Implementation of a National Marshbird Monitoring Program: Using Wisconsin as a Test of Program Study Design

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Background and Objectives

Largely because of their secretive behavior and difficult-to-access habitats, marshbirds such as rails, bitterns, coots, and grebes are among the most poorly monitored bird groups in North America. Yet many species are of high conservation concern (e.g. American Bittern, King Rail, Yellow Rail), some are harvested (e.g. Sora, Virginia Rail, Wilson's Snipe), and most are thought to be excellent indicators of wetland ecosystem quality (Conway 2009). Hence more information on their population status, trends, and habitat associations is greatly needed.

Marshbird monitoring has received greater attention in the past decade but most work has focused on standardization of survey protocols, often in the context of national wildlife refuges or other localized management units (Conway 2009). However, the U.S. Fish & Wildlife Service's Division of Migratory Bird Management in Patuxent, Maryland, recently initiated a surge toward a national marshbird monitoring program, with hopes of establishing a study design and sampling framework that can be used on state, regional, and national scales (Johnson et al. 2009). The primary objectives of the national program are to: (1) estimate population trends for conservation planning; (2) provide status data, especially for harvested species; and (3) collect ancillary habitat data to inform habitat management decisions at multiple scales.

In 2008, Wisconsin became the first state to pilot implementation of the national marshbird monitoring program through coordination efforts of the Wisconsin Bird Conservation Initiative (http://www.wisconsinbirds.org/) and Wisconsin Department of Natural Resources. The goals of the pilot study are to: (1) shape study design of the national program (e.g. provide estimates of detection probability and occupancy, determine number of survey sites required for desired power, and assess utility of WWI/NWI maps for site selection); (2) inform coordination/implementation efforts (e.g. state and regional coordination needs, how surveyors and volunteers are recruited, operating costs, and reliability of volunteer bird surveyors); (3) provide baseline data on detectability, occupancy, abundance, and habitats of Wisconsin's marshbirds; and (4) establish the foundation for an annual, long-term marshbird monitoring program in Wisconsin.

Methods

Study Design

Details of the general sampling design framework can be found in Johnson et al. (2009). In Wisconsin, we defined the sampling frame as all wetlands in the state that could potentially have marshbirds. We identified these from digital layers of the Wisconsin Wetland Inventory (WWI; http://dnr.wi.gov/wetlands/inventory.html) using the following classes: (1) aquatic bed, (2) emergent/wet

meadow, and (3) shrub/scrub ONLY when interspersed with emergent/wet meadow. Wetlands were divided into two strata, including (1) discrete wetlands ≤3 ha in size, and (2) extensive wetlands >3 ha. Survey effort in each stratum was proportional to the distribution of the wetland type within each primary sampling unit (Johnson et al. 2009).

We selected survey sites using two-stage cluster sampling via a Generalized Random Tessellation Stratified procedure (GRTS). The larger sample units, known as Primary Sampling Units (PSUs), were 40 km^2 hexagons that may be thought of as "routes." PSUs were first selected irrespective of habitat via GRTS from a hexagonal grid that uniformly covered the entire state (Figure 1). Individual survey points, known as Secondary Sampling Units (SSUs), were then selected via GRTS in defined marshbird habitat within each PSU (Figure 2). This procedure yielded a spatially-balanced, random selection of survey points statewide but clustered points to improve logistical efficiency. Such a habitat-based, probabilistic design allows for broad statistical inference on the state scale and is perhaps the most innovative aspect of this pilot study.

We then analyzed PSUs and SSUs in the order selected to assess their suitability for the survey. This involved remote assessment using aerial photographs and on-site groundtruthing in the field. Selected SSUs were excluded if they had inappropriate habitat (i.e. no longer a wetland, succeeded to shrub/scrub, too dry, etc.) or were too difficult to access (i.e. bordered by impenetrable habitat and/or greater than ~400 meters from any road/trail access). We allowed SSUs to be moved up to 150 meters from their original location to achieve suitability (but not simply to be in "better" habitat). Selected PSUs were excluded if they had less than five suitable SSUs to be surveyed.

