Monitoring and Mapping Avian Resources in the Nearshore and Open Waters of Lakes Erie, Huron, Michigan, and St. Clair – Phase 2

FINAL REPORT

MNFI Report Number 2015-01

Name: Michael J. Monfils

Affiliation: Michigan Natural Features Inventory, Michigan State University Extension

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Abstract: Through a subcontract agreement with the Great Lakes Commission, the Michigan Natural Features Inventory (MNFI) conducted aerial bird surveys during 2013-2014 over several Wind Resource Areas (WRAs) located in central Lake Huron. This effort represented the second phase of an ongoing project consisting of multiple partners to monitor and map avian resources in the nearshore and open waters of several Great Lakes. We conducted eight surveys, with four occurring during fall migration (late October through mid-December) and four during spring migration (mid-April through mid-May). Surveys were conducted along two sets of parallel transects traversing the WRAs and immediate vicinity. Transects within each set were 5 km apart, thus 2.5 km separated the full set of transects. We used a Partenavia P68C twin-engine fixed-wing aircraft for all surveys. Surveys were flown at approximately 91 m above water level and speeds of 130-200 km/hr. Two observers conducted surveys (one on each side of the aircraft). For each flock or individual bird, we recorded the species (or lowest taxonomic group), number observed, latitude and longitude (using GPS receiver), and the distance band in which it was first detected (0 – 100 m, 101 – 200 m, 201 – 300 m, 301 – 412 m, and >412 m).

We recorded a total of 7,143 birds during the eight aerial surveys (4,431 during fall 2013; 2,712 during spring 2014). Waterfowl accounted for 84.1%, waterbirds represented 15.8%, and all other birds made up <0.1% of the total birds detected. Long-tailed Duck (*Clangula hyemalis*) was the most common species observed and accounted for 62.3% of the total birds and 74.1% of all waterfowl detected. Large gulls were the second most common birds detected, representing 11.9% of all birds and 75.5% of all waterbirds recorded. Canada Goose (*Branta canadensis*) made up 11.6% of all birds and 13.6% of all waterfowl detected. Unidentified waterfowl accounted for 4.0%, unidentified sea ducks 2.3%, Bufflehead 2.2%, and Common Loon 1.6% of the total. None of our transect segments were devoid of birds and we detected small flocks of birds widely distributed throughout the survey area. Raw relative total bird and waterfowl densities were greatest on the northern portion of the Central Lake Huron WRA compared to other geographic groupings of the WRAs, but relative bird densities were low across the survey area. There was no significant difference in raw relative bird densities between fall and spring survey periods. Some species/groups, such as Bufflehead (*Bucephala albeola*), Common Goldeneye (*B. clangula*), Canada Goose, and loons, appeared to occur more often on transects located closer to the shoreline.

Table of Contents:

Section A: Description of Survey Implementation

1. **Survey time period**: Fall 2013-Spring 2014.
2. **Number of surveys**: Eight surveys total (4 during fall, 4 during spring).
3. **Identify geographic areas surveyed**: We surveyed the Central Lake Huron Wind Resource Area (WRA) and Sanilac County WRA of Lake Huron (Mikinetics Consulting and Private Sector Consultants 2010; Figure 1).

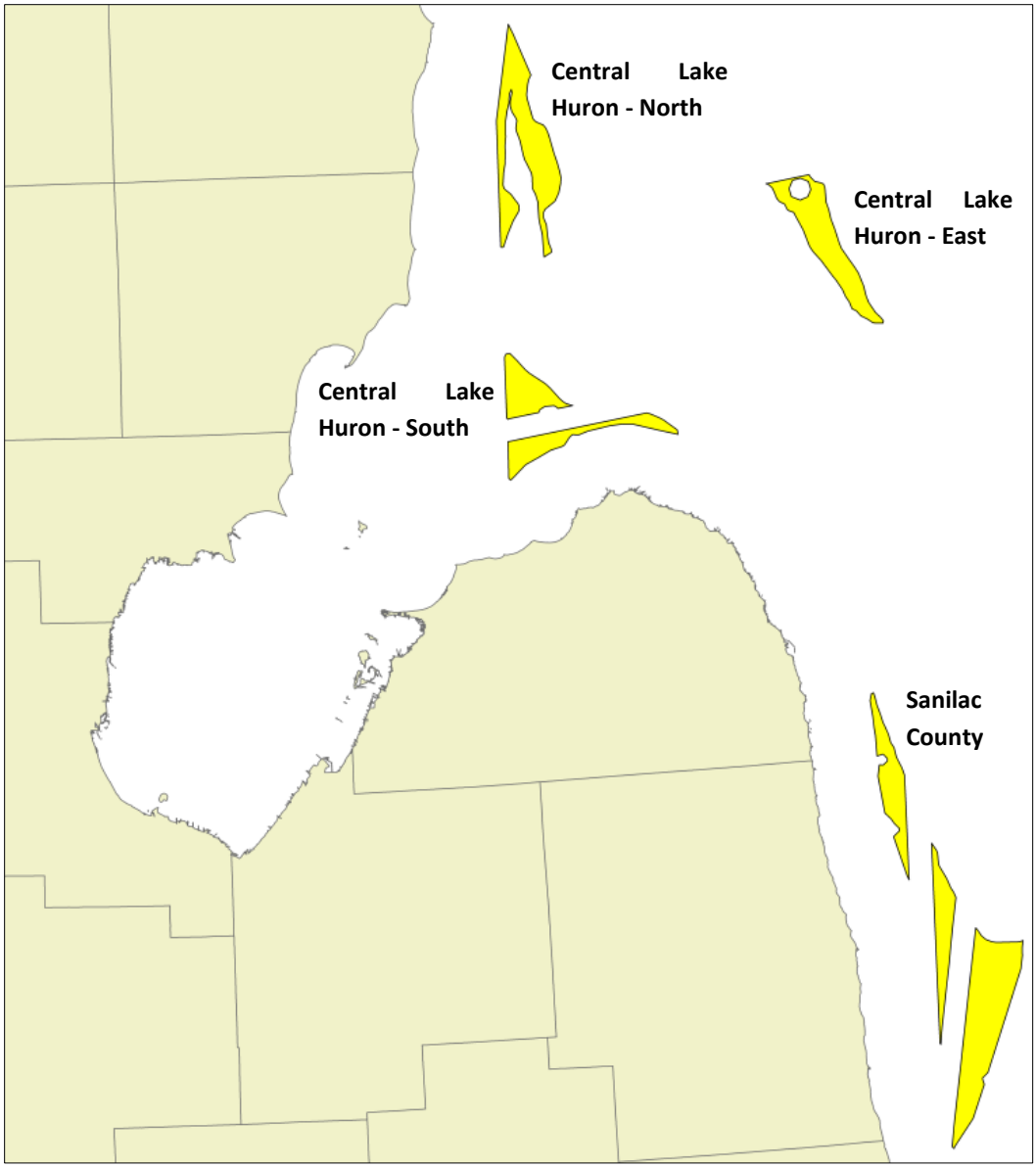

Figure 1. Lake Huron Wind Resource Areas identified by the Michigan Great Lakes Wind Council that were examined during aerial bird surveys conducted by the Michigan Natural Features Inventory, 2013-2014.

