Habitat Preferences of Parulidae and Emberizidae in Northern Wisconsin/Michigan's Upper Peninsula

BIOS 35502 Practicum in Environmental Field Biology

Jaime McConachie

Mentor: Kristin Bahleda

2016

Abstract

Cape May warbler, black-throated green warbler, northern parula, ovenbird, and white-throated sparrow were the indicator species observed in this study. These species breed at the University of Notre Dame Environmental Research Center [UNDERC] in the Upper Peninsula of Michigan. UNDERC property encompasses a variety of habitat types. In this study we hoped to determine if these birds show specific habitat preferences. In order to test our hypothesis, point count surveys were conducted in four distinct habitat types to collect presence/absence data on the study birds. A statistically significant relationship between habitat and presence/absence of study bird species was found (Friedman test, $Q = 13.73, \chi^2\ df = 5, p = 0.0174$). Species composition of the habitat types were found to be distinct from one another, which is supportive of my hypothesis that these indicator species show habitat preference.

Keywords: Cape May warbler; black-throated green warbler; northern parula; ovenbird; white-throated sparrow; habitat preference; species composition; neotropical migrants

Introduction

In an attempt to manage migratory bird species, the U.S. Fish and Wildlife Service uses population surveys to collect data (Sauer, 1993). In addition to population information, effective conservation is informed by understanding a bird's relationship with habitats based on spatial interactions (Twedt and Loesch, 2000). A survey in the Greater Yellowstone ecosystem found that many bird species showed significant preferences for at least one habitat type (Debinski et al., 1999). Thus, conservation planning for bird species that are especially vulnerable to extinction requires a combination of focused habitat conservation and restoration, as well as breeding bird inventories to continue monitoring species' annual population sizes (Ford and Roedel, 2000).

Migratory bird populations, specifically those of neotropical migrants, are in a period of decline (Twedt and Loesch, 2000). Damage to both wintering grounds (Weidensaul, 2000) and stopover habitats en route to breeding grounds (Bonter et al., 2008) has been shown to negatively impact neotropical migrant populations. Thus, conservation of these populations depends on widespread habitat preservation, spanning breeding grounds in the Northern Hemisphere and wintering grounds in the Southern Hemisphere, which creates a particularly challenging conservation problem (Weidensaul, 2000). Because neotropical migrants' habitats span the Americas, their relationships with their habitats are not always well understood and are often complicated. For instance, Cape May warblers (*Setophaga tigrina*) [CMWA][1] are insectivorous in their breeding grounds, but primarily consume nectar in their Caribbean wintering grounds (Weidensaul, 2000). During the summer CMWA specialize on a moth caterpillar species, spruce budworm. As such, the budworm population closely affects the warbler population (Weidensaul, 2000). This is an example of a behavioral relationship with habitat that informs researchers and conservationists on aspects of the CMWA's population dynamics.

Like many migrants in the Great Lakes basin (Bonter et al., 2008), CMWA populate forested habitats during breeding season. CMWA's boreal forest breeding habitats range from southeastern Canada to the northeastern United States, including in Michigan (Boreal, 2015). CMWA are classified as being of moderate to high conservation concern in the Cornell Lab of Ornithology's 2016 State of North America's Birds report.

To contrast the CMWA, black-throated green warblers (*Setophaga virens*) [BTGW], northern parula (*Setophaga Americana*) [NOPA] and ovenbirds (*Seiurus aurocapilla*) [OVEN] are of low to moderate conservation concern (Cornell, 2016). All of these neotropical migrants' range spans the UNDERC campus during the summer breeding season (Sibley, 2016). White-throated sparrow (*Zonotrichia albicollis*) [WTSP]

---

[1] For the remainder of this paper, four letter bird banding codes are the abbreviation designations.

also breed at UNDERC (Sibley, 2016). Like BTGW, NOPA, and OVEN, WTSP are of low to moderate conservation concern (Cornell, 2016). Unlike the warblers, WTSP are not neotropical migrants. Instead, they migrate between the U.S. and Canada and the southeastern U.S. (Sibley, 2016). Thus, WTSP provide a potentially interesting comparison between the habitat-bird relationships of neotropical migrants and the habitat-bird relationships of birds who remain in North America. My research question is how CMWA, BTGW, NOPA, OVEN, and WTSP are distributed through habitats at UNDERC.

The UNDERC property encompasses a wide range of habitat types including maple and boreal forest, bogs and lakes, and meadows (Gage et al., 2008). Additionally, UNDERC is the site of a long term acoustic monitoring program (Gage et al., 2008). Acoustic monitoring has been used to monitor the health of environments by using soundscape metrics as environmental indicators (Gage et al., 2012). The sum of the sounds of an ecosystem forms a soundscape, which can be analyzed for sound file species richness (Gage et al., 2012; McLaren, 2012). Because of the vocal behavior of birds as a class, acoustic monitoring can be utilized in studies of bird populations, especially in remote areas that are difficult to access (Depraetere et al., 2012; Sanders and Mennill, 2014). The question is if acoustic monitoring data is comparable in quality and detail to traditional point count monitoring methods (Klingbeil and Willig, 2015; Leach et al., 2016). Some studies suggest acoustic monitoring decreases observer bias and increases detection (Furnas and Callas, 2015), while others demonstrate flaws in acoustic monitoring when it comes to vocally similar species (Cragg et al., 2016). Klingbeil and Willig (2015) and Leach et al. (2016) compared acoustic monitoring protocols and traditional point count methods. Overall, both methods provide similar species richness and composition estimates (Klingbeil and Willig, 2015; Leach et al., 2016). Because of the already ongoing acoustic monitoring project by Gage et al. (2008) at UNDERC, the summer distributions of CMWA, BTGW, NOPA, OVEN, and WTSP can be examined going back several years using soundscape recordings, as well as observed in the current year (2016) using point counts.