This time-intensive groundtruthing process resulted in a route of five to ten suitable SSUs occurring randomly within each PSU (Figure 3). PSUs generally included a mix of roadside and off-road points, and each SSU was at least 375 meters from adjacent points. Many SSUs occurred on wetland edges and were surveyed on foot by land, but some penetrated wetland interiors and/or were surveyed by boat. To facilitate implementation of the pilot study, we focused surveys on public lands in 2008 and 2009 but some private lands were surveyed using roadside points.

Target Species

Primary target species in this survey included Yellow, Sora, Virginia, and King Rails, Least and American Bitterns, American Coot, Common Moorhen, Pied-billed Grebe, and Wilson's Snipe (moved from secondary list in 2008 to primary in 2009). Secondary target species were Red-necked Grebe, Black and Forster's Terns, Marsh and Sedge Wrens (the latter added in 2009), Swamp and Le Conte's Sparrows, Yellow-headed Blackbird, and Sandhill Crane (added in 2009). We selected these secondary species because they also occupy the wetland habitats to be surveyed, may be poorly monitored by existing surveys, and/or are of conservation interest on state or regional levels. Surveyors did not record data on non-target species.

Survey Protocol

Observers conducted surveys at each SSU using the standardized protocol outlined by Conway (2009). This protocol describes when to visit survey points and how to conduct surveys once there. In brief, surveys at each point consisted of an initial five-minute passive listening period followed by successive one-minute segments of broadcast calls for certain target species. The broadcast sequence in this study included five or six species: Least Bittern, Yellow Rail, Sora, Virginia Rail, King Rail (southern WI only), and American Bittern. We excluded other target species because of time constraints at each survey point and previous research suggesting playback does not significantly increase their detectability (e.g. grebes, gallinules). Standardized pre-recorded calls were broadcasted with an mp3 player (Sandisk Sansa

m230) and portable folding speakers (RadioShack portable folding amplified speaker system, #40-1441) at maximum volume.

Observers surveyed each SSU two to three times annually between May 1 and June 15 in southern Wisconsin but between May 15 and June 30 in northern Wisconsin due to later phenology there (Brady 2009). Surveys were conducted either in morning 30 minutes before to three hours after sunrise or in evening three hours before to 30 minutes after sunset (Conway 2009).

Each survey had one primary observer. In this pilot study, observers included a combination of hired field technicians, biologists, and volunteers. All received training via workshops and/or electronic resources to ensure familiarity with survey protocols and identification of target species.

See Brady (2009) for more details on protocol and data recording. An example of a completed data sheet can be found at http://wiatri.net/projects/birdroutes/Docs/SampleDataSheet.pdf. Survey data were entered and stored in the Marsh Birds Population Assessment & Monitoring Project database maintained by the Patuxent Wildlife Research Center (http://www.pwrc.usgs.gov/point/mb/).

Preliminary Results and Discussion

Year One – 2008

2008 was a successful (albeit challenging!) pilot year. Three field technicians, eight biologists, and 17 volunteers surveyed 326 SSUs (points) at 53 PSUs (routes) statewide (Figure 4). Most of these points were surveyed twice between late May and mid-June while some were surveyed only once and others three times between early May and late June (Table 1). Timing of surveys did not perfectly correspond with Conway's protocol (e.g. first survey in early May, second in late May, and third in early June for southern Wisconsin) because groundtruthing took longer than expected and delayed establishment of exact survey routes.

The most commonly detected primary target species were Sora, American Bittern, and Virginia Rail (Table 1). Only small numbers of American Coot, Common Moorhen, Least Bittern, and Pied-billed Grebe were detected (Table 1). Observers also recorded four King Rails and two Yellow Rails. Number of detections was highest for most species during the first, or earliest, survey replicate. Secondary species were dominated by Swamp Sparrows and Marsh Wrens, followed by modest numbers of Black Terns and Wilson's Snipes and only a few Forster's Terns and Yellow-headed Blackbirds (Table 1).

Table 1. Numbers of individuals of target species detected during the 2008 Wisconsin Marshbird Survey.