4. **Briefly describe your methodology**: Surveys were conducted along parallel transects placed systematically across the sites with random starting points. The survey area consisted of the WRAs and a surrounding 2.5 km buffer to account for potential wind development activities that might occur in the immediate vicinity of each WRA. Transects were oriented along a northwest-southeast axis to minimize sun glare. Both Lake Huron WRAs were surveyed in one day. For each survey, observers alternated between two sets of transects to maximize spatial coverage (Figure 2). Transects within each set were 5 km apart, thus 2.5 km separated the full set of transects. Each set of transects was surveyed twice during each migration period, resulting in a total of eight surveys by the completion of the project. We rotated the starting point for each set of transects between surveys, so that transects were not always surveyed at the same time of day.

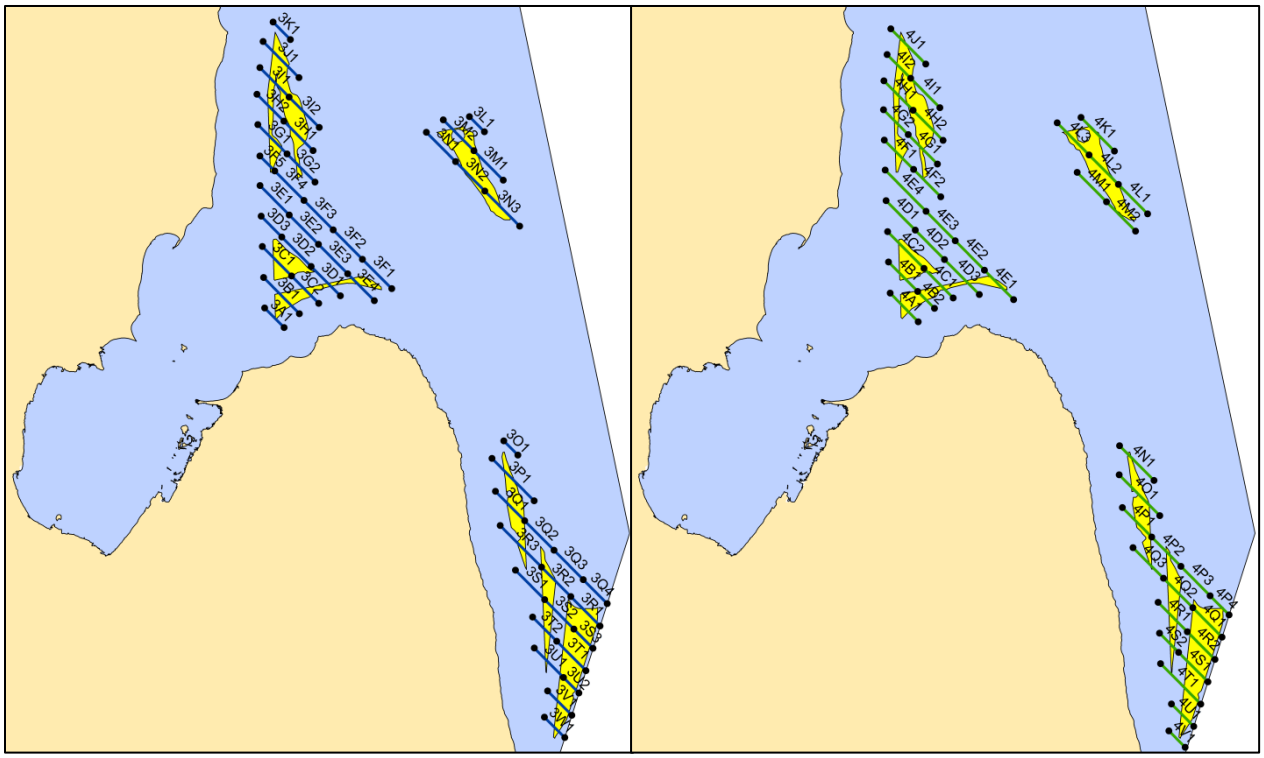

Figure 2. Locations of two sets of transects used for pelagic bird surveys of Lake Huron wind resource areas (yellow polygons) during Phases 1 and 2. One set of transects (i.e., blue – left graphic, or green – right graphic) was surveyed on a given day and the set covered was rotated every other survey. Transects were divided into approximately 10 km segments, with identifiers indicating transect set (number 3 [blue] or 4 [green]), transect (letter), and segment (number).

Surveys were timed to coincide with the typical peak fall (mid-October – mid-December) and spring (mid-March – mid-May) waterfowl migration periods. We completed surveys between sunrise and early afternoon using a Partenavia P68C twin-engine fixed-wing aircraft. Surveys were conducted when wind speeds were ≤28 km/h (≤17 mph) and visibility ≥3.2 km (2 miles). One observer surveyed each side of the aircraft. Surveys were flown at approximately 91 m (300 ft) above water level and at speeds of 130-200 km/hr (80-125 mph). We used five distance bands to estimate the perpendicular distances of bird groups from observers (Figure 3): 0 – 100 m, 101 – 200 m, 201 – 300 m, 301 – 412 m, and >412 m (unlimited outer band). Boundaries of the distance bands were marked on aircraft windows using a clinometer and appropriate angles for the flight altitude. For each flock or individual bird, we recorded the species (or lowest taxonomic group), number observed, latitude and longitude (using GPS receiver), and the distance band in which it was first detected. Observers also recorded the locations of vessels (e.g., sport/commercial fishing, cargo). Survey conditions that might influence bird behavior and detectability were described for each transect, including sea state (Beaufort scale), percent ice cover, percent cloud cover, and the angle and magnitude of sun glare. Each observer recorded geospatial and voice (i.e., bird species and numbers) data using a Columbus V-900 GPS data logger.

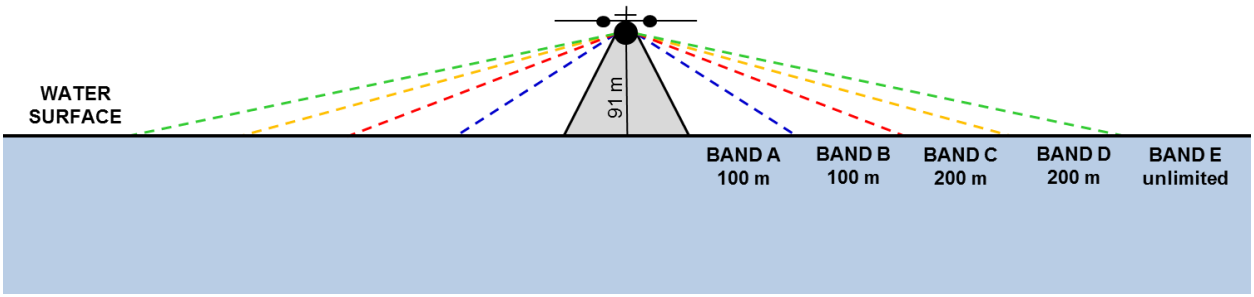

Figure 3. Distance bands used to estimate perpendicular distances of bird groups from transects during 2013-2014 aerial surveys conducted over central Lake Huron.

