2003

Methods for Surveying Waterfowl

by

Joshua Ver Hague

In requirement for Biology 523 – Conservation Biology
Internship with Erie National Wildlife Refuge

Dr. Scott Wissinger, Allegheny College
Jeff Haas, ENWR Manager
Norma Kline, ENWR Wildlife Biologist

Table of Contents

Introduction

The first thought associated with birds is certainly their aesthetic value. Birds provide natural beauty with extreme and exotic colors for humans who enjoy watching them in their natural habitats (Grondahl 1999). Apart from their natural beauty, birds provide certain functions necessary for the survival of an ecosystem. For example, songbird act as hosts for parasites, consume varieties of food (including plant seeds, which are carried and distributed in new locations), and in return serve as food for others (Payne, 1992). Having this understanding of their ecosystem functions, birds become indicators of water quality and represent an ideal measure for biodiversity (Weller 1999). This is why the United States Fish and Wildlife Service (USFWS) manage National Wildlife Refuges for the habitat specific grouping of wildlife known as, wetland birds. "**Wetland birds**...provide a habitat focus that considers birds adapted to a wide range of relatively shallow waters through to those in wet-soil habitats (Weller 1999)." In the book, *Wetland Birds: Habitat Resources and Conservation Implications*, Weller (1999) further categorizes wetland birds as:

> "...**waterbirds**...various groups, commonly identified by habitat- or resources-related descriptors: divers (especially loons), waterfowl (wildfowl in Europe, but also used broadly like waterbirds), waders (herons in Europe), shorebirds (waders in Europe), littoral or water-edge birds, aquatic birds, costal birds, and estuarine birds (Weller 1999)."

Wetland conservation efforts have increased for two reasons. First, such habitats support a wide range of wildlife, either game (increase economic value) or non-game

species. Secondly, their losses have been so numerous. Over the last 200 years, the United States has lost 53% of its wetlands because of anthropogenic impacts (Mitchell 1992). Around 80% of the lost wetlands, were cleared, dredged, tiled or drained for agricultural purposes (Out of the Muck of Bays 1994). In recent years, increased research of wetland habitats has equipped the scientific world with a better understanding of its overall ecosystem dynamics.

Few studies connect wetland resources thought to be important for birds and bird use (ex. food and nesting cover provided from wetlands). Chapter ten of Wissinger et al. (2001) describe the restoration process of Partners For Wildlife (PFW) through USFWS. One of the main focal points of "PFW is restoration for non-game and game wildlife, particularly wetland associated birds." Wetland habitats in this scenario were evaluated for suitability by comparing invertebrate and seed biomass.

From September 10, 2002 to March 14, 2003, seed and invertebrate biomass of three wetland habitats were assessed at Erie National Wildlife Refuge (ENWR) (VerHague 2003). The habitats included three Moist-Soil Units (MSU 1,2 & 3), three permanent wetlands (Henslow NW, NE & S), and three autumnal wetlands (McFadden Cattail, Middle, Back). The purpose of this internship is to connect the measured seed and invertebrate biomasses with actual pre-nesting – nesting waterfowl use of the habitats. I will test the hypothesis that increased resources (seed and invertebrate) lead to an increase in waterbird use of a particular wetland habitat. Because of their management control, I predict that the MSU's (1,2 & 3) will support the greatest number of waterbirds.

Common Waterfowl Survey Methods

Hunting

Through the sales of federal duck stamps, special use permits and equipment, hunters are the number one supporters of waterfowl conservation. Each year the number of waterfowl hunters can be calculated with the purchase of the waterfowl stamp. From these data active hunters, hunting trips, and the harvest of ducks, gees and coots is provided by nation, flyways and states. If harvested information from bird bands are not enough, every year random post office and refuges that sell stamps hand out postcards to buyers. Hunters are asked to properly fill out the post cards and return them after the season is over. Furthermore, about 20,000 successful hunters from previous years survey are asked to send in duck wings and goose tail feathers from each bird that they bag. Age, species and health of area populations can be determined simply from wing and tail feathers. The number one problem with this method is getting a response from active hunters (all information from Harvest Information 1995).

Merendino *et al* (1992) partitioned a hunting area into 0.8 x 0.8-km blocks of habitat. They request a wing from each duck harvest during the hunting season. Species, sex, age and kill location provided an index of wetland quality for Canadian habitats. Overall, unless game officials walk from one duck blind to the next, full harvest response will never be met.