It is hypothesized that during the months of late May through July, CMWA, BTGW, NOPA, OVEN, and WTSP will be unevenly distributed throughout UNDERC forest, wetland, and field habitats consistent with the habitat preferences documented in the natural histories of each species.

Methods

Study Site

This study was conducted at UNDERC, which spans almost 8,000 acres in Vilas County (Wisconsin) and Gogebic County (Michigan) (Gage et al., 2008). UNDERC is comprised of four main habitat types: wetland, field, mixed forest, and conifer forest (Gage et al., 2008). For the purposes of this study, wetland was defined as a habitat that was predominantly water, but excluding lakes (i.e. bog or marsh). Field habitats were a flat area predominantly inhabited by grasses. Mixed forests were defined as mostly hardwood forest with scattered conifer stands. Conifer forests were comprised of tree species such as balsam fir (*Abies balsamea*), eastern hemlock (*Tsuga canadensis*), and black spruce (*Picea mariana*). For this study, there were two wetland sites, two conifer forest sites, one mixed forest site, and one field site (Table 1).

Point Counts

Presence/absence data for CMWA, BTGW, NOPA, OVEN, and WTSP was collected in the different UNDERC habitats using point counts. Point counts are a standardized method of data collection employing visual and auditory surveys conducted from a single point to collect data such as a tally of species observed and to estimate bird density (Sauer, 1993; Hamel et al., 1996). One 150 m transect was established at each site. Five transects had three points and one wetland transect had two points approximately 300 m apart because of the deep water in the marsh. The distance between point counts in this study were shorter than the standard 250 m (Hamel et al., 1996; Hanni et al., 2009). A minimum distance of 250 m usually ensures an individual bird is not counted in multiple point counts (Hamel et al., 1996). However, since the goal of this study was to determine the presence/absence of CMWA, BTGW, NOPA, OVEN, and WTSP, a count of individual birds was of lesser interest.

Following the methods of Hanni et al. (2009), a five minute auditory and visual survey was conducted at each point and the total time spent in a transect was approximately half an hour. Surveys were conducted during the sunrise hours, 05:00-05:30 AM, at a predetermined site. Each site was surveyed at least three times. The field, mixed forest, and one wetland sites were surveyed four times.

Upper Great Lakes Soundscape Project

In addition to data collected during point count surveys, data from the Upper Great Lakes Soundscape Project was used. Since 2012, the Upper Great Lakes Soundscape Project has installed nineteen sensors throughout UNDERC's forest, wetland, and field habitats (Gage, 2016). Sounds are recorded every half hour for the duration of one minute using the Song Meter SM2 from Wildlife Acoustics and are then collected and uploaded to the Remote Environmental Assessment Laboratory [REAL] Server (Gage et al., 2008). Recordings from the same time period as the point counts (sunrise during late May through July) from 2014 and 2015 were used to examine trends in the presence/absence of CMWA, BTGW, NOPA, OVEN, and WTSP throughout the different habitats over a three year period.

Of the nineteen acoustic monitoring sensors set up at UNDERC, only six were used in this project (Figure 1). Though the Upper Great Lakes Soundscape Project had different habitat designations than those used in this project, habitats where soundscape data was collected were matched to habitats where point count data was collected based on the above designations.

Statistical Analysis

The presence/absence of CMWA, BTGW, NOPA, OVEN, and WTSP was converted into numerical values, where $presence = 1$ and $absence = 0$. A Shapiro-Wilk test for normality showed the data was non-normal, so two Friedman tests were run to determine if there was a statistically significant results. One test used habitat type as the grouping variable to determine if there was a statistically significant difference between habitat types based on the presence/absence of the target species. The other test used bird species as a grouping variable to determine if there was a statistically significant difference in the presence/absence of study species. A Friedman Multiple Comparison test was used for post hoc analysis.

To look at trends using 2014 and 2015 soundscape data and point count data collected in 2016, there needed to be similar detection of birds for both data collection methods. Soundscape data and point count data from 2016 were directly compared using linear regressions. A comparison was run for each of the six point count sites and soundscapes.

Results

There was a significant difference between habitat types based on the presence/absence of CMWA, BTGW, NOPA, OVEN, and WTSP (Friedman test, $Q = 13.73$, $\chi^2\ df = 5$, $N = 22$, $p = 0.0174$). Further post hoc analysis showed some significant differences between the bird species composition of specific habitats. There were differences between the two conifer forest sites and the field site (Table 2). The field site was also different from the marsh wetland site, as was the mixed forest site (Table 2). The two wetland sites, one bog and one marsh, were also significantly different from each other (Table 2).