We compiled data for this report into the following groups, based on taxonomic classification, habitat usage, food habits, and foraging strategies: (1) Canada Goose; (2) swans (genus *Cygnus*); (3) dabbling ducks (genus *Anas*); (4) diving ducks (genus *Aythya*); (5) sea ducks (eiders, scoters, mergansers, goldeneyes, and Long-tailed Duck); and (5) waterbirds (loons, grebes, gulls, terns, and Double-crested cormorant [*Phalacrocorax auritus*]). We estimated raw, unadjusted bird densities (bird detections/ha) within each segment assuming a maximum survey distance of 1,250 m on either side of the transect. We approximated geographic locations of birds using latitude and longitude coordinates recorded with GPS data loggers, which were adjusted using the midpoints of the recorded distance bands. We used 860 m on either side of the aircraft as the approximate midpoint of the unlimited distance band E (i.e., midway between the outer edge of band D and our assumed maximum survey distance of 1,250 m).

We used a mixed model (PROC MIXED; SAS Institute, Cary, NC) to compare raw relative abundance (i.e., detections/ha, unadjusted for declining detection probability with increasing distance) of all birds and total waterfowl estimated on transect segments among four geographic groupings of wind resource areas (Figure 1). We used a model consisting of season (i.e., fall, winter, and spring) and WRA (i.e., Central Lake Huron North, South, and East, and Sanilac County) as fixed effects, and survey date and transect segment as random effects. We incorporated a repeated measures component to account for multiple surveys of the same transect segment.

5. **Describe how you implemented any changes in survey methodology between the first to second phases of the project**: During Phase 2, we implemented several changes to our methodology to address the *Recommendations for Standardizing Data Collection for Great Lakes Aerial Surveys* (Biodiversity Research Institute [BRI] 2013): (1) rotated the starting point for surveys, so that transects were not always surveyed at the same time of day; (2) added glare angle, glare magnitude, and observation condition ranking to the list of environmental variables used to describe transects; and (3) modified our distance bands to be consistent with other surveys. During Phase 1, we assigned bird detections to the following distance bands: 0 – 100 m, 101 – 200 m, 201 – 412 m, and >412 m. For Phase 2 surveys, we divided our third band into two bands to make our data consistent with the BRI recommendations. The distance bands used in Phase 2 were as follows: 0 – 100 m, 101 – 200 m, 201 – 300 m, 301 – 412 m, and >412 m (Figure 3).

6. **Summarize challenges encountered**: As with Phase 1 surveys, weather presented the greatest challenge to meeting goals. Poor weather caused us to conduct our fourth fall 2013 survey later than we would have preferred, and the late spring ice melt on Lake Huron resulted in a later initiation of spring surveys compared to Phase 1.

7. **Describe how these challenges impacted the data**: Overall bird abundance during spring 2014 was lower than spring 2013 (Phase 1), which was largely because of reduced Long-tailed Duck numbers. However, Canada Goose abundance was the greatest observed during any season across both phases of the project.

8. **If applicable, please list any equipment purchased to assist in the survey effort**: We purchased two Columbus V-900 GPS data loggers to replace aging units used for the project.

Section B: Description of the Data Collected for Phase II (Fall 2013-Spring 2014)

1. **List the geographic area(s) with the most counts during survey period**: We recorded the greatest single-survey count (1,003 birds on 24 April 2014) and average survey abundance (403 birds detected/survey) on transects covering the northern portion of the Central Lake Huron WRA (Figure 1).
2. **Describe any unique, observed bird activity**: None.

3. **Make any additional observations related to the data collected in Phase 1 and Phase 2**: During our Phase 2 spring surveys, we observed more Canada Geese than any other period surveyed for Phases 1 or 2. We detected 818 Canada Geese, which represented 30.2% of the birds recorded during spring 2014 surveys. Only five Canada Geese were recorded during all previous surveys. The increased number of geese detected may have been related to a later spring thaw and later survey dates compared to spring surveys conducted for Phase I that happened to coincide with Canada Goose migration.

Section C: Summarize Data (Phase 1 and Phase 2)

For Phase 2, we conducted eight aerial surveys over central Lake Huron, with four occurring during fall 2013 and four in spring 2014. Fall 2013 surveys were completed from late October through mid-December and spring 2014 surveys were conducted from mid-April through mid-May. The survey transects covered an area of approximately 2,200 km^2 (850 mi^2). We observed 7,143 birds during the eight Phase 2 aerial surveys (4,431 during fall 2013; 2,712 during spring 2014). We recorded our greatest single-survey count of 1,719 birds on 24 April 2014. During Phase 2 surveys, we identified the following eight waterfowl species: Canada Goose, Canvasback (*Aythya valisineria*), Redhead (*A. americana*), Common Eider (*Somateria mollissima*), White-winged Scoter (*Melanitta deglandi*), Long-tailed Duck, Bufflehead, and Common Goldeneye. We placed other waterfowl that could not be identified to species in the following groups: unidentified waterfowl, unidentified swan, unidentified duck, unidentified sea duck, unidentified scaup (Lesser Scaup [*Aythya affinis*] and Greater Scaup [*A. marila*] combined), unidentified scoter, and unidentified merganser. We observed four waterbird species, Common Loon (*Gavia immer*), Double-crested Cormorant, Great Black-backed Gull (*Larus marinus*), and Caspian Tern (*Hydroprogne caspia*), and placed remaining waterbirds that could not be identified to species in five groups (unidentified loon, unidentified grebe, unidentified large gull, unidentified small gull, and unidentified tern). In addition to waterfowl and waterbirds, we detected a small number of unidentified shorebirds. Birds that could not be identified to species or placed in one of the above groups were listed as unidentified birds, which accounted for less than 0.1% of the birds detected.

Waterfowl accounted for 84.1% and waterbirds represented 15.8% of the total birds recorded. Long-tailed Duck was the most common species observed during surveys, making up 62.3% of the total birds and 74.1% of all waterfowl detected. Large gulls were the second most common birds detected, accounting for 11.9% of all birds and 75.5% of all waterbirds recorded. Canada Goose represented 11.6% of all birds and 13.6% of all waterfowl detected. Unidentified waterfowl made up 4.0%, unidentified sea ducks 2.3%, Bufflehead 2.2%, and Common Loon 1.6% of the total. All of the other species/groups that we detected accounted for less than 0.1% of the total.

We observed no strong distributional patterns in bird use of the offshore areas we surveyed. Birds were typically widely distributed in small groups (mean = 6.3 birds per flock; Figure 4). Sea ducks accounted for 67.7% of all waterfowl detections and were found throughout the survey area (Figure 5). Long-tailed ducks were observed throughout the survey area, whereas Canada Goose, Bufflehead, and Common Goldeneye were detected more often on transects covering WRAs closer to the shoreline (i.e., CHN,

CHW, and SAN; Figure 6). Although gulls were widespread across the survey area, we tended to detect other waterbirds, such as loons, closer to the shoreline (Figure 7).

We compared raw relative densities (detections/ha) of total birds and total waterfowl between fall and spring periods and among four spatial groupings of the Lake Huron WRAs (Central Lake Huron North [CHN], South [CHS], and East [CHE], and Sanilac County [SAN]; Figure 1). No transect segments were devoid of birds (Figure 8) but raw relative densities were generally low for both waterfowl (Figure 9) and waterbirds (Figure 10). We found no significant differences in relative total bird density ($F_{1,267}$=0.86, P=0.354) or relative waterfowl density ($F_{1,267}$=0.75, P=0.387) between seasons. Relative density of total birds ($F_{3,267}$=8.02, P<0.001) and waterfowl ($F_{3,267}$=7.98, P<0.001) differed significantly among the four geographic groupings of the WRAs. Mean densities on transects traversing the CHN grouping were significantly greater than those of the other three geographic groupings. Average total bird and waterfowl relative densities recorded from the CHS, CHE, and SAN groupings were similar.