Trapping and Tracking

An easy method to initiate radio tracking is to trap wild waterfowl. Each year, Ducks Unlimited traps 60 mallard hens at a limited number of sites. A live decoy hen

swims inside the center chamber of a trap. Three enclosed compartments surround the decoy, each one having its own trap door mechanism. "When a pair is seen on a wetland for a couple of days, it indicates they have established a territory." At this point a dominant hen will fend off any intruder from the pairs territory. Thus, seeing a live female decoy will stimulate her to attack and defend her territory. Once trapped, surgery is conducted and transmitter is put in place. The hen is then monitored every day until her eggs hatch and then every 7 days until brood is 45 days old (based from Trapping and Tracking 2002).

Aerial

The easiest way to assess large waterfowl population numbers over vast areas is through aerial surveys (Prenzlow & Lovvorn 1996). Small airplanes (Piper Cup Aircraft or Cessna 172) or helicopters are often the means to conduct such a survey (Madsen 1998; Cordts *et al* 2002; Rempel *et al* 1997). However, more times than not, ground surveys are still needed for "truthing" purposes (Prenzlow and Lovvorn 1996).

Cordts *et al* 2002 compared ground versus helicopter counts. They "recorded similar numbers of breeding pairs of mallards and wood ducks each year, but helicopter produced higher counts for blue-winged teal and other late-nesting species in 1997." Possible differences in number for late nesting birds, most likely is related to temporal changes in pair numbers during migration and not counting faults. Additionally, visibility concerns were addressed by conducting a survey of both methods at same time and biases seemed minimal.

Prenzlow and Lovvorn (1996) stated, "Aerial Surveys to estimate the size of wildlife populations invariably contain visibility biases because some proportion of

animals are not seen by aerial observers." Ground counts (drove, walked or canoed) were still needed the day before up two days after aerial counts for "truthing" purposes. Cordts *et al* 2002 found costs for each survey (helicopter vs. ground) to be similar. Yet, Prenzlow and Lovvorn (1997) need to "redesigned to concentrate on areas of high waterfowl density and to resemble more closely the continental waterfowl survey in terms of design, procedures and estimates of precision."

Madsen (1998) tested human disturbances (fishing, sailing, windsurfing, and waterfowl hunting) on autumn-staging waterbirds in coastal wetlands. Ironically, Madsen expressed the difficulty of counting flushed flocks of waterfowl as well as double counting birds while using a Piper Cup Aircraft or Cessna 172. Twenty-one aerial trips were conducted to 'mass' count waterfowl, again ground surveys were conducted weekly from elevated points and observation towers (4m above the water).

Erwin *et al* (1991) studied the relative influence of migratory bird use with Open Marsh Water Management (OMWM). Eleven aerial surveys with Cessna 182 (fall and winter) were needed to run transects. Prior to aerial surveying, pipes were pounded into the ground around ponds for proper identification. Ground surveys were still needed for vegetation and pond status.

Overall, if Cordts *et al* 2002 found costs for each survey (helicopter vs. ground) to be similar. Why not always conduct ground counts? The answer to this question is difficult to a certain extent. Using 400m (aerial) wide transects would take a long time to be further broken down by humans, and would take even more time to walk. However, the efficiency level seems to fall with the use of aerial techniques.

Ground Counts

Cashen and Brittingham (1998) used modified line-transects (Burnham et al 1981), modified point counts (Verner and Ritter 1985), and playback recordings (Manci and Rusch 1988) in one study of waterfowl use of restored wetlands. Each site was monitored three times during breeding season (mid May to July), five times during fall migration (August to November), five times during spring migration (mid March to mid May).

To obtain maximum visibility, Grover and Baldassarre (1995) placed four points (two interior and two boundary) equidistant around the perimeter of each wetland. If the wetland was too small, two interior points were placed within 10-25m of the wetland boundary. "Wetland boundaries were defined by the presence of hydrophytic vegetation and hydrology (*see* Tiner, 1984)" within 5m from waters edge. Then a 20-minute count at each point was performed. Only birds seen or heard inside the wetland boundary were recorded as using the wetland. Any birds flying over wetland were counted if they were flying tree height or lower. Also, any birds flushed upon entry were quickly identified and counted. During the last five minutes of each count, a recording of rails and bitterns was played to prompt a response. Each wetland was sampled twice: 1) beginning a half and hour before sunrise and ending three and a half hours after sunrise. 2) starting three and half-hours before sunset and ending a half-hours after sunset.

Five times during breeding season, between sunrise and nine a.m., VanRees-Seiwert and Dinsmore (1996) establish three observation plots in each wetland. This included one random compass bearing, with the other two an equidistant from the first. During a six minute counting period, a census of birds was taken within a 20m radius of

each plot was identified. Halfway through (the third minute) a 30 second tape recording was introduced to excite bird. The wetland and 30m of the surrounding uplands were searched for nests five times during the breeding season. Any species of an active nest which was found, a flightless brood was seen or that were present 3-5 visits was regarded as breeding.