Species	Survey 1	Survey 2	Survey 3	Total
American Bittern	48	18	0	66
American Coot	5	2	0	7
Common Moorhen	0	3	1	4
King Rail	2	2	0	4
Least Bittern	2	4	0	6
Pied-billed Grebe	13	6	1	20
Sora	74	55	4	133

Virginia Rail	31	29	9	69
Yellow Rail	2	0	0	2
Black Tern	8	39	0	47
Forster's Tern	2	6	0	8
Le Conte's Sparrow	4	4	2	10
Marsh Wren	115	97	8	220
Red-necked Grebe	0	0	0	0
Swamp Sparrow	374	384	97	855
Wilson's Snipe	23	24	4	51
Yellow-headed Blackbird	0	3	0	3
Points Surveyed	*326*	*307*	*63*	*326*
Median Survey Date	*29-May*	*15-Jun*	*26-Jun*	---

Mark Seamans (USFWS-Patuxent) developed occupancy models for the three primary target species with sufficient data and a coarse overview of these initial results is presented here for example. More detailed analyses will be performed after two to three years of data collection. For Sora, the top model indicated occupancy was positively related to the *size of the wetland* the survey point was located in (as determined by WWI) and to the *percentage of wetland* within a 100-meter radius of the survey point (as estimated by observers in the field), but negatively related to wetlands classified as *seasonally inundated* (WWI hydrological modifier = "K"). Mean SORA occupancy was 0.141 (SE = 0.040) at discrete wetlands and 0.302 (SE = 0.047) at extensive wetlands. Detection probability decreased with each visit but only slightly between surveys one and two (p = 0.589±0.078 vs. 0.507±0.077). Factors affecting occupancy were similar for American Bittern but detection probability decreased greatly between periods one and two (p = 0.61±0.13 vs. 0.19±0.06). For Virginia Rail, occupancy was again positively related to wetland size and percentage of wetland but also was positively related to wetlands classified by WWI as permanently inundated (hydrological modifier = "H"). Detection probability for this species did not decrease across replicate surveys but was greater in discrete wetlands (p = 0.274±0.060) than in extensive wetlands (p = 0.201±0.067).

From these survey results, some patterns emerge:

- Number of detections and occupancy rates for primary target species were lower than expected. However, these are likely explained by our late start and a relatively high number of survey points occurring in "marginal" marshbird habitat, i.e. wetlands that were too dry, too shrubby, a monoculture of reed canary grass, etc. We were conservative in this first year and did not want to assume too much regarding where marshbirds would and would not be. Based on 2008 results, many of these sites were eliminated in 2009 (see below).
- Detections of deep marsh and hemi-marsh species – such as Pied-billed Grebe, Least Bittern, gallinules, and Yellow-headed Blackbird – were especially low. It remains unclear if these species are as uncommon as results indicate, if WWI and/or the random design did not accurately identify or sample these wetter wetlands, or if the groundtruthing process somehow introduced bias into the sampling design.

- King Rails were expectedly scarce and mainly in southeast Wisconsin. We also detected very few Yellow Rails – a nocturnal survey on a more regional scale may be needed to adequately monitor this species.
- This survey may be able to monitor population trends of Wilson's Snipe – a harvested species – at the state level. This species was only a secondary target in 2008 but moved to the primary list in 2009, which entails a finer level of data collection (see Brady 2009). Some researchers also are investigating the use of playback, which could further improve monitoring of this species.
- Hydrology had profound influence on occupancy for the survey's three most common species, suggesting that water level may be an important variable for explaining patterns in marshbird population parameters. Hydrological modifiers from the WWI may be incorporated into the long-term sampling design (e.g. separate strata), and water depth should be measured at survey sites to the degree possible (though this is challenging on a state scale).
- Detection probabilities generally decreased throughout the survey period, which was expected based on analyses of historical data (M. Seamans, pers. comm.) and findings from other studies (Conway 2009) and likely can be attributed to decreased calling activity with progression of the nesting cycle. If 2008 results are consistent throughout the pilot study, we may be able to meet monitoring objectives with just two replicate surveys.