Table 1. Total number of flocks and individuals detected by species/bird group during aerial surveys conducted over central Lake Huron in 2012-2014.

	Fall 2012		Winter 2013		Spring 2013		Fall 2013		Spring 2014	
Species or group	n-flocks	n-indiv	n-flocks	n-indiv	n-flocks	n-indiv	n-flocks	n-indiv	n-flocks	n-indiv
Waterfowl										
Canada Goose					3	5			13	818
Swans	1	10			7	153	1	6	2	13
Mallard					1	1				
Canvasback					1	1	1	1		
Redhead							1	6		
Scaup	1	1			5	6			1	1
Unidentified Diving Ducks			1	1	1	1				
Common Eider	2	3					1	1		
White-winged Scoter			1	2			1	6	1	8
Surf Scoter	9	12								
Unidentified Scoters	6	12	7	11	2	4			3	9
Long-tailed Duck	357	2,087	949	5,921	378	2,798	485	3,584	182	869
Bufflehead	5	19	17	32	8	32	13	85	9	71
Common Goldeneye	3	7	1	1	4	9	7	26	4	10
Common Merganser					4	10				
Unidentified Mergansers					2	2			3	4
Unidentified Sea Ducks	11	31	4	18	13	22	26	144	17	22
Unidentified Ducks	3	12	24	91	16	98	5	20	13	19
Unidentified Waterfowl									10	286
Waterbirds										
Common Loon			3	3	16	23	25	51	49	63
Unidentified Loons	46	59					19	43	17	25
Unidentified Grebes	3	3			1	1	2	2	2	2
Double-crested Cormorant	1	1			2	21			3	10
Herring Gull			3	3						
Great Black-backed Bull	1	1	1	1	1	1	1	1		
Large Gulls	127	146	85	111	251	432	267	420	232	430
Small Gulls	2	4			5	6	17	31	19	33
Unidentified Gull									3	3
Caspian Tern							1	1		
Unidentified Terns					6	7			5	11
Miscellaneous										
Bald Eagle					1	1				
Unidentified Shorebirds	1	1			3	6	1	3	1	1
Unidentified Birds	3	4	37	145	3	9			4	4
Grand Total	582	2,413	1,133	6,340	734	3,649	874	4,431	593	2,712

Section D: Observations/Findings

1. **Maps and ArcMap shape files of bird locations**: The following GIS outputs are desired:
   A. All Observations from all surveys for (Fall 2013, Winter 2014 and Spring 2014) – Displayed as a count range.

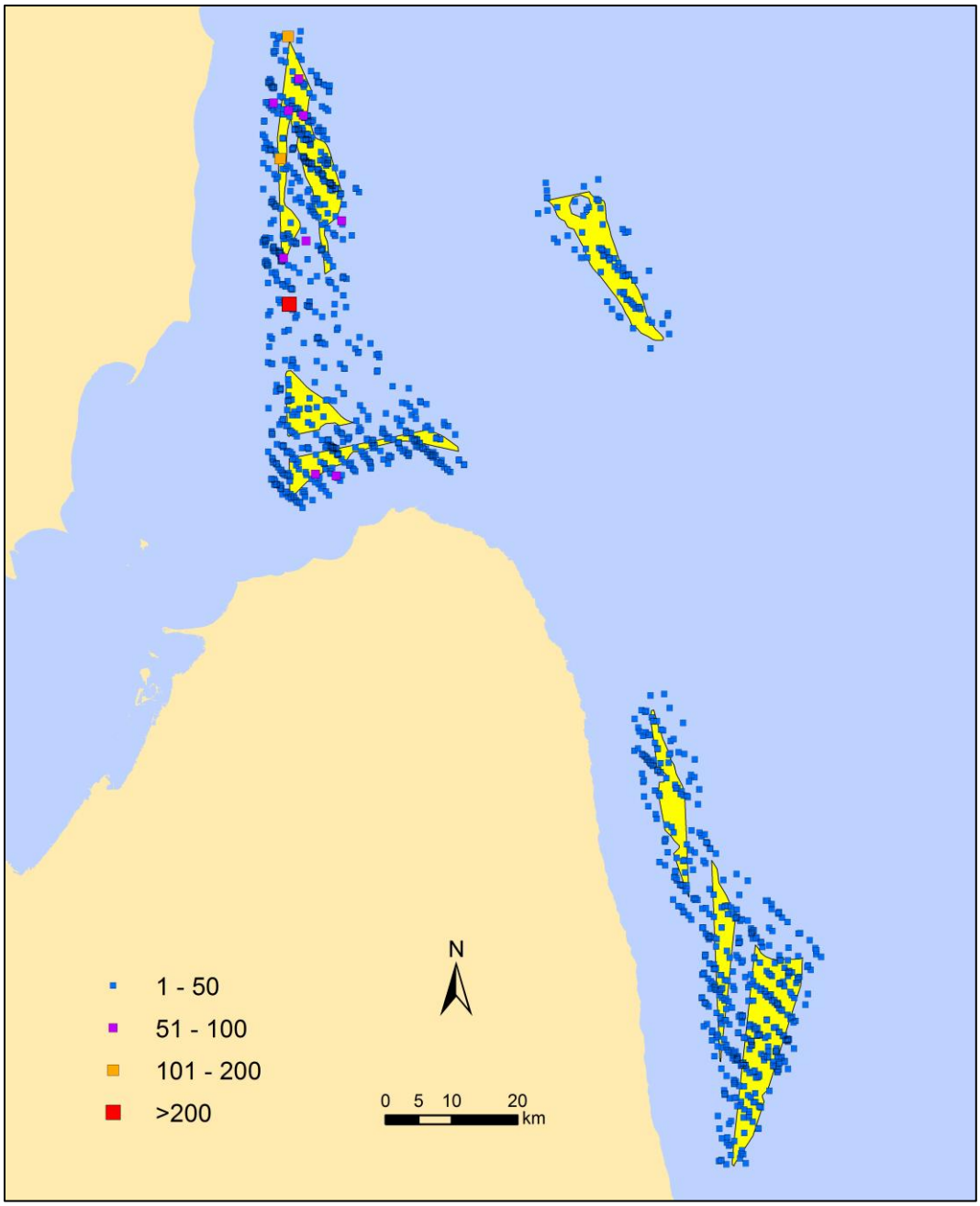

Figure 4. Approximate locations and relative abundances of all birds observed during aerial surveys conducted over central Lake Huron in 2013-2014. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

B. Distribution of the most observed species group in the survey area for (Fall 2013, Winter 2014 and Spring 2014) – Displayed as a count range.