Diefenbach and Owen (1989) introduced the use of tree platforms in or on the edge of wetlands because of the extremely tense black duck. All wetlands in their study were visited within four hours after sunrise. If the wetland was greater than 10 hectares, it was observed for two hours, smaller wetlands received a shorter observation period proportionally to its size. Since larger wetlands are hard to view, Diefenbach and Owen compensated by viewing for a longer amount of time to cover all bases.

The significance of this study was a single-observer used binoculars or a spotting scope to identify birds (Twedt et al 1998). Each field was observed for 5-30 minutes, twice during each of nine consecutive two-week periods. Contrary to a single observer, six observers (all >5 years experience) conducted limited-radius point counts (*see* Ralph *et al* 1993) for three morning and one evening in this study. Desrochers *et al* (1998) would not survey in weather with strong winds because of possible sampling error due to undetectable birds.

Vehicle Counts

To speed up a particular ground count, a vehicle is often used. Weller *et al* (1996) sat in a vehicle from elevated impoundment roads, which surrounds the studied wetland. Their particular interest was waterbirds use of vegetation zones found within each

wetland. The use of a vehicle decreased their walking time to particular point used for surveying, but created a bias against that preferred dense cover.

Hands *et al* (1991) counted shorebirds by vehicle on survey routes during the summer and fall. Interestingly, spring surveying was performed with a vehicle and on foot. In this situation, walking and using a vehicle showed no bias for shorebirds that like dense cover. Hands *et al* also expressed that equal hours of daylight must be adjusted for every sampling period. This would allow for an addition of no biased opinions in surveying.

The use of vehicles extends to Weber and Haig (1996) viewing waterfowl from raised dikes around managed wetlands. They also surveyed from a tower and a sand dune to observe habitats inaccessible by vehicle. Since this study identified shorebirds, surveying within two hours of high tide was absolutely necessary.

Blinds

Blinds are an alteration to ground counts that decrease the chance of waterfowl detecting an observer during crucial surveying periods. Gammonley and Heitmeyer (1990) observed ducks during all daylight hours and recorded their activity using scan-sampling techniques (*see* Altmann 1974). Fairbairn and Dinsmore (2001) followed the spring pair count protocol of the USFWS (1987) and surveyed each wetland complex only once during their study. Prior to entering the wetland, open water was observed from a vantage point to identify any waterbirds before flushing them. Predetermined blinds were used to play recording of calls to stimulate activity; one blind for wetlands <0.4ha, 2 blinds for any wetlands between 0.4-1.0.

Point Counts

Madsen (1998) identified ground counts to monitor in a more detailed fashion. The study included waterbird numbers and their distribution in response to human activities. By "using telescopes from elevated points in the terrain or from observations towers," Madsen set up transects by placing posts in the ground where it was necessary. Surveys were conducted mostly during mornings and weekdays in order to, "take into account diurnal or weekly variations in bird distributions and human activities, but rather the index of numbers and distributions." The most interesting point from the article was, "waterfowl hunting caused a displacement of quarry species, resulting in a species-poor waterfowl community."

USFWS Protocols

The USFWS performs numerous protocol surveys, that very from region to region. Here are just a few examples and their relation to primary literature. In Breeding Waterfowl Habitats Conditions (1995), the USFWS is trying to obtain data on wetland habitats and their conditions for broods. During the month of May (1995), aerial surveys take place "along each transect at the same time observers are recording waterfowl and brood information." This study was limited to May through June, because ground counts could not be done.

Waterfowl Population Status and Trends also introduced in 1995, considered biases with aerial surveys. From May till early June (1995) a subset of transects (71,100km broken into 50 strata – geographic regions) was surveyed by aerial and ground crews to understand Visibility Correction Factor (VCF). Being able to recognize VCF has increased the accuracy of an aerial census.

Anderson (2000) studied water drawdowns and how it impacts invertebrates, vegetative composition and seed availability for waterfowl use. The method for surveying waterfowl the use of a blind, with one to two man teams present with binoculars (to avoid any bias – if present). Cooperrider *et al* (1986) described some of the recommendations made by Dzubin (1969). They include, surveying from a vehicle at a vantage point. Census should start at 8:00 a.m. and end at 12:00 p.m. and take place during the height of the breeding period, where lone drakes and breeding pairs are easily identified. Surprisingly, Cooperrider recommends to "census only on bright days with temperatures above 4°C and winds less than 24 km/h." I must note, that the extent and continuance of USFWS waterfowl surveying over the years, has influenced numerous management and conservation plans.

Applications of Methods

It is obvious I will not be conducting an aerial survey. The *Fund of '39* was generous enough, but not to that extent. To engage in such a method would probably not even be suitable for all of ENWR – considering the limited numbers of large bodies of water. Since it is the spring, the use of hunting is illegal and does not pertain to the specifics of this research. Traps and tracking are also ruled out, because they demand specific attention that I do not have. However, ground counts are plausible to the specific survey methods developed for this study.

