MONITORING AND MAPPING AVIAN RESOURCES IN THE NEARSHORE AND OPEN WATERS OF LAKES ERIE, HURON AND MICHIGAN AS AN EVALUATION TOOL FOR POTENTIAL OFFSHORE WIND DEVELOPMENT AND CONSERVATION PLANNING

MICHIGAN NATURAL FEATURES INVENTORY PHASE I FINAL REPORT

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Cover photograph by Michael J. Monfils.

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INTRODUCTION

Tax credits, renewable energy mandates, and a desire for non-polluting energy sources have increased the development of wind energy world-wide. In 2010, the Michigan Great Lakes Wind Council identified several "wind resource areas" for possible future wind development of offshore areas of the Great Lakes (Mikinetics Consulting and Public Sector Consultants 2010). The Great Lakes offer strong and consistent winds, making them attractive to potential wind energy development; however, little is known about the potential impacts of wind energy development on migrant and wintering waterfowl and waterbirds using the Great Lakes. An estimated three million swans, geese, and ducks annually travel along migration corridors crossing the Great Lakes region (Great Lakes Basin Commission 1975, Bellrose 1980). Some sea ducks, such as Common Goldeneye (*Bucephala clangula*) and Long-tailed Duck (*Clangula hyemalis*) are also known to overwinter on the Great Lakes and major tributaries (Bellrose 1980). Several waterbird species, including loons, grebes, and gulls, use the Great Lakes during migration and wintering periods (Wires et al. 2010). Potential impacts of wind development could be direct, such as collisions with turbines, or indirect, such as displacement from critical sites used for feeding and loafing. Data on bird use of offshore portions of the Great Lakes are generally unavailable for planning and impact assessment purposes.

In fall of 2012, the Michigan Natural Features Inventory (MNFI), in collaboration with the Great Lakes Commission (GLC), began aerial surveys to assess migrant and wintering bird use of several wind resource areas located in Lake Huron. Information collected by MNFI and other regional partners will be used to inform management decisions about potential wind power development in the Great Lakes. This report summarizes the results of MNFI surveys conducted during Phase I of this project.

METHODS

Aerial Surveys

We conducted low-level aerial waterfowl surveys in fall 2012 (late October – early December), winter 2013 (early February – early March), and spring 2013 (late March – mid-May) over the Central Lake Huron Wind Resource Area (WRA) and Sanilac County WRA of Lake Huron (Figure 1). We designated the project survey area as the WRAs plus 2.5 km buffers surrounding each WRA to account for potential wind development activities that might occur in the immediate vicinity. Surveys were done along parallel transects placed systematically across survey areas with random starting points (Figure 2). Transects were oriented along a northwest-southeast axis to minimize sun glare during surveys. We alternated between two sets of transects during each survey to maximize spatial coverage and allow all transects in a given set to be surveyed in one day (Figure 2). Transects in each set were 5 km apart, thus 2.5 km separated the full set of transects. We completed four surveys during the fall, winter, and spring seasons, so each set of transects was surveyed twice during each survey period.

We conducted surveys between one hour after sunrise and approximately 14:00 hours using a Partenavia P68C twin-engine, fixed-wing aircraft. Surveys were only initiated on days with no precipitation and wind speeds less than 25 km/hr (15 mi/hr) and were terminated if wind speeds exceeded 40 km/hr (25 mi/hr) or precipitation impaired visibility or safety. One observer surveyed each side of the aircraft. Surveys were flown at approximately 91 m (300 feet) above water level at speeds of 130-200 km/hr (80-125 mph). We used four distance bands to categorize perpendicular distances of bird groups from the transect: two 100-m bands, a 200-m band, and an open-ended outer band (Figure 3). Distance estimates were used to approximate bird locations and create GIS data layers and could also be used to estimate bird densities that incorporate imperfect detection probabilities (Buckland et al. 2001). We marked boundaries of the distance bands on aircraft windows using a clinometer and appropriate angles for the survey elevation.