There was not, however, an overall significant difference between bird species based on habitat type (Friedman test, $Q = 6.53$, $\chi^2\ df = 4$, $p = 0.16$). The post hoc Friedman Multiple Comparisons test did show some significant differences between specific bird species. CMWA showed a significant habitat preference over OVEN and WTSP ($p = 0.039$, $p = 0.039$). Compared to each other, OVEN and WTSP were very similar ($p = 1.00$). BTGW and NOPA did not show any significant difference compared to the other species.

Point counts and soundscape data collected in the current year (2016) were compared to determine the similarity in detection in the two data collection methods. Six linear regressions were run for point counts and soundscape data based on habitat type and none of them were significant (Table 3). Since point count data and soundscape data were not similar (Figure 2), trends using the soundscape data from 2014 and 2015 and point count data from 2016 were not examined.

Discussion

The hypothesis that CMWA, BTGW, NOPA, OVEN, and WTSP would be unevenly distributed through UNDERC habitats was supported by the results that showed significant differences between habitat types in study bird species composition.

Morissette et al. (2013) demonstrated that differences in species composition exists between wetland habitat types, like bogs and marshes. This study of CMWA, BTGW, NOPA, OVEN, and WTSP presence/absence found similar results. Though the bog and the marsh were both classified as wetland habitat, different plant compositions and edge habitats were observed during point count surveys. The bog was covered by a mat of *sphagnum* moss and plant species such as tamarack (*Larix laricina*) and blue flag iris (*Iris versicolor*). Edge habitat surrounding the bog was mixed hardwood-conifer forest. The marsh wetland site's edge habitat was a lake and a conifer forest, and the vegetation was mostly grasses and rushes, like the common cattail (*Typha latifolia*). Vegetation composition is a well studied component of bird community variation (Jankowski et al., 2013; Morissette et al., 2013), so the differences in the UNDERC wetland habitat vegetation structure and edge habitat type could account for the significant difference in the presence/absence of the study bird species.

Though overall the habitat types were shown to be significantly different, post hoc analysis revealed some similarities (Table 2). For instance, the bog wetland site was similar to the mixed forest site, which is possibly due to mixed forest habitat adjacent to the bog wetland site and a separate bog habitat near the mixed forest site. The similarity could also be due to a little understood aspect of landscape composition and configuration (Carrara et al., 2015). A greater number of mixed forest and bog wetland sites in future studies could decrease the similarities seen during analysis and clarify the relationship between bog wetland and mixed forest habitat bird species composition.

Despite the differences between habitat types in target species composition, the statistical analysis was insufficient in determining whether the study species' showed habitat preferences. The Friedman test and post hoc analysis only showed if habitat preference varied between study species, but not which habitats the species preferred.

There were a few observable habitat preferences; for instance, none of the study species were present in the marsh wetland site. Additionally, during point count surveys OVEN displayed a habitat preference for forest habitats or habitats with forest edges, like the bog wetland and the field sites (Figure 6), which is consistent with the literature (Smith et al., 1993; Sibley, 2016). WTSP were mostly observed in or near early successional habitats, such as bogs (Figure 7), which is similar to findings of past studies of neotropical migrants in the Northeast (Smith et al., 1993). BTGW and NOPA are documented to prefer forested habitat during the breeding season (Smith et al., 1993; Sibley, 2016), but both had high presence in the field site, which could be due to coniferous forest habitat near the field (Figure 4; Figure 5). CMWA was the least observed bird species, occurring in only the field site and one of the conifer forest sites (Figure 3). CMWA are of high to moderate conservation concern (Cornell, 2016) and it follows logically that they would be less common than OVEN. However, CMWA's lower presence at UNDERC could also be related to observer bias due to the difficulty in distinguishing CMWA from black-and-white warblers, which occur in similar habitats (Sibley, 2016), during point counts.

The natural progression of this study would be to look at population density of CMWA, BTGW, NOPA, OVEN, and WTSP as well as presence/absence in the UNDERC habitat types. Additionally, increasing the number of study sites and repeated measures could elucidate some results.

Changes in point count methodology, like recording the birds detected every minute and the distances at which birds are detected, could result in more significant results in the comparative analysis of point count and soundscape data collection methods. The Song Meter SM2 used to record sounds has a radius of 50 m whereas point count surveys can detect birds as far as 300 m, which was not taken into account during the statistical analysis.

During point count surveys, there seemed to be more birds singing in May and June than in July. Since the data collected during this study was presence/absence and not a count of individuals, these observations could not be quantified and analyzed. However, a potential subsequent study could look at the temporal behavior shift between the mating season and the breeding season in neotropical migrants (Hau, 2001).

As was expected, distinct habitat types varied in study species composition. Further investigation into the specific habitat preferences exhibited by the study species could help inform conservation efforts, particularly in the case of species of high conservation concern like CMWA.

Acknowledgements

I would like to acknowledge the UNDERC-East faculty and staff who helped me with this project from conception to execution: Dr. Michael Cramer, Kristin Bahleda, Catherine McQuestion, Hannah Madson, and Dr. Gary Belovsky. I would also like to thank for my peers who helped with my point count surveys: Kathryn Marshall, Delaney Martin, Tricia Holland, Ashley Sanchez, Liz Wildenhain, and Tessa Cafritz. Finally, I am grateful for the Bernard J. Hank Family Endowment for making this experience possible.