Surveying will be conducted mostly during mornings and weekdays and will begin March 31, 2003 and end April 30, 2003. This time span covers five weeks; surveying will be conducted at a minimum of 10 times (2 per week) or 15 times (3 times

a week). Hands *et al* (1991) expressed that equal hours of daylight must be adjusted for every sampling period. I will begin a half hour before sunrise and will survey no later than 8:00 a.m. If sunset is the time decided for surverying, time will be adjusted for that day so equal time will be given. An example, if on April 4th, I decide to conduct a sunset survey, the earliest I can start is 3:48 p.m. and I must finish at 7:19 p.m. A rotation of surveying times will be conducted to control for the time of day (ex. Day 1 - MSU 1-3, McFadden Cattail – Back, Henslow NW – S; Day 2 Henslow NW – S, MSU 1-3, McFadden Cattail – Back; *etc.*)

The main portion of surveying will conducted while walking and standing. Before encompassing the wetland, open water must be observed from a vantage point to identify any birds that could be flushed (Fairbairn and Dinsmore 2001). I will be using binoculars (Twedt et al 1998) and a field guide to eastern United States birds to help identify any and all species. The "Wetland boundaries or edge is defined by the presence of hydrophytic vegetation and hydrology" (*see* Tiner, 1984) within 5m from waters edge. Only birds seen or heard inside the wetland boundary will be recorded as using the wetland. Any birds flying over the wetland will be counted if they are flying tree height or lower (Grover and Baldassarre 1995). Also, any birds flushed upon entry will be quickly identified and counted (Grover and Baldassarre 1995). A perimeter count must also be conducted. Time is important, so every perimeter count will be timed to adjust for flushed birds per minute. Standardizing the perimeter count ensures equal birds found no matter the size of the wetland.

Each wetland will be observed for 5-10 minutes, during each survey over the five-week period (Verner and Ritter 1985). Any species of an active nest which was found, a

flightless brood was seen or that were present 3-5 visits will be regarded as breeding (VanRees-Seiwert and Dinsmore 1996). The wetland and 10m of the surrounding uplands will also be searched for nests (VanRees-Seiwert and Dinsmore1996). A Overall, there should be no biased opinions in surveying.

Protocol:

1.) *Surveying Pattern*

a. standarize time - equal hours of assessment must be adjusted for every sampling period (ex. more likely to see birds at 7a.m. than 8 a.m.) (Hands *et al* 1991)
b. rotation of sampling – the order that wetlands are sampled must be random with respect to time (ex. Day 1; Henslow NW – McFadden Back, Day 2; MSU 3 – Henslow S etc.)

2.) *Point Count*

a. vantage point – entire pond can be observed (Fairbairn and Dinsmore 2001)
b. single-observer will use binoculars (Twedt *et al* 1998)
c. 5 minutes – standardized time that will be used for each wetland (Grover and Baldassarre 1995)
d. birds flying over wetland – will count if they fly tree height or lower (Grover and Baldassarre 1995)

3.) *Perimeter Count*

a. "Wetland boundaries or edge is defined by the presence of hydrophytic vegetation," (*see* Tiner, 1984) within 5m from waters edge.
b. perimeter – survey the habitats by walking (normal pace) the entire perimeter
c. flushed birds - any birds flushed upon entry will be quickly identified and counted (Grover and Baldassarre 1995)
d. breeding pairs - Any species of an active nest, a flightless brood or present 3-5 visits will be regarded as breeding (Seiwert and Dinsmore 1996)
e. birds flying over wetland – will count if they fly tree height or lower (Grover and Baldassarre 1995)
f. timed – each perimeter count will be timed to standardized any differences in wetland size (ex. Henslow S - 15 birds/15 minute walk vs. McFadden Back 3 birds/3 minute walk).

Note:
Desrochers *et al* (1998) would not survey in weather with strong winds because of possible sampling error due to undetectability. However, because of time constraints (March 31 – April 30), I will survey during all weather conditions

4.) *Data Sheet* – initially categories (dabbling ducks, diving ducks, wading birds, songbirds) to fill in species. Based on early surveys, I will make a more complete data sheet so that I can simply checkmark and record the number observed beside each species.

