
NAWA	-0.40	-0.04	0.50	1.08	0.25	-0.01	0.38	-0.08	-4.69	0.84	0.01	-0.14
OVEN	0.61	0.16	0.08	0.01	0.79	0.13	0.11	0.02	-0.10	-0.25	0.95	-0.18
REVI	-0.33	0.01	0.30	0.00	-0.95	0.43	0.01	0.00	1.42	-0.10	0.50	-0.17
SWTH	0.38	0.29	0.03	0.00	-1.14	0.77	<0.001	-0.01	NA	NA	NA	0.00
VEER	0.28	-0.01	0.37	0.01	0.28	0.07	0.19	0.00	-0.37	-0.23	0.82	0.00
WTSP	-0.41	0.05	0.22	0.01	0.45	0.14	0.10	0.01	5.62	0.63	0.04	0.02

Table 4. *Estimated linear trends (percent change in captures per 600 net hours) for 28 species in total at Wolf Ridge (WOLF-9 spp.) and Weiss Creek (WECR-19 spp.) 2007-2020 and Hawk Ridge Biological Observatory (HRBO-17 spp.) 2015-2020. Species are lumped according to nesting guild (cavity vs. ground vs. shrub/sub-canopy vs. canopy) and habitat association as identified in Niemi et al. (2016) and Table 3. Significant relationships are indicated by green (positive) and orange (negative) shading. Trends were reported only for guilds with 3 or more species represented at a station.*

Guild	WOLF			WECR			HRBO		
	Linear trend	**Adjusted R^2**	***P***	**Linear trend**	**Adjusted R^2**	***P***	**Linear trend**	**Adjusted R^2**	***P***
Canopy Nester-Coniferous	NA	NA	NA	0.02	-0.08	0.92	NA	NA	NA
Cavity Nester-Deciduous	NA	NA	NA	NA	NA	NA	-1.88	-0.06	0.44
Ground Nester-Mixed Forest	NA	NA	NA	1.45	0.66	0.00	NA	NA	NA
Ground Nester-Early Successional	-1.13	0.30	0.02	-0.55	0.06	0.20	8.59	0.73	0.02
Ground Nester-Lowland Coniferous	-0.95	0.07	0.18	0.69	0.23	0.05	-3.92	0.64	0.04
Shrub and Subcanopy Nester-Deciduous	NA	NA	NA	NA	NA	NA	0.87	-0.20	0.69
Shrub and Subcanopy Nester-Early Successional	-0.17	-0.08	0.86	0.49	-0.03	0.46	8.37	0.66	0.03

Table 5. *Comparison of trends from banding data summarized in this report for WOLF, WECR, and HRBO stations to point count data from 1995-2019 on Superior National Forest (Grinde et al. 2019), and Breeding Bird Survey from 1995-2019 for Minnesota (Sauer et al. 2020) where "NS" denotes no significant trend, "I*" denotes significantly increasing trends, and "D*" denotes significantly decreasing trend. Nesting guild and habitat associations from (Grinde et al. 2019) are also reported.*

Species	Nesting	Habitat Association	WOLF trend	WECR trend	HRBO trend	NRRI trend	BBS trend
AMRE	Shrub/subcanopy	Early successional	NS	NS	I*	I*	I*
CAWA	Ground	Mixed forest	NS	I*	NS	NS	NS
CSWA	Shrub/subcanopy	Early successional	NS	I*	I*	D*	NS
MOWA	Ground	Early successional	NS	D*	NS	D*	D*
NAWA	Ground	Lowland conifer	NS	NS	D*	I*	NS
OVEN	Ground	Deciduous	NS	NS	NS	NS	NS
REVI	Shrub/subcanopy	Deciduous	NS	D*	NS	D*	I*
SWTH	Shrub/subcanopy	Lowland conifer	I*	D*	NS	D*	NS
VEER	Ground	Early successional	NS	NS	NS	NS	NS
WTSP	Ground	Early successional	NS	NS	I*	NS	NS

CONCLUSION

Our measures of species diversity and proportion of the most common species captured at each site indicates that while each station is located within the same general forest biome, there are subtle differences in the avian community among them. We discovered few cases where local trends at one station were supported by regional trends, as measured by NRRI and BBS, and these trends were not consistent among stations or with NRRI and BBS in all cases.

Our results provided specific insight for applications to forest management, which include the ability of local managers to impact the breeding bird community at a local level. The importance of maintaining conifer forest to maintain high diversity in the avian community. Lastly, they suggest a need to examine not just the amount of young forest habitat, but also the site characteristics as it relates to species' needs. We intend to produce this report on a bi-annual basis, and we will explore additional methods to analyze adult demographics (survivorship and sex ratio) and productivity as our sample size grows.