References cited

Bonter, D.N., S.A. Gauthreaux Jr., and T.M. Donovan. 2008. Characteristics of important stopover locations for migrating birds: remote sensing with radar in the great lakes basin. *Conservation Biology* 23:440-448.

Boreal Songbird Initiative. 2015. Guide to Boreal Birds: Cape May Warbler. Retrieved on 15 May 2016. http://www.borealbirds.org/bird/cape-may-warbler

Carrara, E., V. Arroyo-Rodríguez, J.H. Vega-Rivera, J.E. Schondube, S.M. de Freitas, and L. Fahrig. 2015. Impact of landscape composition and configuration on forest specialist and generalist bird species in the fragmented Lacandona rainforest, Mexico. *Biological Conservation* 184:117-126.

Cornell University via: The North American Bird Conservation Initiative. 2016. State of North America's Birds 2016: Species Assessment Summary and Watch List. Retrieved on 19 May 2016. http://www.stateofthebirds.org/2016/resources/species-assessments/

Cragg, J.L., A.E. Burger, and J.F. Piatt. 2016. Techniques for monitoring *Brachyramphus* murrelets: a comparison of radar, autonomous acoustic recording and audio-visual surveys. *Wildlife Society Bulletin* 40:130-139.

Debinski, D.M., K. Kindscher, and M.E. Jakubauskas. 1999. A remote sensing and GIS-based model of habitats and biodiversity in the greater Yellowstone ecosystem. *Int. J. Remote Sensing* 20:3281-3291.

Depraetere, M., S. Pavoine, F. Jiguet, A. Gasc, S. Duvail, and J. Sueur. 2012. Monitoring animal diversity using acoustic indices: implementation in a temperate woodland. *Ecological Indicators* 13:46-54.

Ford, R.P. and M.D. Roedel. 2000. Bird conservation planning in the Interior Lower Plateaus. Strategies for Bird Conservation: The Partners in Flight Planning Process. Cornell Lab of Ornithology.

Furnas, B.J. and R.L. Callas. 2015. Using automated recorders and occupancy models to monitor common forest birds across a large geographic region. *The Journal of Wildlife Management* 79:325-337.

Gage, S., G. Belovsky, M. Cramer, and E. Kasten. 2008. The Upper Great Lakes Soundscape. Remote Environmental Assessment Laboratory. University of Notre Dame, Michigan State University. http://www.real.msu.edu/projects/one_proj.php?proj=nd

Gage, S., E.P. Kasten, J. Fox, and W. Joo. 2012. The remote environmental assessment laboratory's acoustic library: an archive for studying soundscape ecology. *Ecological Informatics* 12:50-67.

Gnass Giese, E.E., R.W. Howe, A.T. Wolf, N.A. Miller, and N.G. Walton. 2015. Sensitivity of breeding birds to the "human footprint" in western Great Lakes forest landscapes. *Ecosphere* 6:1-22.

Hamel, P.B., P.S. Smith, D.J. Twedt, J.R. Woehr, E. Morris, R.B. Hamilton, and R.J. Cooper. 1996. A land manager's guide to point counts of birds in the southeast. USDA Forest Service, Washington D.C. SO-I 20.

Hanni, D. J., C. M. White, J. A. Blakesley, G. J. Levandoski, and J. J. Birek. 2009. Point Transect Protocol. Unpublished report. Rocky Mountain Bird Observatory, Brighton, CO.

Hau, M. 2001. Timing of breeding in variable environments: tropical birds as model systems. *Hormones and Behavior* 40:281-290.

Jankowski, J.E., C.L. Merkord, W.F. Rios, K.G. Cabrera, N.S. Revilla, and M.R. Silman. 2013. The relationship of tropical bird communities to tree species composition and vegetation structure along an Andean elevational gradient. *Journal of Biogeography* 40:950-962.

Klinbeil, B.T. and M.R. Willig. 2015. Bird biodiversity assessments in temperate forest: the value of point count versus acoustic monitoring protocols. *PeerJ Inc.* 3:e973.

Leach, E.C., C.J. Burwell, L.A. Ashton, D.N. Jones, and R.L. Kitching. 2016. Comparison of point counts and automated acoustic monitoring: detecting birds in a rainforest biodiversity survey. *Emu*. Internet. http://www.publish.csiro.au/paper/MU15097.htm

McLaren, J. 2012. Monitoring techniques for temperate bird diversity: uncovering relationships between soundscape analysis and point counts. Unpublished paper. University of Notre Dame.

Morissette, J.L., K.J Kardynal, E.M. Bayne, and K.A. Hobson. 2013. Comparing bird community composition among boreal wetlands: is wetland classification a missing piece of the habitat puzzle? *Wetlands* 33:653-665.

Ralph, J., S. Droege, and J. R. Sauer. 1995. Managing and Monitoring Birds Using Point Counts: Standards and Applications. USDA Forest Service, Washington D.C., PSW-GTR-149.

Sanders, C.E. and D.J. Mennill. 2014. Acoustic monitoring of nocturnally migrating birds accurately assesses the timing and magnitude through the Great Lakes. *The Condor* 116:371-383.

Sauer, J.R. 1993. Monitoring goals and programs of the U.S. Fish and Wildlife Service. U.S. Dept. of Agriculture, Forest Service: 245-251.

Sibley, D.A. 2016. The Sibley field guide to birds of North America. Alfred A. Knopf, New York.