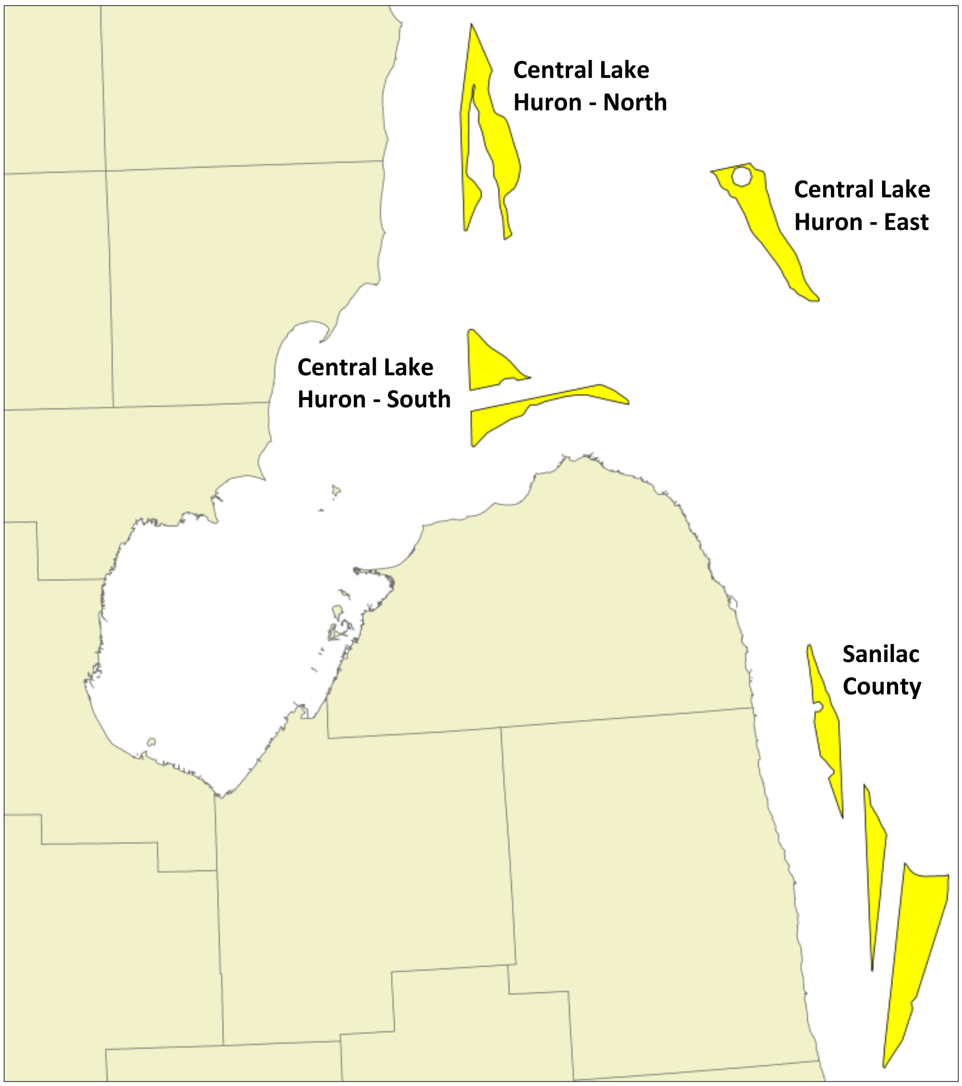

Figure 1. Lake Huron Wind Resource Areas identified by the Michigan Great Lakes Wind Council (Mikinetics Consulting and Public Sector Consultants 2010) that were examined during aerial bird surveys conducted by the Michigan Natural Features Inventory, 2012-2013.