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APPENDIX A: HABITAT STRUCTURE ASSESSMENT

Three most common habitat types are listed by percent coverage at each station below. Descriptions are based on National Vegetation Classification Standard codes (USNVC 2017). Pie charts representing more general classifications for each station are below.

WOLF

1. 60% late-successional cold-deciduous woodland dominated by quaking aspen (*Populus tremuloides*) in the overstory and broad-leaved shrub mid-story.
2. 20% early-successional seasonally flooded cold-deciduous shrubland composed primarily of alder shrubs (*Alnus spp.*).
3. 15% mid-successional boreal cold-deciduous forest with a maple (*Acer spp.*) and birch (*Betula spp.*) overstory and broad-leaved shrub mid-story.

WECR

1. 50% mid-successional conical-crowned temperate needle-leaved evergreen forest dominated by upland black spruce and quaking aspen in overstory, and balsam fir understory.
2. 17% temporarily flooded cold-deciduous shrubland dominated by alder shrubs and some northern white cedar (*Thuja occidentalis*) trees.
3. 14% mid-successional rounded-crowned temperate needle-leaved evergreen woodland with a mixed pine (*Pinus spp.*) and spruce (*Picea spp.*) over and mid-story.

HRBO

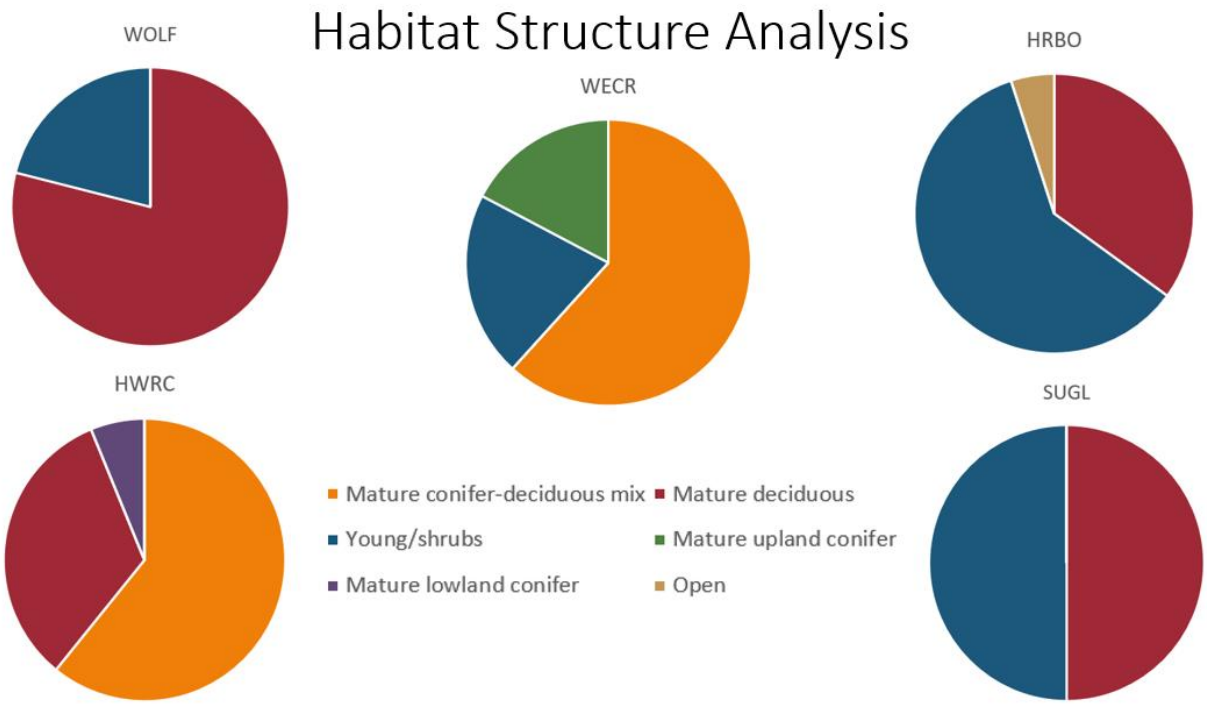
1. 60% alder and willow shrub swamp with occasional quaking aspen (Populus tremuloides) and red pine (Pinus resinosa).
2. 35% Second growth upland deciduous forest dominated by quaking aspen (Populus tremuloides), sugar maple (Acer saccharum) and red oak (Quercus rubra) with occasional conifer spp.
3. 5% old field with scattered shrubs over bedrock with scattered rocky outcrops.

HWRC

1. 59% mid-successional mixed needle-leaved evergreen-cold deciduous forest dominated by red pine (*Pinus resinosa*) and quaking aspen in the overstory with a beaked hazel understory (*Chorylus cornida*).
2. 32% late-successional saturated cold-deciduous forest dominated by black ash (*Fraxinus nigra*).
3. 6% Conical-crowned temperate needle-leaved evergreen forest consisting of lowland black spruce (*Picea mariana*) and tamarack (*Larix laricina*) forest.