Smith, C.R., D.M. Pence, and R.J. O'Connor. 1993. Status of neotropical migratory birds in the Northeast: a preliminary assessment. U.S. Dept. of Agriculture, Forest Service: 172-188.

Twedt, D.J. and C.R. Loesch. 2000. Conservation planning and monitoring avian habitat. Strategies for Bird Conservation: The Partners in Flight Planning Process. Cornell Lab of Ornithology.

Weidensaul, S. 2000. Living on the wind: across the hemisphere with migratory birds. North Point Press, New York.

Tables and Figures

Table 1. Point count site distribution among the different habitat types.

Habitat Types	Number of sites
Wetland	2
Conifer forest	2
Mixed forest	1
Field	1

Table 2. Statistically significant results of the post hoc Friedman Multiple Comparison test with habitat type as the grouping variable. Wet1 refers to the bog wetland site whereas Wet2 is the marsh wetland site.

Comparison	Statistic	P-value
Con1 – Field1	3.41	0.0028
Con2 – Field1	2.68	0.015
Wet2 – Field1	4.62	0.00016
Wet2 – Mix1	2.68	0.015
Wet2 – Wet1	2.68	0.015

Table 3. Comparison between point count and 2016 soundscape data to determine similarity in detection of the different data collection methods.

Point Count Sites & Soundscape Codes	**Statistics**
Wet-1 & ND10	$F_1 = 0.057, p = 0.82$
Wet-2 & ND02	$F_1 = 0.051, p = 0.83$
Con-1 & ND16	$F_1 = 0.127, p = 0.74$
Con-2 & ND18	$F_1 = 0.027, p = 0.88$
Mix-1 & ND09	$F_1 = 0.030, p = 0.87$
Field-1 & ND05	$F_1 = 0.013, p = 0.91$

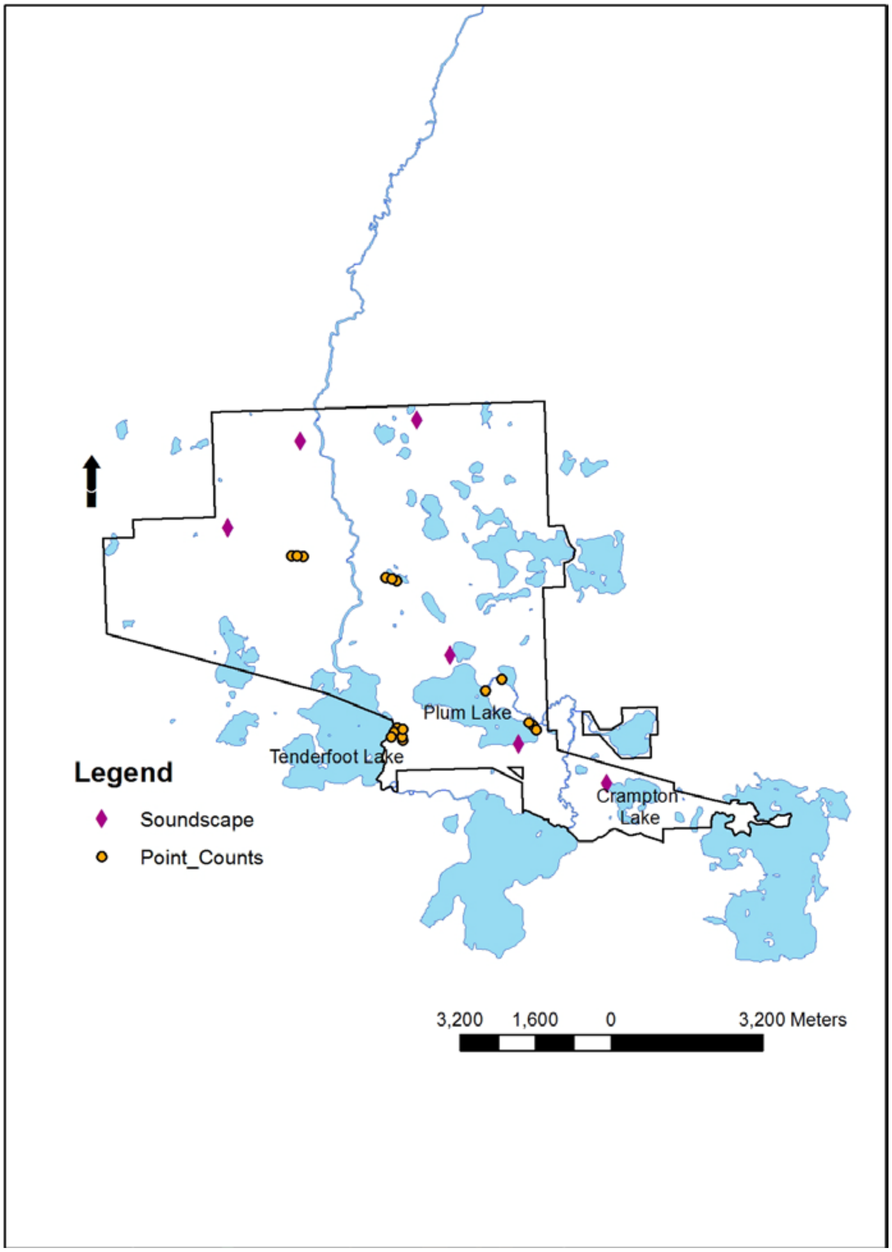

Figure 1. Point count transects and soundscape locations on UNDERC property.