Year Two – 2009

In 2009, we improved the survey effort by building on our experiences of the 2008 pilot year. As discussed above, we applied less conservative groundtruthing criteria and thus eliminated SSUs within "marginal" habitat. In some cases, this also caused some PSUs to be removed. However, these losses were at least partially balanced by adding new SSUs within remaining PSUs. Thus the total sampling effort was maintained but better focused in appropriate marshbird habitat. In addition, we were better prepared to implement the survey this second year (i.e. fewer groundtruthing barriers), which resulted in an earlier start (e.g. early May in southern Wisconsin) and more replicate surveys (three vs. two) as recommended by Conway's protocol (2009). Collectively, these factors at least in part led to a substantial increase in detections for most target species (Table 2).

Overall, two field technicians, four biologists, and 19 volunteers surveyed 311 SSUs at 42 PSUs statewide in 2009 (Figure 4). Twenty-nine routes were surveyed three times, 12 routes twice, and one route only once. Twenty-five routes occurred in southern Wisconsin and 17 in northern Wisconsin (see Brady 2009 for definition of north vs. south). Survey effort was distributed evenly throughout each of the three survey periods (Table 2).

Table 2. Numbers of individuals of target species detected during the 2009 Wisconsin Marshbird Survey.

Species	Period 1	Period 2	Period 3	Total
American Bittern	93	62	48	203
American Coot	39	12	4	55
Common Moorhen	14	2	1	17
King Rail	2	5	4	11
Least Bittern	6	5	4	15
Pied-billed Grebe	28	21	11	60
Sora	262	113	22	397

Virginia Rail	56	46	30	132
Wilson's Snipe	31	17	12	60
Yellow Rail	2	1	1	4
Black Tern	6	5	29	40
Forster's Tern	27	4	0	31
Le Conte's Sparrow	8	7	5	20
Marsh Wren	113	155	136	404
Red-necked Grebe	0	0	0	0
Sandhill Crane	262	211	207	680
Sedge Wren	175	240	231	646
Swamp Sparrow	549	634	613	1796
Yellow-headed Blackbird	1	1	1	3
Routes Surveyed	*38*	*37*	*37*	*42*
Points Surveyed	*270*	*266*	*265*	*311*
Median Survey Date	*11-May*	*28-May*	*13-Jun*	---

The three most common primary target species again were Sora, American Bittern, and Virginia Rail (Table 2). Detections of deep marsh and open water species such as Least Bittern, Pied-billed Grebe, and Yellow-headed Blackbird, were again low but improved somewhat over 2008. Eleven King Rails were detected but ten of these came at three survey points within one state wildlife area in east-central Wisconsin and likely included fewer individuals detected repeatedly over replicate surveys. Yellow Rails remained elusive with only four birds found. Swamp Sparrows, Sandhill Cranes, and Sedge and Marsh Wrens dominated the secondary species totals (Table 2). Data on Sandhill Crane, which was added to the target species list in 2009, may support future harvest decisions for this species. Swamp Sparrow and the two wrens are Watch List species identified by Partners in Flight, and these data will complement those of the federal Breeding Bird Survey while providing unique opportunities for conservation modeling and planning.

As in 2008, detections decreased through time for most primary species but not for secondary species. In particular, the number of Sora detections dropped drastically from 262 in Period 1 to just 22 in Period 3 (Table 2). Results of occupancy models and detection probabilities were not available at the time of writing this report but will be included upon completion. These results should provide better estimates than 2008 because of the improved survey effort.

<u>Comments on Study Design and Implementation</u>

- The Wisconsin Wetland Inventory appropriately identified wetlands in most cases. Limitations included old data (e.g. most WWI data based on maps 15-30 years old), some counties not yet digitized (and thus not yet in the sampling framework), and exclusion of restored wetlands. We did not assess accuracy of WWI class types, wetland sizes/boundaries, modifiers, etc.
- The two-stage cluster sampling using GRTS was effective in producing "routes" of survey points in appropriate habitat while maintaining randomization and spatial balance. Initial concerns about logistical inefficiency because points were not systematically spaced at minimum intervals

did not materialize. The current design allowed time for eight to ten SSUs per PSU to be surveyed in a single outing.