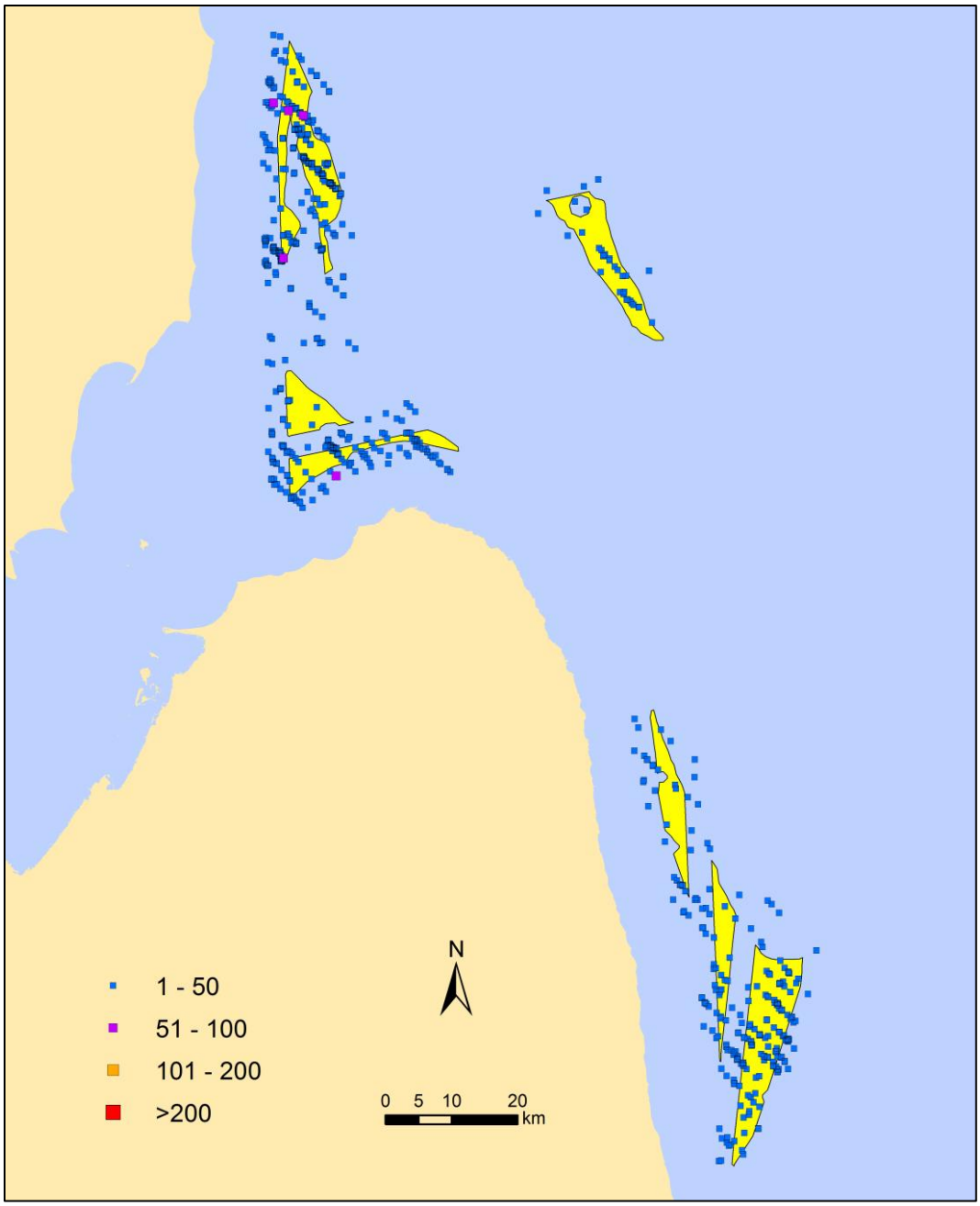

Figure 5. Approximate locations and relative abundances of sea ducks observed during aerial surveys conducted over central Lake Huron in 2013-2014. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

Optional Maps to include:

C. Distribution of ducks and geese observed during (Fall 2013, Winter 2014 and Spring 2014) – Displayed as a count range.

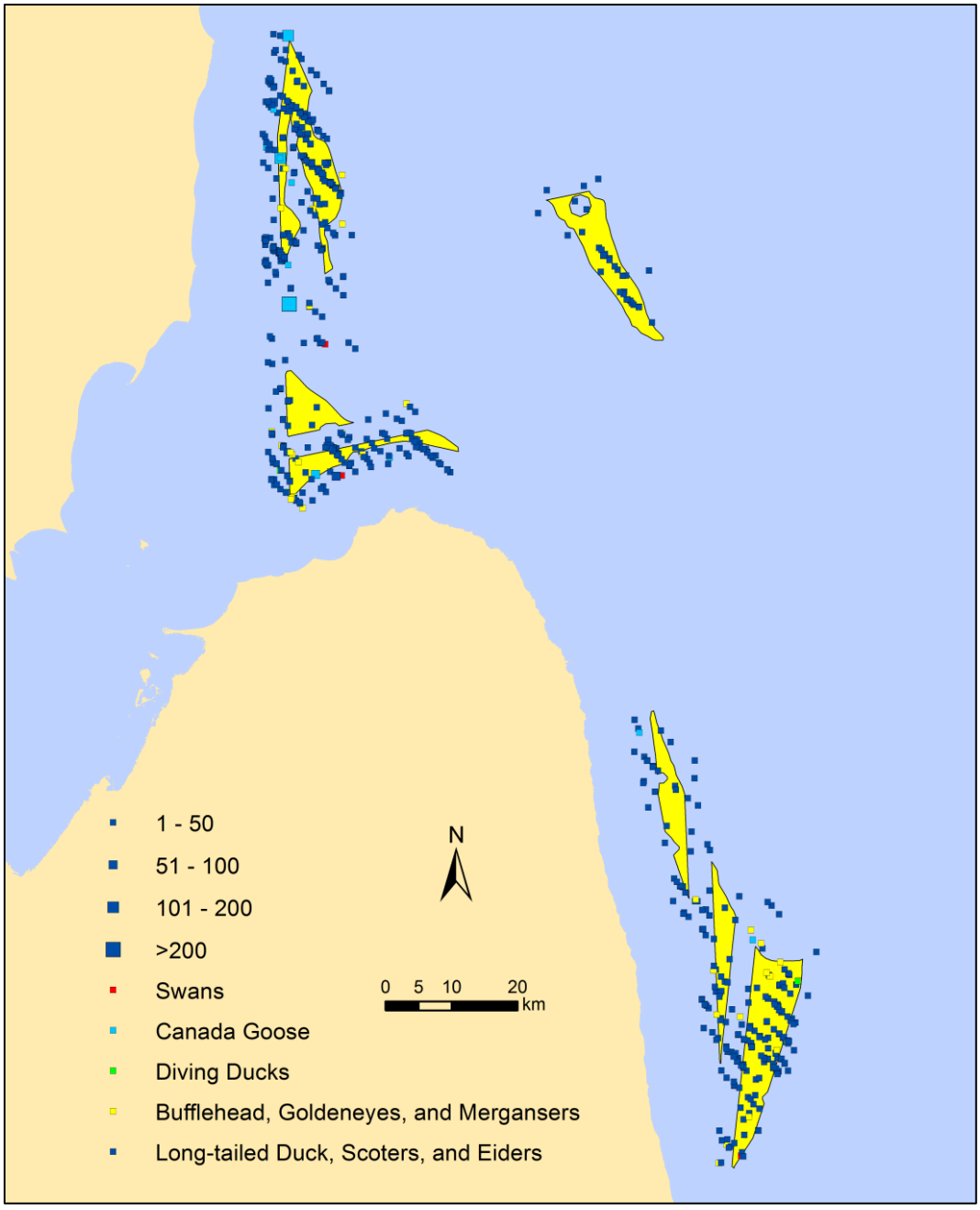

Figure 6. Approximate locations of waterfowl within five species groupings during aerial surveys conducted over central Lake Huron in 2013-2014. Point colors indicate species group and size is scaled by number of individuals detected. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

D. Distribution of gulls and terns observed during (Fall 2013, Winter 2014 and Spring 2014) – Displayed as a count range.