Habitat:_____ **Weather:**_____
Survey Date:_____ _____
Starting Time:_____
Ending Time:_____
Perimeter Time:_____

Category	# Obs.	# Flushed	Total # Counted	# Nest's	Notes
Dabblers					
W. Duck					
B.W. Teal					
G.W. Teal					
Mallard					
Divers					
H. Merganser					
Buffalohead					
Scaup					
Ring-neck					
Waders					
G.B. Heron					
Snipe					
Songbirds					
R.W. B.B					
Song Sparrow					
Tree Swallow					
E. Bluebird					
Cardinal					
House Finch					
Canada Goose					

Results

The relationship between total birds and wetland type was found to be significant. Permanent habitats (Henslow NW, NE & S) supported the highest number of birds throughout the study (**Fig. 1** - one-way ANOVA; $F_{2, 105} = 6.446$; $p = 0.002$). The group of Henslow NW, NE & S also supported the highest number of waterfowl (**Fig. 2** - one-way ANOVA; $F_{2, 105} = 5.366$; $p = 0.006$). However, no significance was found for Duck usage of the three habitats (**Fig. 3** - one-way ANOVA; $F_{2, 105} = 0.423$; $p = 0.656$).

Non-waterfowl use was also found to be insignificant among the habitats (**Fig. 4** - one-way ANOVA; $F_{2, 105} = 2.348$; $p = 0.101$). Redwing blackbird (*Agelaius phoeniceus*) utility of the varying wetlands was insignificant (**Fig. 5** - one-way ANOVA; $F_{2, 105} = 2.125$; $p = 0.125$). A significant result was found between song sparrow (*Melospiza melodia*) use and wetland type (**Fig. 6** - one-way ANOVA; $F_{2, 105} = 5.762$; $p = 0.004$). Overall, a significant result was found between number of nests found and wetland habitat (**Fig. 7** - one-way ANOVA; $F_{2, 105} = 9.554$; $p = 0.0002$). A chi-squared test showed no significance between observed breeding activity and wetland type ($\chi^2 = 1.31$; $p > 0.05$).

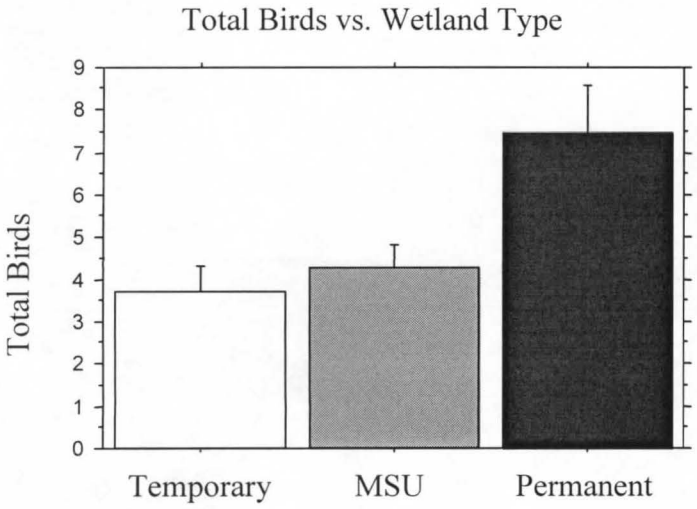

Fig. 1 – A mean of total birds observed among the three wetland habitats. Symbols indicate the mean ± 1 SE.

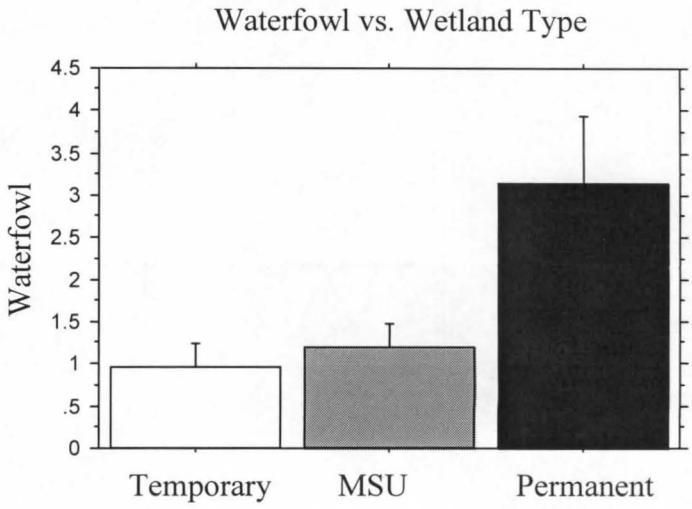

Fig. 2 – The number of waterfowl was compared against wetland type. Symbols indicate the mean ± 1 SE.