- Groundtruthing represented the greatest investment of time and resources but was an essential part of implementing this design, especially with volunteer surveyors. We applied objective criteria for keeping, moving, and eliminating SSUs. Use of aerial images and GIS software was an important first step for assessing accessibility and habitat suitability of survey points.
- Volunteers were reliable and performed well, with retention high across years. Training was critical as the protocol is more complex than other surveys and requires use of audio equipment and GPS receivers. We found it essential to explain the study design to volunteers so they understood why they were visiting random wetland locations instead of favored sites of interest. Their understanding, passion, and proficiency suggest this survey could be mostly or entirely citizen-based in the long-term, at least here in Wisconsin.
- Proper coordination and implementation required a statewide survey coordinator. These were facilitated by WBCI's Wisconsin Marshbird Survey website (http://wiatri.net/projects/birdroutes/marshbirds.htm).
- Conway's protocol (2009) appeared to be effective and was readily implemented by trained surveyors. By far, estimating distances to detected birds presented the greatest challenge, especially for individuals beyond 100-150 meters.
- We provided standardized equipment, including mp3 players, portable folding speakers, and GPS receivers, to all surveyors. We first tested the audio files and equipment with a sound meter to ensure they met required decibel levels (Conway 2009). GPS was required because it was not reasonable to permanently mark and provide detailed directions to all survey points statewide.
- Measuring habitat variables at survey sites is a significant concern given the large scale of this survey (e.g. not focused on refuges or other discrete management units) and heavy reliance on volunteers (i.e. usually not biologists). What variables to measure and how to measure them proved difficult but see an example from this pilot study at http://wiatri.net/projects/birdroutes/Docs/SampleHabitatSheet.pdf. Measuring water levels, a potentially important predictor of marshbird occupancy, could be especially challenging.
- Availability of a centralized database and statistician through the Patuxent Wildlife Research Center fulfilled important state-level needs after surveys were completed. Such coordination will also ensure effective regional monitoring as other states join the national survey effort.

Future Work

The first two years of this pilot study have set the stage for an annual, long-term marshbird monitoring program in Wisconsin. Survey points on public lands are largely set and the framework for coordination and implementation is in place. As other states join the national program (e.g. Idaho, Kentucky, and New York in 2009, Michigan and Florida in 2010), here's what's in store in Wisconsin for the years ahead:

- In 2010, we will focus on surveying more private lands. We surveyed mostly public lands in the first two years for ease of implementation.
- In 2011, we will add wetland restorations to complete the sampling framework and compare marshbird population parameters there to non-restored wetlands from the WWI.
- In 2011, we plan to conduct intensive habitat analyses to characterize marshbird habitat associations and determine which variables to measure over long-term and how to measure them.
- The survey may require adaptations to better monitor uncommon or rare species. How we handle this will depend on state priorities and if other states in the region join the national survey effort (e.g. conducting surveys aimed at Yellow Rails would be most appropriate on a regional scale).
- We will continue to conduct analyses of occupancy, detectability, power, abundance, etc. to inform survey design and conservation planning for target species.

- We will increase volunteer recruitment with the goal of making the survey mostly or entirely citizen-based by 2012. Thus far, enthusiasm for the survey has been remarkable.

Acknowledgments

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Literature Cited

Brady, R. 2009. Wisconsin Marshbird Survey Instructions Booklet 2009. Available on the Wisconsin Bird Monitoring website at http://wiatri.net/projects/birdroutes/Docs/MarshProtocol.pdf. Accessed 27 January 2010.

Conway, C. J. 2009. Standardized North American Marsh Bird Monitoring Protocols, version 2009-1. Wildlife Research Report #2009-01. U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ. Available at http://www.cals.arizona.edu/research/azfwru/NationalMarshBird/.

Johnson, D.H., J.P. Gibbs, M. Herzog, S. Lor, N.D. Niemuth, C.A. Ribic, M. Seamans, T.L. Shaffer, W. G. Shriver, S.V. Stehman,, and W.L. Thompson. 2009. A Sampling Design Framework for Monitoring Secretive Marshbirds. Waterbirds 32(2):203-215.

For information and future updates please visit http://wiatri.net/projects/birdroutes/marshbirds.htm.