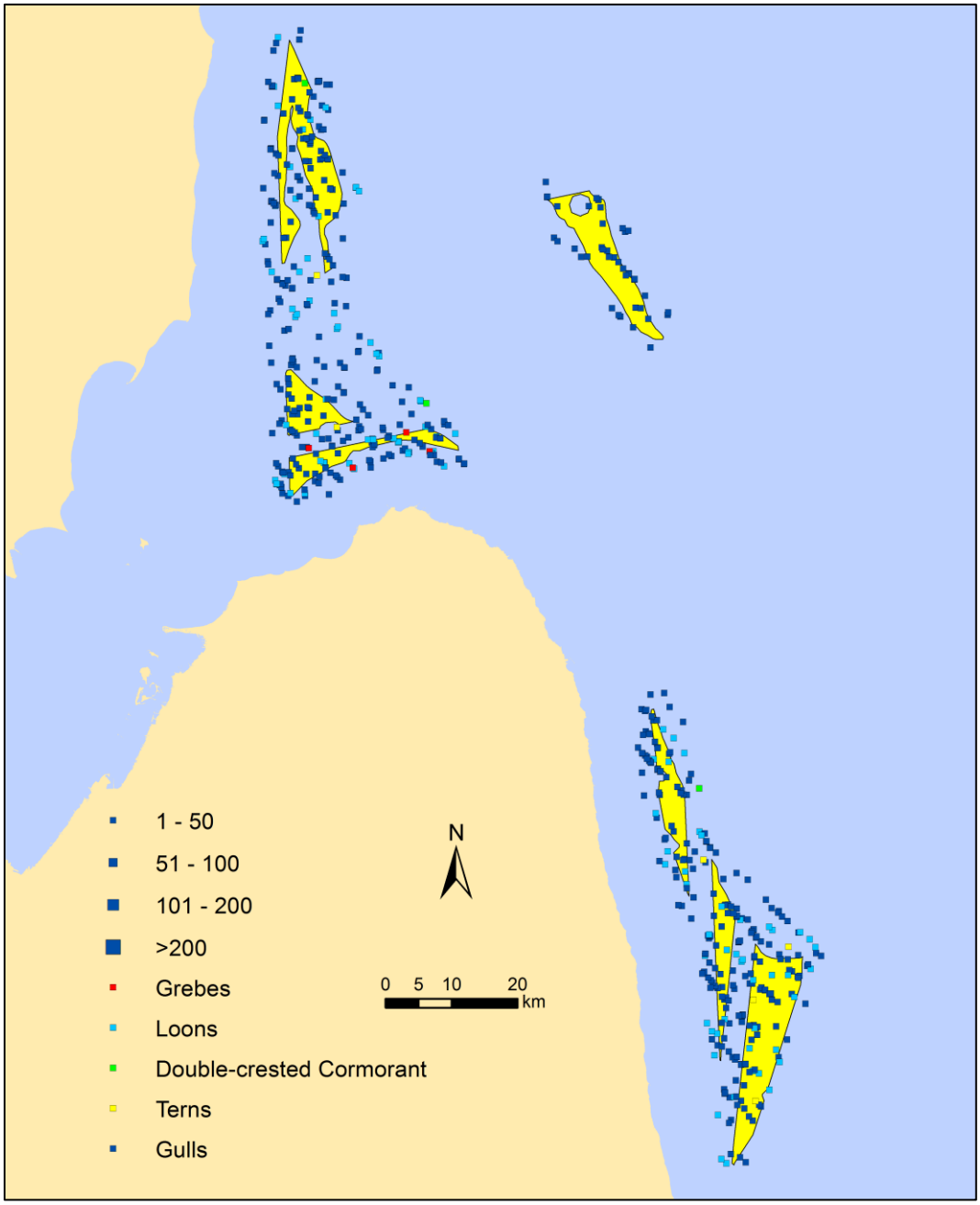

Figure 7. Approximate locations of waterbirds within five species groupings during aerial surveys conducted over central Lake Huron in 2013-2014. Point colors indicate species group and size is scaled by number of individuals detected. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

E. Other Maps of interest.

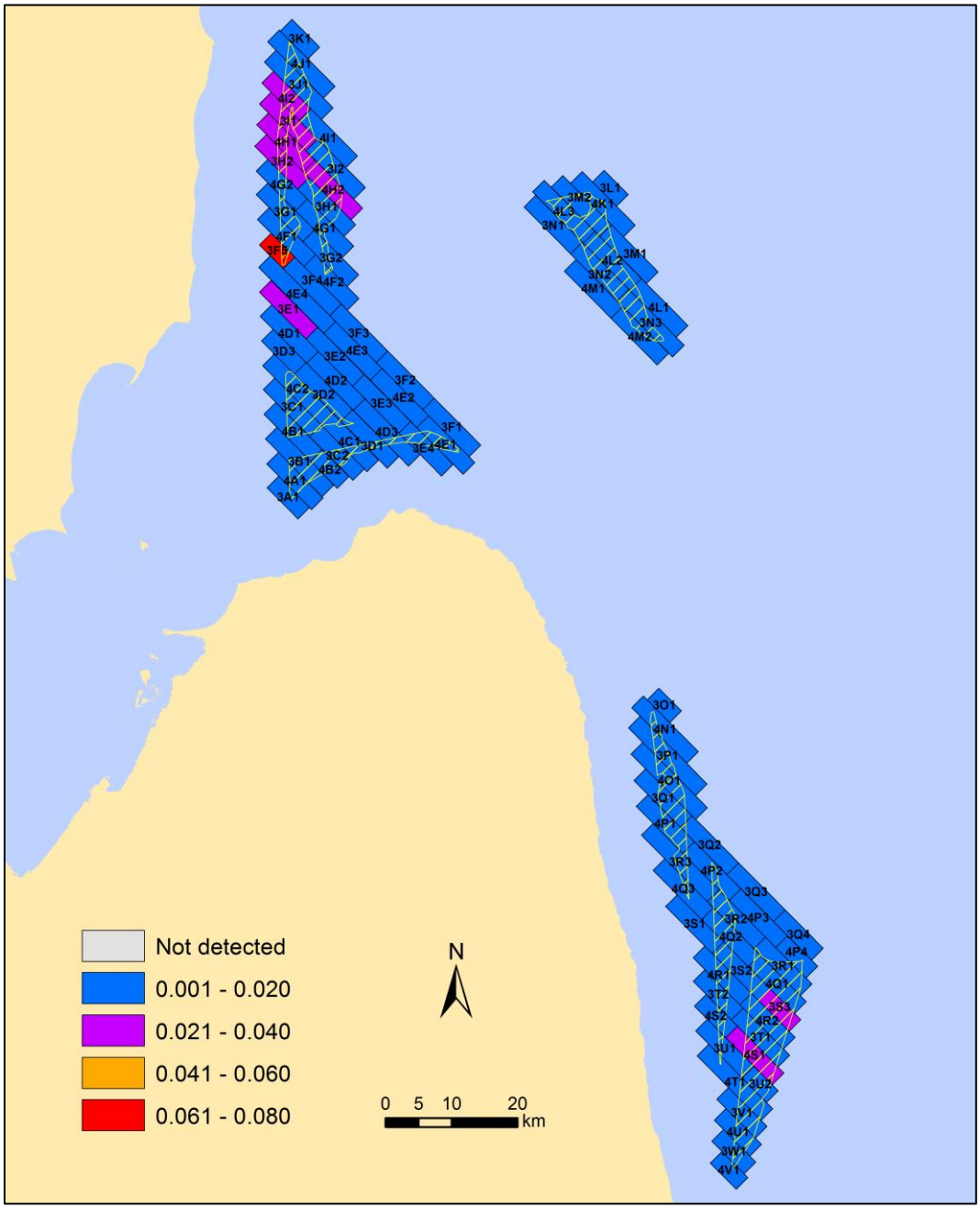

Figure 8. Estimated raw relative total bird density (detections/ha) by transect segment during aerial surveys conducted over central Lake Huron in 2013-2014. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow cross hatching.