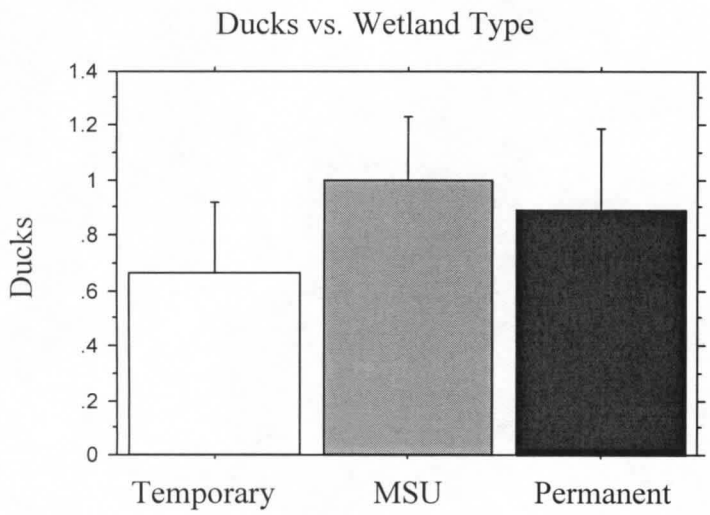

Fig. 3 – The total number of ducks observed was found to be insignificant among habitats. Symbols indicate the mean ± 1 SE.

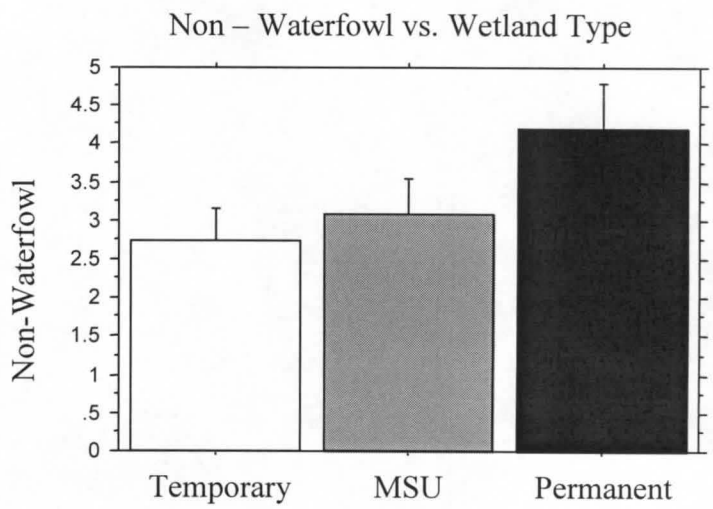

Fig. 4 – Non-waterfowl (primarily songbirds) use of different habitats did not result in significance. Symbols indicate the mean ± 1 SE.

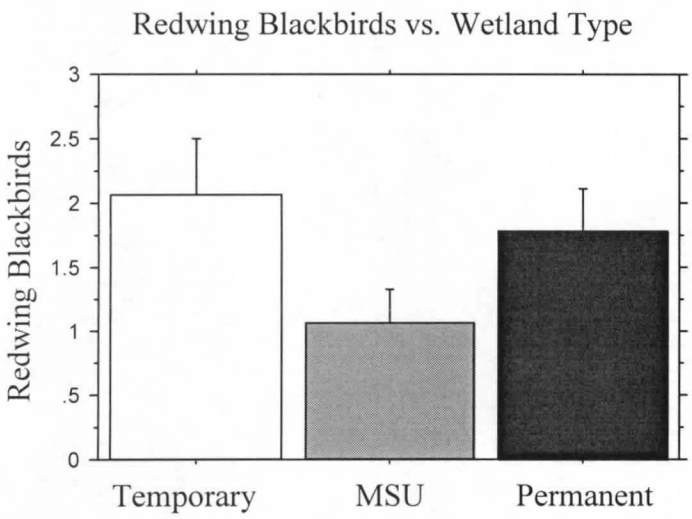

Fig. 5 – Redwing Blackbirds (*Agelaius phoeniceus)* Displayed no significance in choice of wetland. Symbols indicate the mean ± 1 SE.

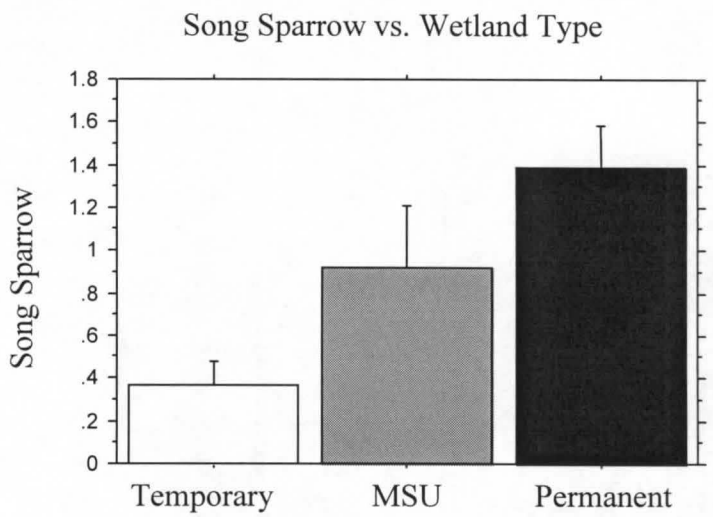

Fig. 6 – Song Sparrow's (*Melospiza melodia*) showed significance towards permanent wetlands. Symbols indicate the mean ± 1 SE.