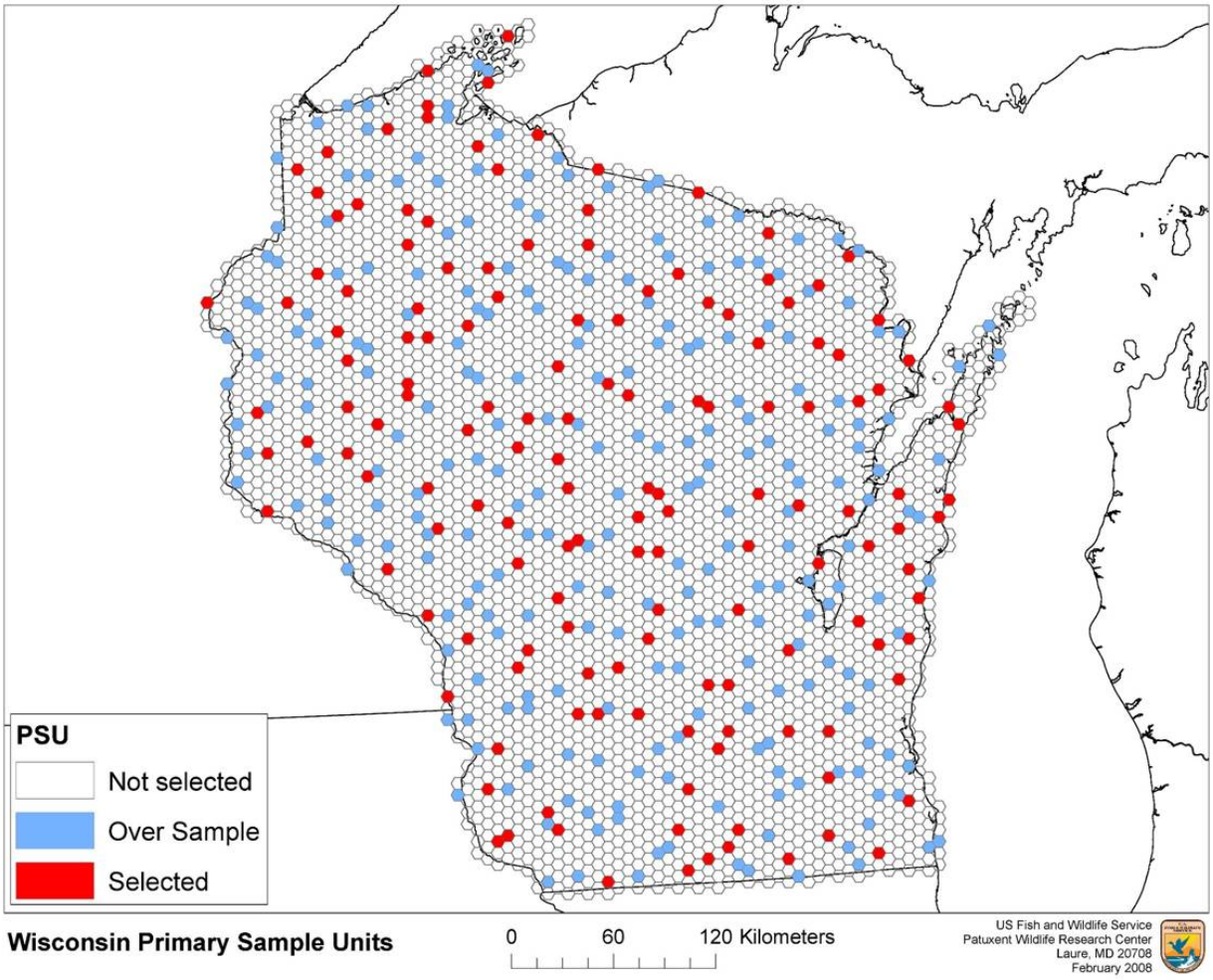

Figure 1. Selection of Primary Sample Units (PSUs) during the first stage of the two-stage cluster sampling process. We used PSUs from the oversample when those from the original selection could not be surveyed (see text for details). Graphic courtesy of Mark Seamans, USFWS-Patuxent.