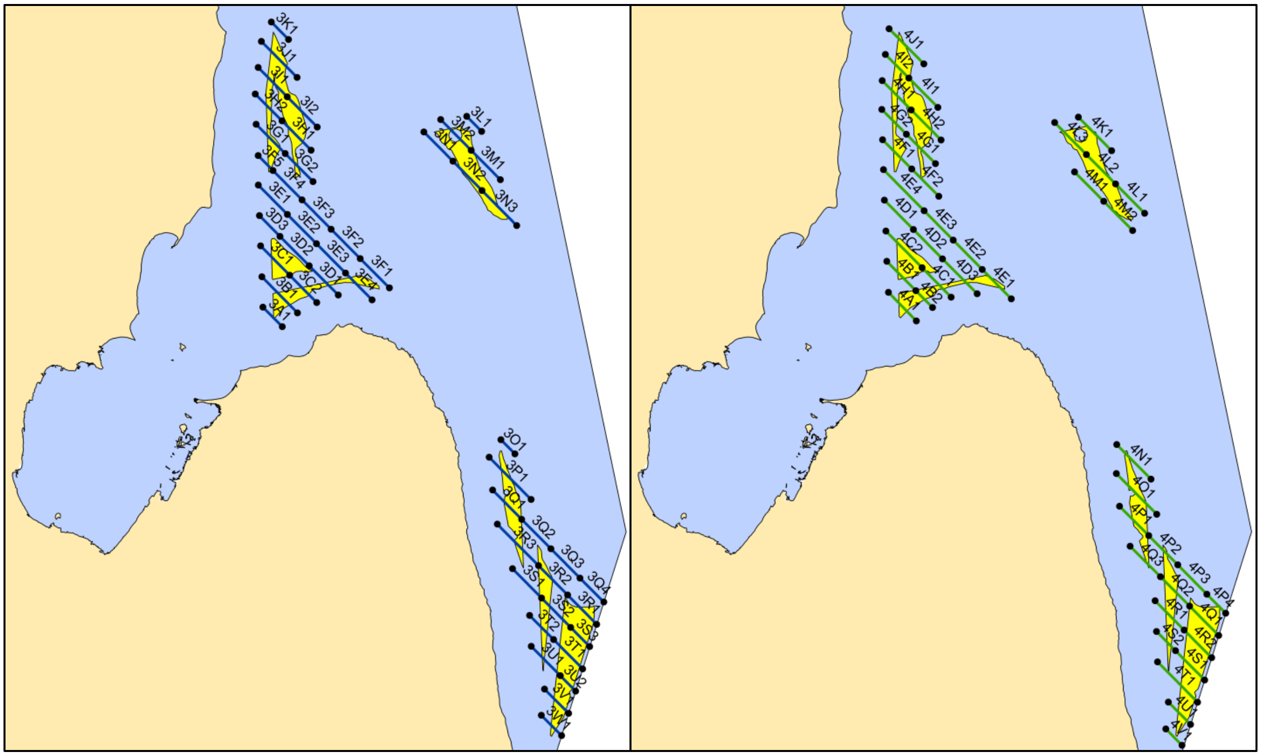

Figure 2. Locations of two sets of transects used for pelagic bird surveys of Lake Huron wind resource areas (yellow polygons) during fall 2012, winter 2013, and spring 2013. One set of transects (i.e., blue – left graphic, or green – right graphic) was surveyed on a given day and the set covered was 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).

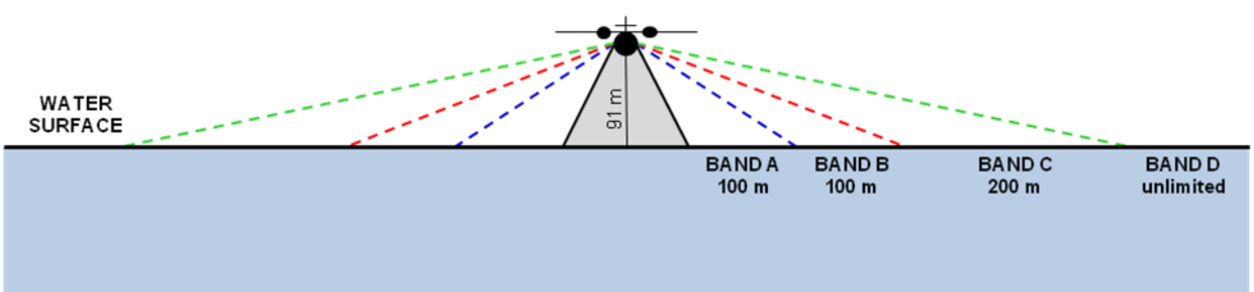

Figure 3. Distance bands used to estimate perpendicular distances of bird groups from transects during 2012 aerial surveys conducted Lake Huron.

For each flock or individual bird detected, we recorded the species (or lowest taxonomic group), number observed, latitude and longitude (using a GPS receiver), and the distance band in which it occurred. We also noted the locations of vessels (e.g., sport fishing, freight transport) for future analyses, because human activities could influence bird locations. Each observer recorded geospatial and voice (i.e., bird species and numbers) data using a Columbus V-900 GPS data logger. At the beginning of each transect segment, we categorized the cloud cover, precipitation level, sea state (according to Beaufort Scale), and glare conditions.

Analysis

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 D (i.e., midway between the outer edge of band C and our assumed maximum survey distance of 1,250 m; Figure 3).

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 at the same transect segment.

RESULTS

We conducted 12 aerial surveys over central Lake Huron, of which four occurred during fall 2012, four in winter 2013, and four in spring 2013. Fall 2012 surveys occurred from late October through early December, winter 2013 surveys were done from early February through early March, and spring 2013 surveys were completed from late March through mid-May. The survey transects covered an area of approximately 2,200 km^2 (850 mi^2). We detected 12,402 birds of 29 species/taxonomic groups during the 12 surveys. On average, we observed greatest relative bird abundance during winter surveys (1,585 birds detected/survey), followed by the spring (912 birds detected/survey) and fall (603 birds detected/survey) periods (Table 1). However, our greatest winter totals occurred during surveys conducted in early March, which likely included spring migrants that had already begun moving into the area. Furthermore, we found no significant difference in mean raw total bird relative abundance ($F_{2,414}$=1.28, P=0.278) or raw waterfowl relative abundance ($F_{2,414}$=1.31, P=0.271) among seasons. We recorded our greatest single-survey total of 2,883 birds on March 29, 2013.