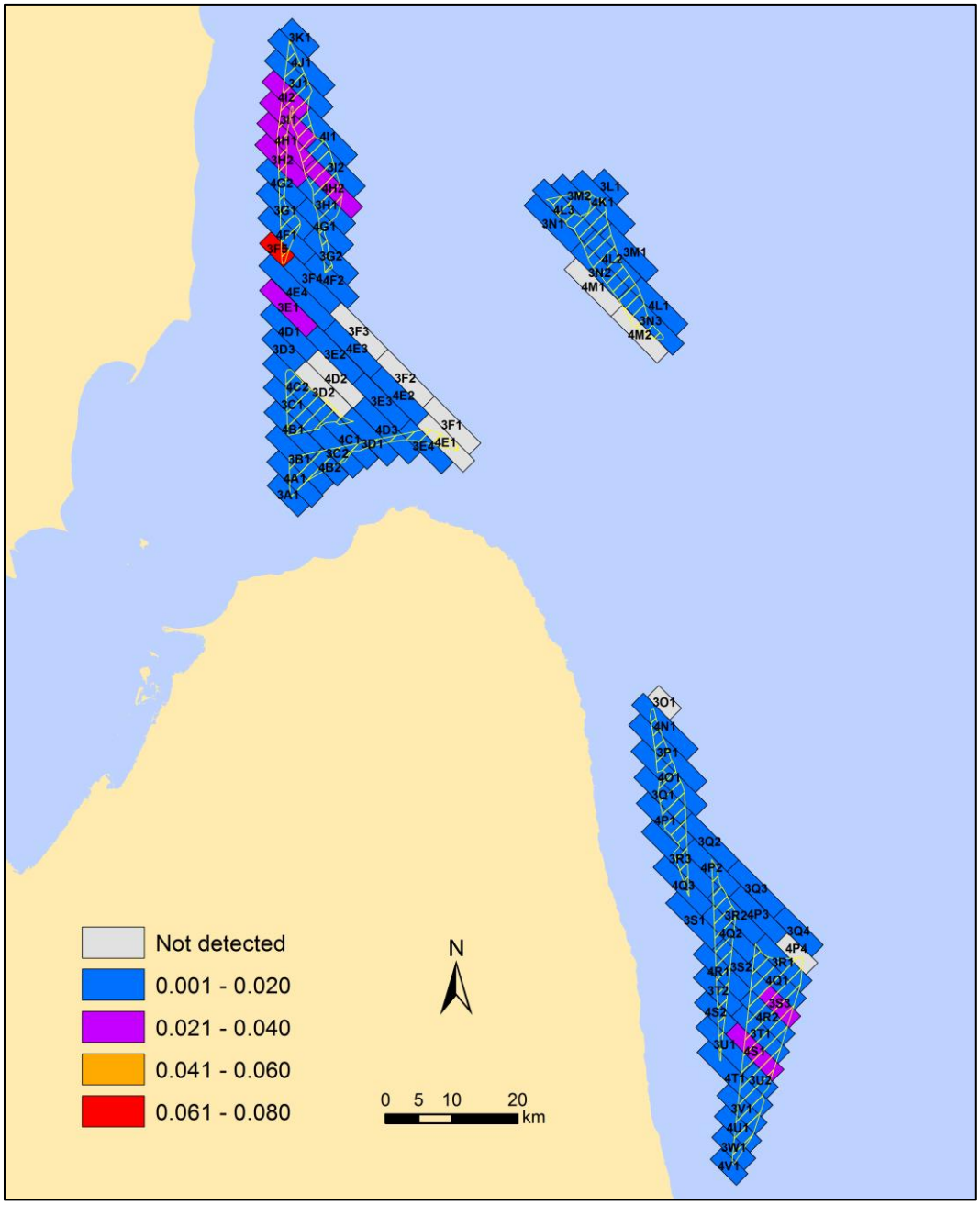

Figure 9. Estimated raw relative waterfowl density (detections/ha) by transect segment during aerial surveys conducted over central Lake Huron in 2013-2014. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow cross hatching.