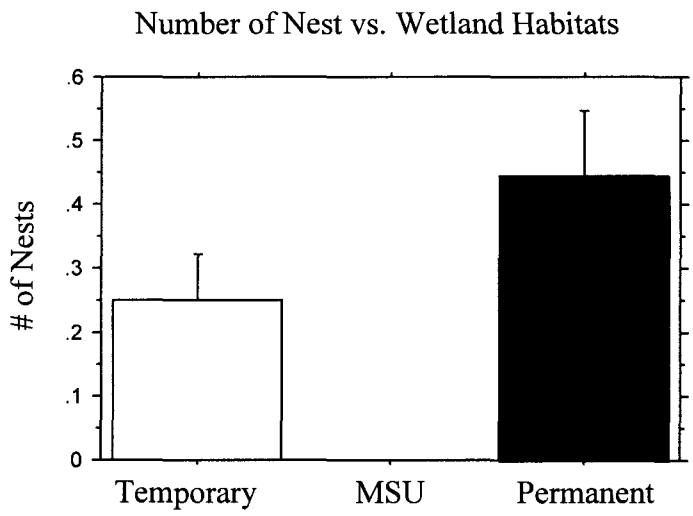

Fig. 7 – The number of nests found showed significance among habitats. Symbols indicate the mean ± 1 SE.

Discussion

The hypothesis in this study was not supported. Total bird use was found to be significantly highest within the permanent habitats (**Fig. 1**; Henslow NW, NE & S). Furthermore, waterfowl (ducks, geese etc.) was significantly largest in regard to permanent habitats (**Fig. 2**). Separating ducks and geese use showed very interesting results. **Fig. 3** represents the duck use of the three-wetland types. Without geese (*Branta Canadensis)* present, waterfowl numbers would not be significant.

Total non-waterfowl numbers showed no significance among the habitats, including redwinged blackbirds *(A. phoeniceus)* (**Fig. 4** & **Fig. 5**). However, song sparrow's (*M. melodia*) showed significance towards permanent habitats (**Fig. 6**). Throughout the study (April 2003), breeding activity and nesting activity was observed and recorded. No nests were found in or around the MSUs (**Table 1**), and high

significance was found between the number of nest and wetland habitats (**Fig. 7**). A chi-squared test showed no significance of observed breeding activity in any wetland.

It is recommended that MSUs be mowed, disced or burned every three to five years (Ver Hague 2003). If one of the three occurred, another study should replicate this survey through the succession cycle. Increased resources (seed and invertebrate) should lead to an increase in waterbird use of MSU habitats. Because of management control, MSU's (1,2 & 3) can support the greatest number of waterbirds any time of the year.

Literature Cited

Anderson, J.T. 2000. Integrated Wetland Management for Shorebirds and Wintering Waterfowl on Region 5 National Wildlife Refuges: Year 2. Region 5 USFWS

Breeding Waterfowl Habitats Conditions.1995.http://policy.fws.gov/722fw3.html. Breeding Waterfowl Habitat Conditions. Migratory Bird Surveys. Office of Migratory Bird Management. Ch. 3

Cashen, S.T. and M.C. Brittingham 1998. Avian Use of Restored Wetlands in Pennsylvania. Final Repot to *The Pennsylvania Game Commission*. Contract Number ME239501

Cooperrider, A.Y., R.J. Boyd and H.R. Stuart. 1986. Inventory and Monitoring of Wildlife Habitat. U.S. Department of Interior. Ch. 18

Cordts, S.D., G.G. Zenner and R.R. Koford. 2002. Comparison of Helicopter and Ground Counts for Waterfowl in Iowa. Wildlife Society Bulletin. 30:317-326

Desrochers, A., L. Rochefort and J.L. Savard. 1998. Avian Recolonization of Easter Canadian Bogs After Peat Mining. Canadian Journal of Zoology. 76:989-997

Diefenbach, D.R. and R.B. Owen. 1989. A Model of Habitat Use by Breeding American Black Ducks. Journal of Wildlife Management. 53:383-389

Erwin, R.M, D.K. Dawson, D.B. Stotts, L.S. McAllister, and P.H. Geissler. 1991. Open Marsh Management in the Mid-Atlantic Region: Aerial Surveys of Waterbird Use. Wetlands. 11:209-228

Fairbairn, S.E. and J.J. Dinsmore. 2001. Local and Landscape-level Influences on Wetland Bird Communities of the Prairie Pothole Region of Iowa, USA. Wetlands. 21:41-47

Gammonley, J.H. and M.E. Heitmeyer. 1990. Behavior, Body Condition, and Foods of Buffleheads and Lesser Scaups During Spring Migration Through the Klamath Basin, California. Wilson Bulletin. 102:672-683.