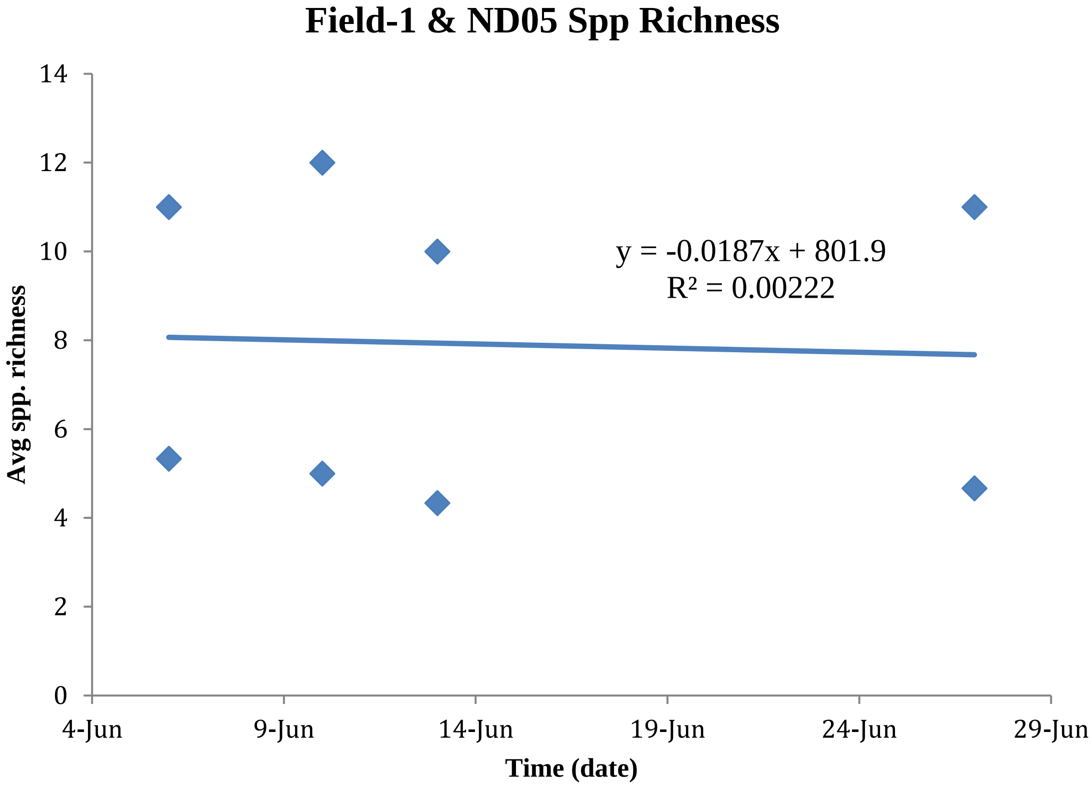

Figure 2. Linear regression of point count and soundscape data from the field habitats ($F_1 = 0.013, p = 0.91$).

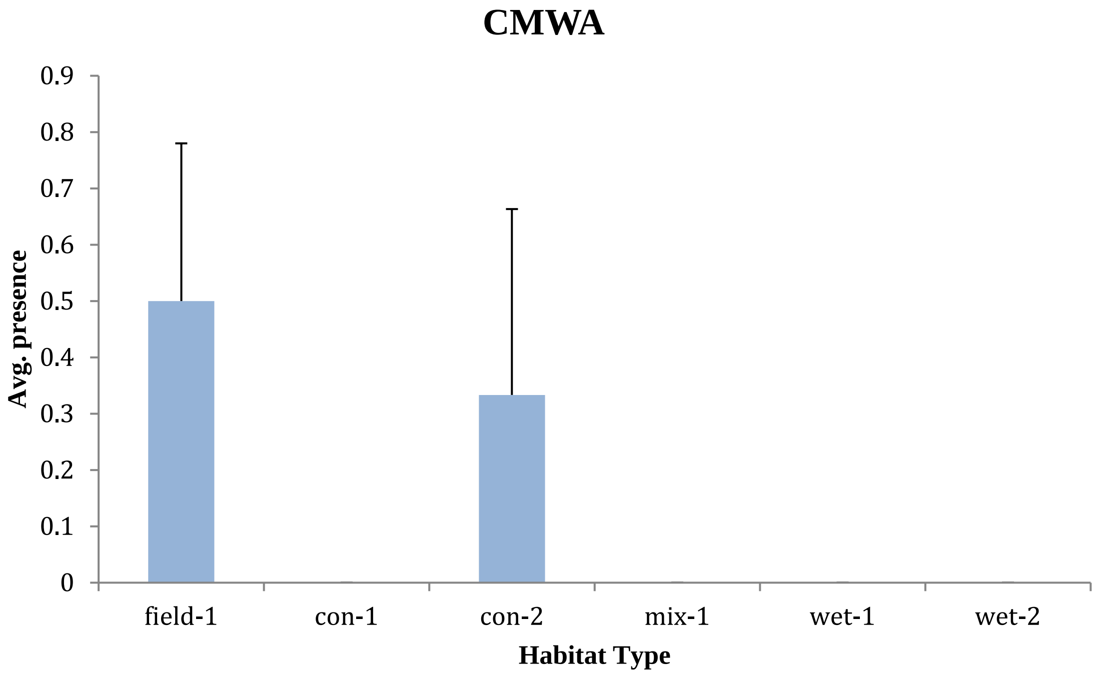

Figure 3. Average presence/absence of CMWA in each habitat type.