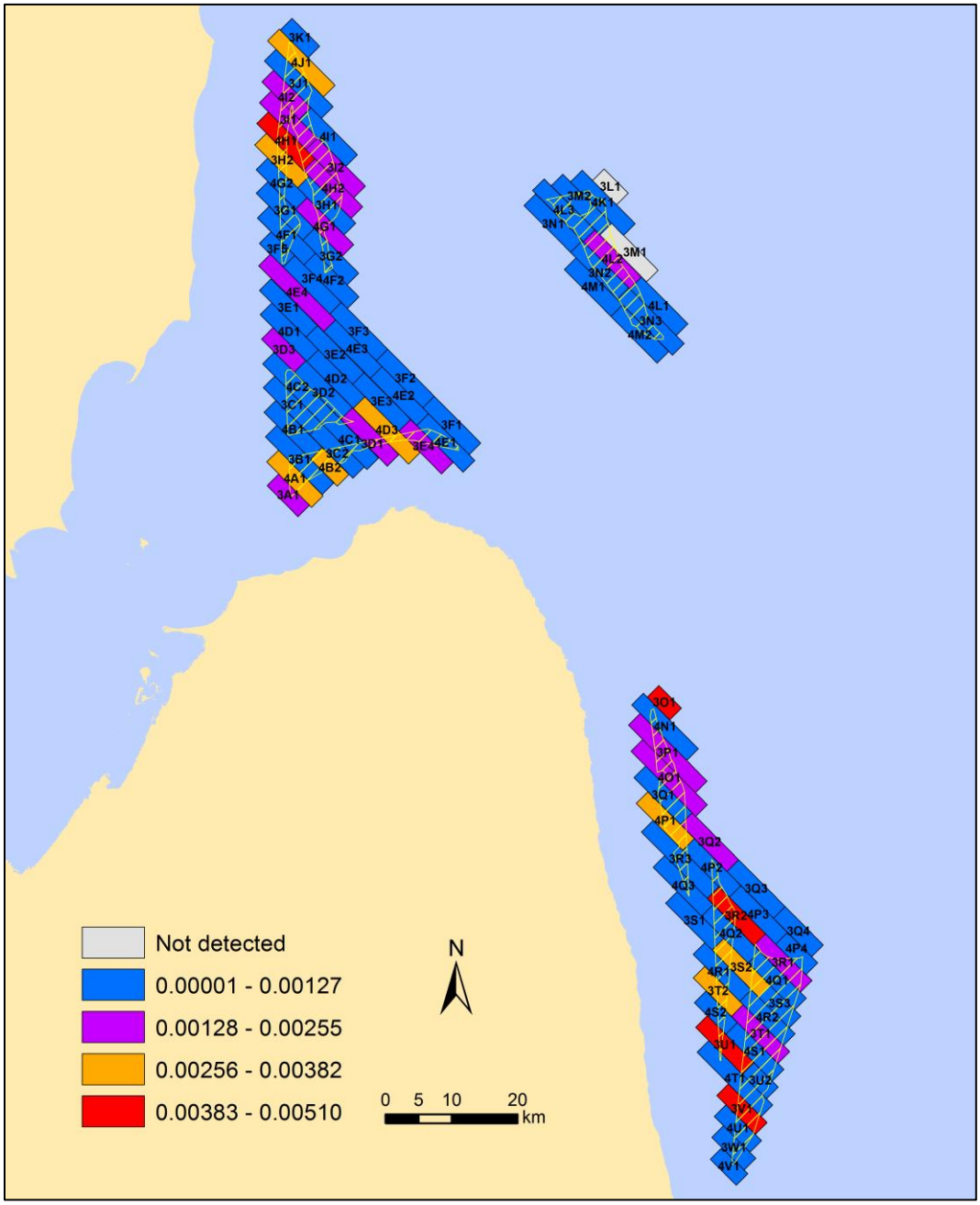

Figure 10. Estimated raw relative waterbird density (detections/ha) by transect segment during aerial surveys conducted over central Lake Huron in 2013-2014. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow cross hatching.

2. **Discussion**: Our bird observations recorded during both phases of the project were consistent with the results of other aerial surveys implemented over the Great Lakes. During aerial surveys conducted by MNFI over other parts of Lake Huron, Monfils and Gehring (2012, 2013) observed widespread use of the lake by sea ducks and gulls. These and other studies typically found swans, geese, and dabbling ducks concentrated near the shoreline (Lott et al. 2011, Monfils and Gehring 2012, 2013). During surveys of Saginaw Bay and northern Lake Huron, Monfils and Gehring (2012, 2013) found that diving ducks were also more abundant near shore compared to sea ducks, but often occurred further from shore than swans, geese, and dabbling ducks. Lott et al. (2011) observed a similar pattern in the Ohio portion of Lake Erie and noted that diving and sea ducks were found in deeper water, whereas dabbling ducks, swans, and geese were concentrated along the shoreline. Gull observations on Lake Erie were widespread and located miles from the shoreline (Lott et al. 2011). Lott et al. (2011) suggested that no area of Lake Erie was devoid of birds, but they observed decreasing numbers of waterfowl and waterbirds with increasing distance from the shoreline. Sea ducks were most common during surveys of western Lake Michigan, with Long-tailed Ducks being the most frequently detected species, followed by Red-breasted Mergansers, and Common Goldeneyes (Mueller et al. 2011). As part of the Lower Great Lakes January Waterfowl Survey conducted in 2006, researchers with the Long Point Waterfowl and Wetlands Research Fund and Canadian Wildlife Service expanded surveys of Lake Ontario beyond the typical nearshore transect located 0.5 km offshore and parallel to the shoreline, with additional transects located 2, 4, 10, and 20 km offshore (Sea Duck Joint Venture 2007). They observed 83% to 100% of the total scaup, Bufflehead, Common Goldeneye, Common Merganser, and Red-breasted Merganser on the shoreline transect and all individuals of these species were recorded with the addition of the 2-km offshore transect (Sea Duck Joint Venture 2007). The nearshore transect accounted for 57% of the total Long-tailed Ducks and 48% of scoter species, the 2-km offshore transect resulted in an additional 30% of both Long-tailed Duck (87% cumulative) and scoter species (76% cumulative), and over 98% of the total Long-tailed Ducks and scoters observed were accounted for after the addition of the 4-km offshore transect (Sea Duck Joint Venture 2007). Given the findings of the above Great Lakes studies, it is not surprising that sea ducks and gulls were the most common bird groups detected during our surveys of offshore central Lake Huron WRAs.

   Sea ducks and gulls appear to be the bird groups most likely to be influenced by future wind energy development within the area we surveyed for this project. Of the species detected during surveys, Long-tailed Duck was most common overall, making up 62.3% of all birds recorded during Phase 2 and 87.1% of the birds detected during Phase 1. Canada Goose was the second most common waterfowl species detected during Phase 2 (11.6% of total), but represented less than 0.1% of the birds recorded during Phase 1. Of the waterbirds detected during surveys, gulls dominated our observations, accounting for 81.5% of all waterbirds and 12.9% of all birds detected during Phase 2. During Phase 1, gulls represented 85.7% of all waterbirds and 5.7% of all birds recorded. More research is needed, such as surveys to monitor numbers and behavior before and after construction, to determine if wind development of

offshore Great Lakes waters would result in negative effects to waterfowl and waterbird populations.

We did not observe strong distributional or seasonal patterns in bird use during Phase 2. Although preliminary comparisons of raw relative total bird and waterfowl densities indicated significantly greater relative densities within particular portions of the survey area during both phases, the observed patterns were not consistent between Phases 1 and 2. We found the greatest relative total bird and waterfowl densities on segments covering the northern portion of the Central Lake Huron WRA during Phase 2, whereas during Phase 1 we recorded our greatest relative bird densities within the Sanilac County WRA. Overall, we detected low relative densities of waterfowl and waterbirds throughout the survey area, with some species/groups (e.g., Canada Goose, Bufflehead, Common Goldeneye, loons) tending to be detected more often on transects closer to the shoreline. Raw relative densities of total birds and waterfowl were similar between fall and spring during Phase 2. We similarly observed no difference in relative densities between fall, winter, and spring during Phase 1.

3. **Concluding Observations**: We documented results from Phase 2 surveys that were largely consistent with our Phase 1 findings. Sea ducks and gulls dominated bird detections, with Long-tailed Duck being the most common species observed. Despite Canada Goose being rarely observed during Phase 1, we commonly detected the species during spring 2014, which may have been a result of the late spring and/or later timing of surveys. None of our transect segments were devoid of birds and we detected small flocks of birds widely distributed throughout the survey area. Although particular portions of the survey area had significantly greater relative bird densities, the pattern was not consistent between Phases 1 and 2 and relative raw densities were low throughout the survey area. We did not observe significant differences in raw relative bird densities among seasons for either of the phases.

4. **Recommendations**: We conducted preliminary analyses to examine general bird use patterns on central Lake Huron in the vicinity of WRAs; however, we recommend further analyses be conducted to better understand bird use of Lake Huron. Observers estimated approximate distances of birds from the aircraft, so we suggest conducting distance sampling analyses (Buckland et al. 2001) for particular bird species or groups (e.g., sea ducks) to refine relative abundance estimates within the project area and examine the influence of environmental conditions (e.g., glare, sea state) on detectability. Furthermore, researchers could also use spatial and abundance data collected for bird locations to help build models to predict bird occurrence on the Great Lakes based on environmental characteristics (e.g., water depth, distance from shoreline). Such predictive models could help guide wind development toward locations less likely to negatively affect migrating or wintering birds. With the large amount of data now available from surveys conducted as part of this and other similar projects implemented on the Great Lakes, there are substantial opportunities to pool data sets and conduct large-scale analyses that address knowledge gaps about bird use of offshore waters.

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