SUGL

1. ~50% alder and willow shrub swamp with scattered ninebark (*Physocarpus opulifolius*) and balsam poplar (*Populus balsamifera*).
2. ~50% Second growth upland deciduous forest dominated by balsam poplar (*Populus balsamifera*), with occasional white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*).



APPENDIX B: SPECIES CODES AND GUILDS

Species codes used in this document are referenced below and correspond to those identified by the American Ornithologist Society. Nesting and habitat guilds are identified for those species used for guild analysis ($^{+}$ = HRBO, * = WECR, $^{\wedge}$ = WOLF).

Species Name	Scientific Name	Species Code	Guild
Alder Flycatcher	*Empidonax alnorum*	ALFL	Shrub nesters in early successional forest$^{+, *, \wedge}$
American Redstart	*Setophaga ruticilla*	AMRE	Shrub nesters in early successional forest$^{+, *, \wedge}$
Black-and-white Warbler	*Mniotilta varia*	BAWW	Ground nesters in mixed forest*
Black-capped Chickadee	*Poecile atricapillus*	BCCH	Cavity nesters in deciduous forest^{+}
Blackburnian Warbler	*Setophaga fusca*	BLBW	Canopy nesters in coniferous forest*
Canada Warbler	*Cardellina canadensis*	CAWA	Ground nesters in mixed forest*
Cape May Warbler	*Setophaga tigrina*	CMWA	Canopy nesters in coniferous forest*
Cedar Waxwing	*Bombycilla cedrorum*	CEDW	*Species not used in guild analysis*
Chestnut-sided Warbler	*Setophaga pensylvanica*	CSWA	Shrub nesters in early successional forest$^{+, *, \wedge}$
Chipping Sparrow	*Spizella passerina*	CHSP	Canopy nesters in coniferous forest*
Common Yellowthroat	*Geothlypis trichas*	COYE	*Species not used in guild analysis*
Downy Woodpecker	*Picoides pubescens*	DOWO	Cavity nesters in deciduous forest^{+}
Golden-crowned Kinglet	*Regulus satrapa*	GCKI	Canopy nesters in coniferous forest*
Golden-winged Warbler	*Vermivora chrysoptera*	GWWA	Ground nesters in early successional forest$^{+, \wedge}$
Gray Catbird	*Dumetella carolinensis*	GRCA	Shrub nesters in early successional forest^{+}
Hairy Woodpecker	*Picoides villosus*	HAWO	Cavity nesters in deciduous forest^{+}
Hermit Thrush	*Catharus guttatus*	HETH	Ground nesters in mixed forest*
Least Flycatcher	*Empidonax minimus*	LEFL	Shrub nesters in deciduous forest^{+}
Magnolia Warbler	*Setophaga magnolia*	MAWA	*Species not used in guild analysis*
Mourning Warbler	*Geothylpis philadelphia*	MOWA	Ground nesters in early successional forest$^{+, *, \wedge}$
Nashville Warbler	*Leiothlypis ruficapilla*	NAWA	Ground nesters in lowland forest$^{+, *, \wedge}$
Northern Waterthrush	*Parkesia noveboracensis*	NOWA	Ground nesters in lowland forest*
Ovenbird	*Seiurus aurocapillus*	OVEN	*Species not used in guild analysis*

Purple finch	*Haemorhous purpureus*	PUFI	*Species not used in guild analysis*
Red-eyed Vireo	*Vireo olivaceus*	REVI	Shrub nesters in deciduous forest[+]
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	RBGR	Shrub nesters in deciduous forest[+]
Song Sparrow	*Melospiza melodia*	SOSP	*Species not used in guild analysis*
Swanison's Thrush	*Catharus ustulatus*	SWTH	*Species not used in guild analysis*
Swamp Sparrow	*Melospiza georgiana*	SWSP	Ground nesters in early successional forest[*]
Tennessee Warbler	*Leiothlypis peregrina*	TEWA	Ground nesters in lowland forest[+, *, ^]
Veery	*Catharus fuscescens*	VEER	*Species not used in guild analysis*
White-throated Sparrow	*Zonotrichia albicollis*	WTSP	Ground nesters in early successional forest[+, *, ^]
Winter Wren	*Troglodytes hiemalis*	WIWR	Ground nesters in lowland forest[*]
Yellow-bellied Flycatcher	*Empidonax flaviventris*	YBFL	Ground nesters in lowland forest[+, *, ^]
Yellow-bellied Sapsucker	*Sphyrapicus varius*	YBSA	Cavity nesters in deciduous forest[+]
Yellow-rumped Warbler	*Setophaga coronata*	MYWA	Canopy nesters in coniferous forest[*]