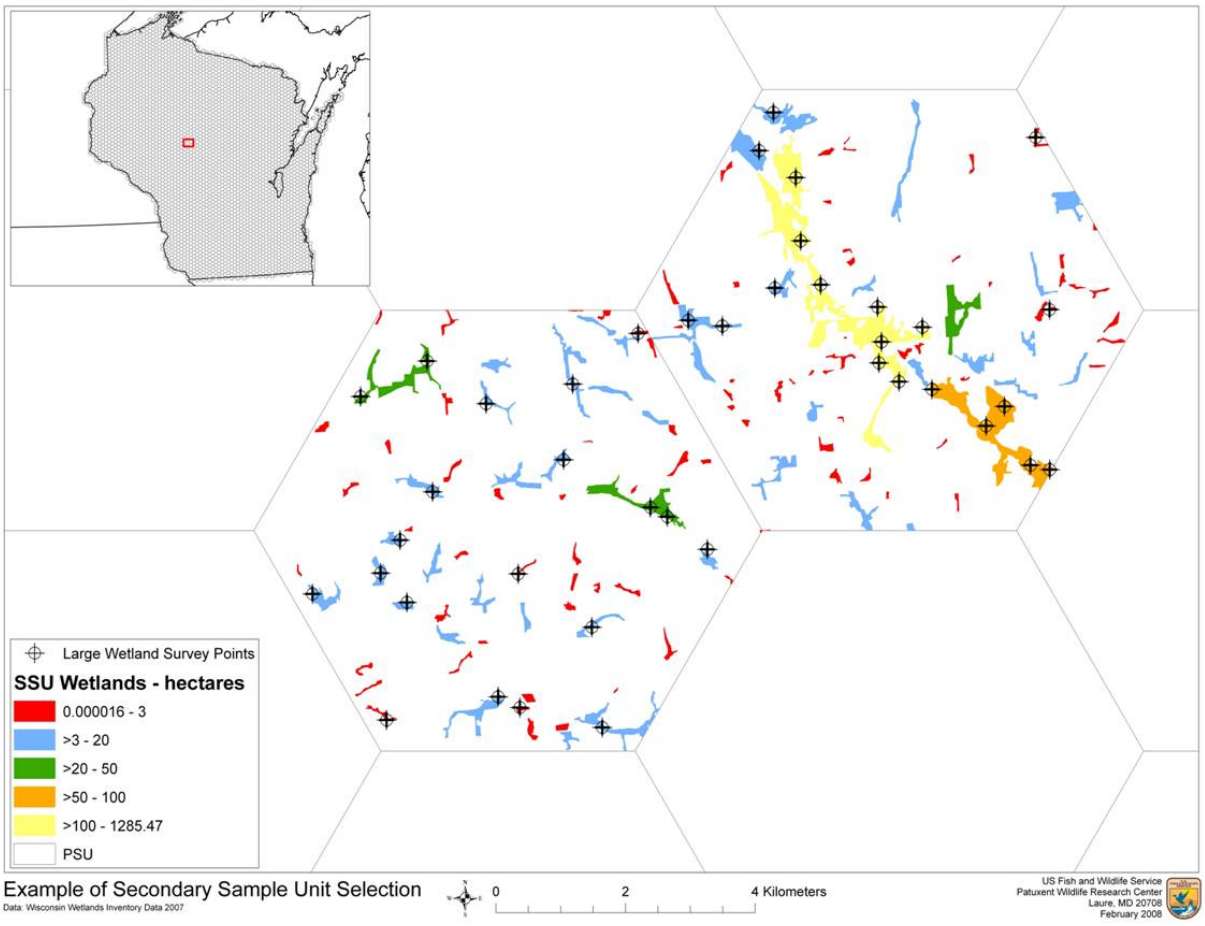

Figure 2. Selection of Secondary Sample Units (SSUs) during the second stage of the two-stage cluster sampling process. Only SSUs from large, extensive wetlands >3 ha are shown for example. Graphic courtesy of Mark Seamans, USFWS-Patuxent.