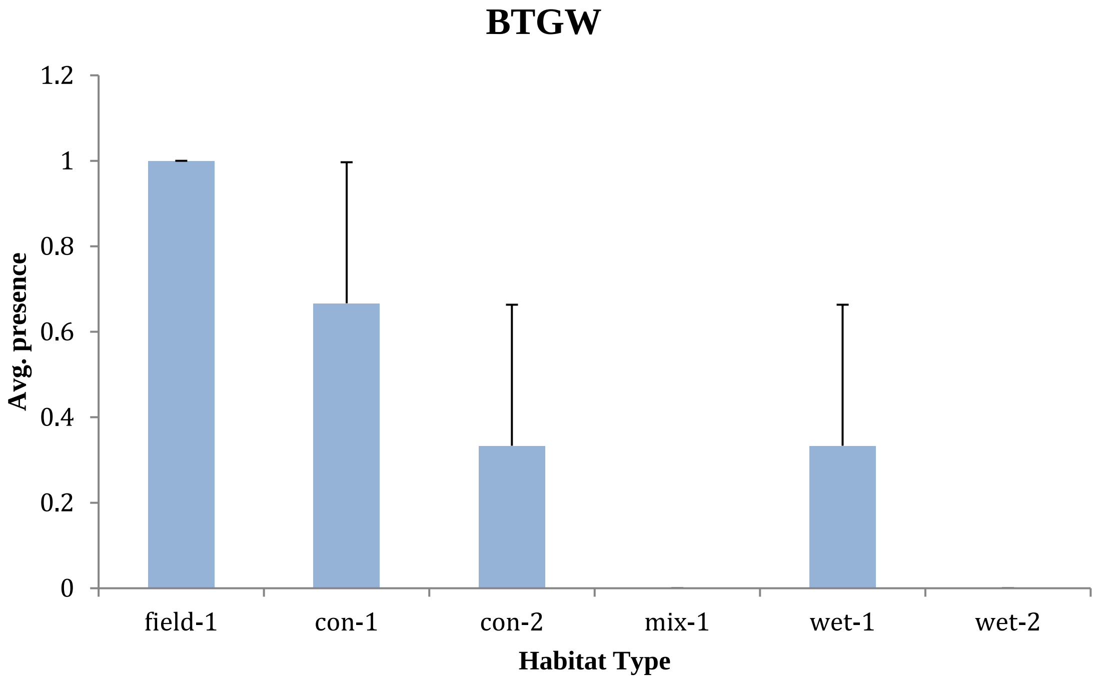

Figure 4. Average presence/absence of BTGW in each habitat type.

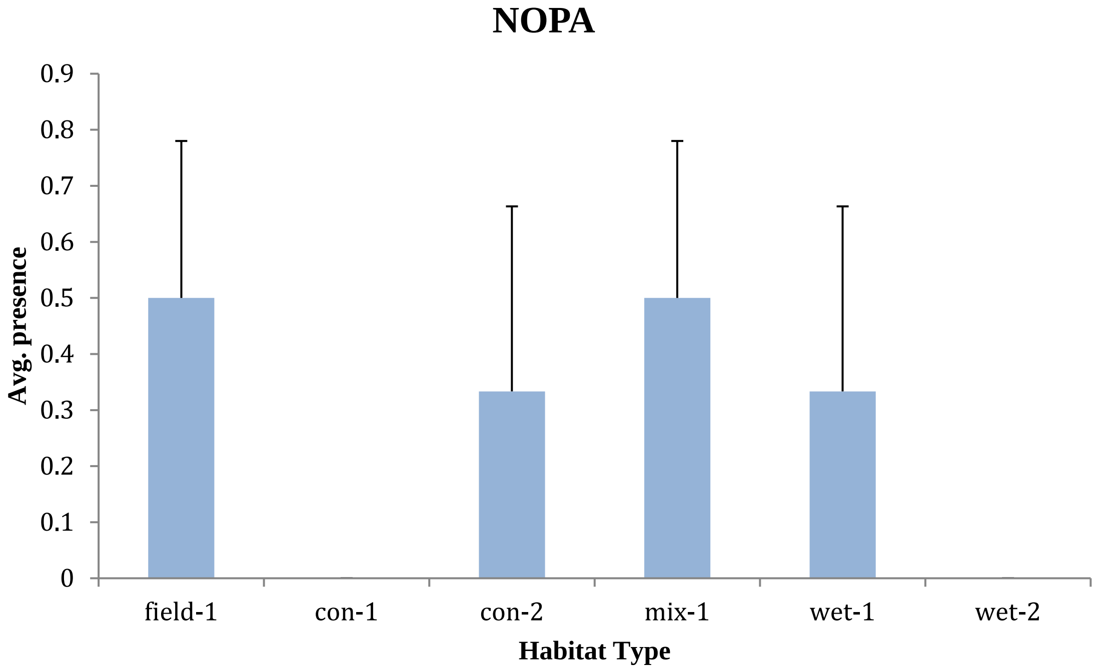

Figure 5. Average presence/absence of NOPA in each habitat type.