Grondahl, Chris. 1999. Attracting Wildlife to Your Back Yard: A Guide to Increasing Wildlife Diversity and Aesthetic Value Around Your Home. North Dakota Game & Fish Department Nongame and Watchable Wildlife Program. 46 pages. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. (Version 16SEP99). http://www.npwrc.usgs.gov/resource/1999/wildback/wildback.htm

Grover, A.M. and G.A. Baldassarre. 1995. Bird Species Richness within Beaver Ponds in South-Central New York. Wetlands. 15:108-118

Hands, H.M., M.R. Ryan and J. W. Smith. 1991. Migrant Shorebird Use of Marsh, Moist-Soil, and Flooded Agricultural Habitats. Wildlife Society Bulletin. 19:457-464

Harvest Information 1995. http://policy.fws.gov/722fw4.html. Harvest Information. Migratory Bird Surveys. Office of Migratory Bird Management. Ch. 4

Madsen, J. 1998. Experimental Refuges for Migratory Waterfowl in Danish Wetlands. I. Baseline Assessment of the Disturbance Effects of Recreational Activities. Journal of Applied Ecology. 35:386-397

Merendino, M.T., D.G. Dennis and C.D. Ankney. 1992. Mallard Harvest Data: An Index of Wetland Quality for Breeding Waterfowl. Wildlife Society Bulletin. 20:171-175

Mitchell, J.G. 1992. Our Disappearing Wetlands. National Geographic. Oct., p.12-45

Out of the Muck of Bays. 1994. American Horticulturalist. May, p.10

Payne, R. 1992. *The Birds of North America*. A. Poole, P. Stettenheim and F. Gill, Editors

Prenzlow, D. M. and J.R. Lovvorn. 1996. Evaluation of Visibility Correction Factors For Waterfowl Surveys in Wyoming. Journal of Wildlife Management. 60:286-297

Prenzlow, D. M. and J.R. Lovvorn. 1997. Design and Results of a Waterfowl Breeding Population Survey for Whyoming. Journal of Wildlife Management. 61:758-767

Rader, R.R., D.P. Batzer, and S.A. Wissinger (eds). 2001. *Bioassessment and Management of North American Freshwater Wetlands. John Wiley & Sons,* New York, USA

Rempel, R.S., K.F. Abraham, T.R. Gadawski, S. Gabor and R.K. Ross. 1997. A Simple Wetland Habitat Classification for Boreal Forested Waterfowl. Journal of Wildlife Management. 61:746-757

Trapping and Tracking 2002. http://www.ducks.org/conservation/fieldmethods.asp Trapping and Tracking Methods. Ducks Unlimited Webpage. Conservation Section

Twedt, D.J., C.O. Nelms, V.E. Rettig and S.R. Aycock. 1998 Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. American Midland Naturalist. 140:140-152

VanRees-Seiwert, K.L. and J.J. Dinsmore. 1996. Influence of Wetland Age on Bird use of Restored Wetlands in Iowa. Wetlands. 16:577-582

Ver Hague, J.P. 2003. Invertebrate and Seed Biomass of Wetland Habitats Managed for Waterfowl at Erie National Wildlife Refuge. Senior Thesis. Allegheny College.

Waterfowl Population Status and Trends.1995. http://policy.fws.gov/722fw2.html. Waterfowl Population Status and Trends. Migratory Bird Surveys. Office of Migratory Bird Management. Ch.2

Weber, L.M. and S.M. Haig. 1996. Shorebird Use of South Carolina Managed and Natural Coastal Wetlands. Journal of Wildlife Management. 60:73-82

Weller, M.W., E.H. Smith and R.M. Taylor. 1996. Waterbird Utilization of a Freshwater Impoundment on a Coastal Texas Wildlife Refuge. Texas Journal of Science. 48:319-328

Weller, M.W. 1999 *Wetland Birds*. Cambridge, U.K., Cambridge University Press.

Wissinger, S.A., Ingmire, S.G. and Bogo, J.L. 2001. Plant and Invertebrate Communities as Indicators of Success for Wetlands Restored for Wildlife. Pages 207 – 236 *in* R.B. Rader, D. P. Batzer, S A. Wissinger (eds.) Bioassessment and Management of North American Freshwater Wetlands. Wiley, New York.