Figure 3. Example of a "completed" marshbird monitoring route after groundtruthing. This PSU, located at El Dorado Marsh State Wildlife Area (Fond du Lac County), consisted of seven SSUs (one shown is a navigation point), including three along wetland edges and four within wetland interior.

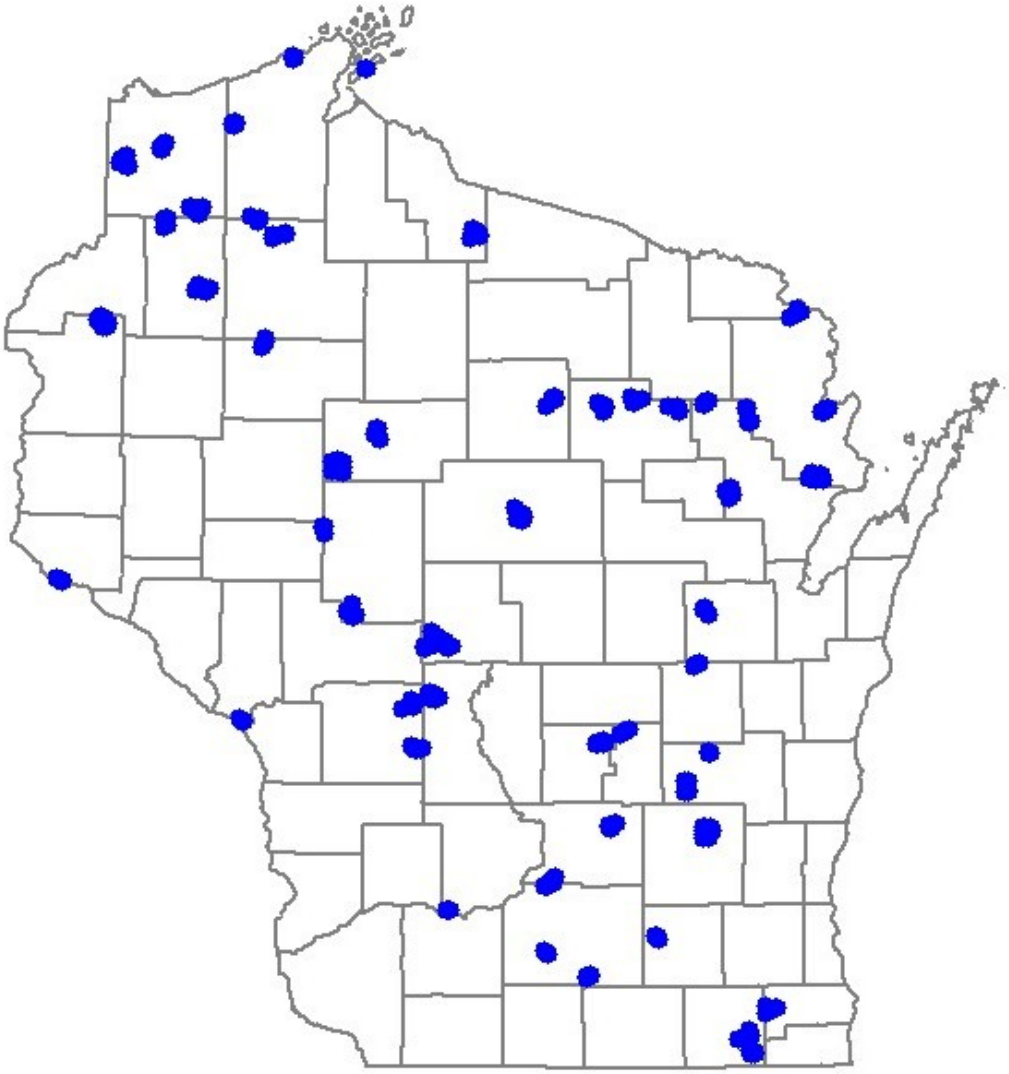

Figure 4. Locations of 2008 survey points. Locations of 2009 points will be added to this report when available but generally were very similar with exception of fewer PSUs in northeastern (e.g. Langlade and Oconto counties) and north-central Wisconsin (e.g. Taylor and Clark counties).