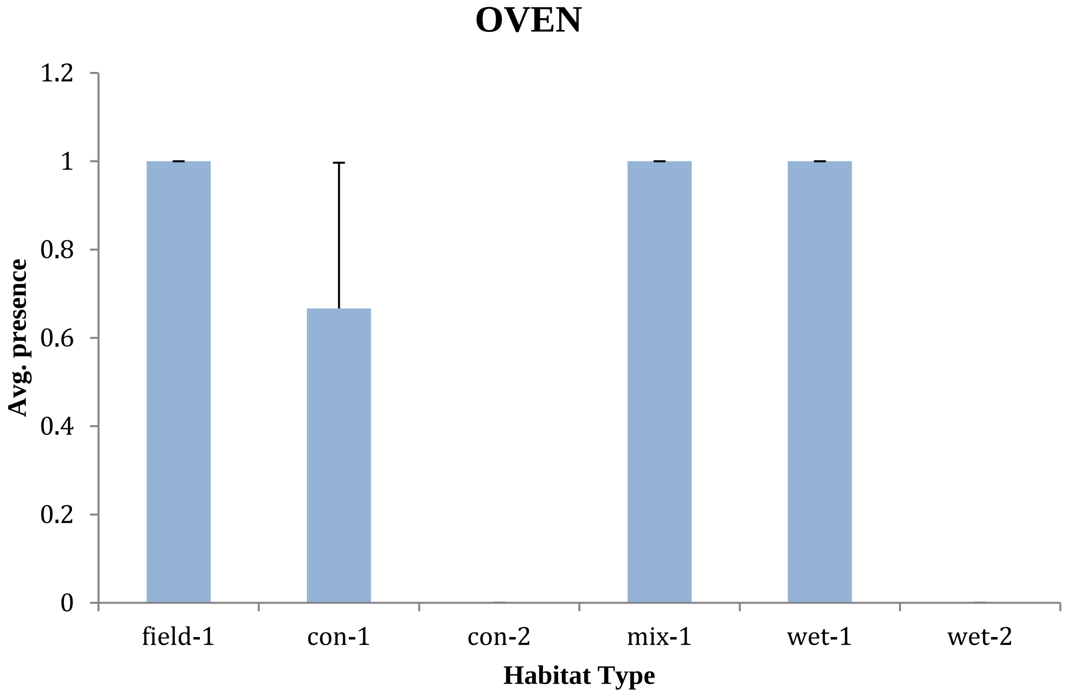

Figure 6. Average presence/absence of OVEN in each habitat type.

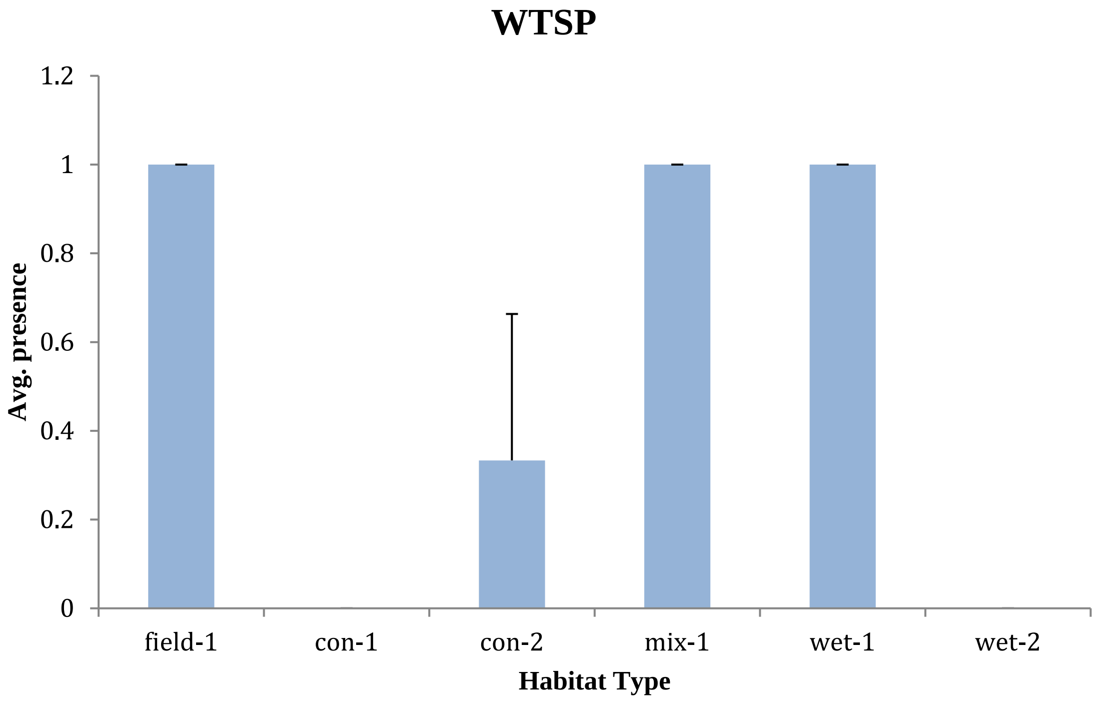

Figure 7. Average presence/absence of WTSP in each habitat type.