We identified 10 waterfowl species (Table 1): Canada Goose (*Branta canadensis*), Mallard (*Anas platyrhynchos*])), Canvasback (*Aythya valisineria*), Common Eider (*Somateria mollissima*), Surf Scoter (*Melanitta perspicillata*), White-winged Scoter (*Melanitta deglandi*), Long-tailed Duck, Bufflehead (*Bucephala albeola*), Common Goldeneye, and Common Merganser (*Mergus merganser*). We placed other waterfowl that could not be identified to species in the following groups: swans, scaup (Lesser [*Aythya affinis*] and Greater Scaup [*A. marila*] combined), diving ducks, eiders, scoters, mergansers, sea ducks, and unknown duck. We recorded four waterbird species, Common Loon (*Gavia immer*), Double-crested Cormorant, Herring Gull (*Larus argentatus*), and Great Black-backed Gull (*Larus marinus*), and placed the remaining waterbirds that could not be identified to species in five groups (loons, grebes, large gulls, small gulls, and terns). In addition to waterfowl and waterbirds, we observed Bald Eagle (*Haliaeetus leucocephalus*) and a small number of unknown shorebirds. Birds that could not be identified to species or placed in one of the above taxonomic groups were listed as unknown birds, which accounted for approximately 1.3% of the birds detected.

Waterfowl accounted for 92.0% of the total birds recorded, with waterbirds representing only 6.6% of the total and all other birds 1.3% of the total. Sea ducks were the most common bird group observed and represented 90.0% of the total birds recorded. The proportion of the total consisting of sea ducks ranged from 78.8% in spring to 94.4% during winter. Long-tailed Duck was the most common species observed and accounted for 87.1% of the all birds and 97.9% of the sea ducks detected. Swans made up 1.4% of the total waterfowl observed and all other waterfowl taxonomic groups accounted for less than one percent of all waterfowl detected.

We compared average raw relative bird abundance and average raw waterfowl relative abundance among four spatial groupings of the Lake Huron WRAs (Central Lake Huron North, South, and East, and Sanilac County; Figure 1). We observed the greatest single-survey count (2,352 birds), average survey count (685 birds), and average raw relative bird abundance (0.02 bird detections/ha) at the Sanilac County WRA. We found significantly different total bird relative abundance ($F_{3,414}$=9.01, P<0.001) and waterfowl relative abundance ($F_{3,414}$=8.98, P<0.001) among the four groupings of WRAs, with mean density being greatest on segments within the Sanilac County WRA (Figure 4). Waterfowl detections were widespread across the survey area (Figure 5) and raw relative abundance was generally low at all four of the WRA groupings.

Table 1. Total number observed and average flock size for bird taxa detected during aerial surveys conducted over Lake Huron during fall, winter, and spring 2012-2013.

Bird Taxon	Fall 2012 Total	Fall 2012 Mean Flock Size	Winter 2013 Total	Winter 2013 Mean Flock Size	Spring 2013 Total	Spring 2013 Mean Flock Size	All Seasons Total	All Seasons Mean Flock Size
Waterfowl								
Canada Goose					5	1.7	5	1.7
Swans	10	10.0			153	21.9	163	20.4
Mallard					1	1.0	1	1.0
Canvasback					1	1.0	1	1.0
Scaup (Lesser and Greater)	1	1.0			6	1.2	7	1.2
Unknown Diving Ducks			1	1.0	1	1.0	2	1.0
Common Eider	3	1.5					3	1.5
White-winged Scoter			2	2.0			2	2.0
Surf Scoter	12	1.3					12	1.3
Unknown Scoters	12	2.0	11	1.6	4	2.0	27	1.8
Long-tailed Duck	2,087	5.9	5,921	6.2	2,798	7.4	10,806	6.4
Bufflehead	19	3.8	32	1.9	32	4.0	83	2.8
Common Goldeneye	7	2.3	1	1.0	9	2.3	17	2.1
Common Merganser					10	2.5	10	2.5
Unknown Mergansers					2	1.0	2	1.0
Unknown Sea Ducks	31	2.8	18	4.5	22	1.7	71	2.5
Unknown Ducks	12	4.0	91	3.8	98	6.1	201	4.7
Waterbirds								
Common Loon			3	1.0	23	1.4	26	1.4
Unknown Loons	59	1.3					59	1.3
Unknown Grebes	3	1.0			1	1.0	4	1.0
Double-crested Cormorant	1	1.0			21	10.5	22	7.3
Herring Gull			3	1.0			3	1.0
Great Black-backed Bull	1	1.0	1	1.0	1	1.0	3	1.0
Large Gulls	146	1.2	111	1.3	432	1.7	689	1.5
Small Gulls	4	2.0			6	1.2	10	1.4
Unknown Terns					7	1.2	7	1.2
Bald Eagle					1	1.0	1	1.0
Unknown Shorebirds	1	1.0			6	2.0	7	1.8
Unknown Birds	4	1.3	145	3.9	9	3.0	158	3.7
Grand Total	2,413	3.4	6,340	5.1	3,649	4.2	12,402	4.3

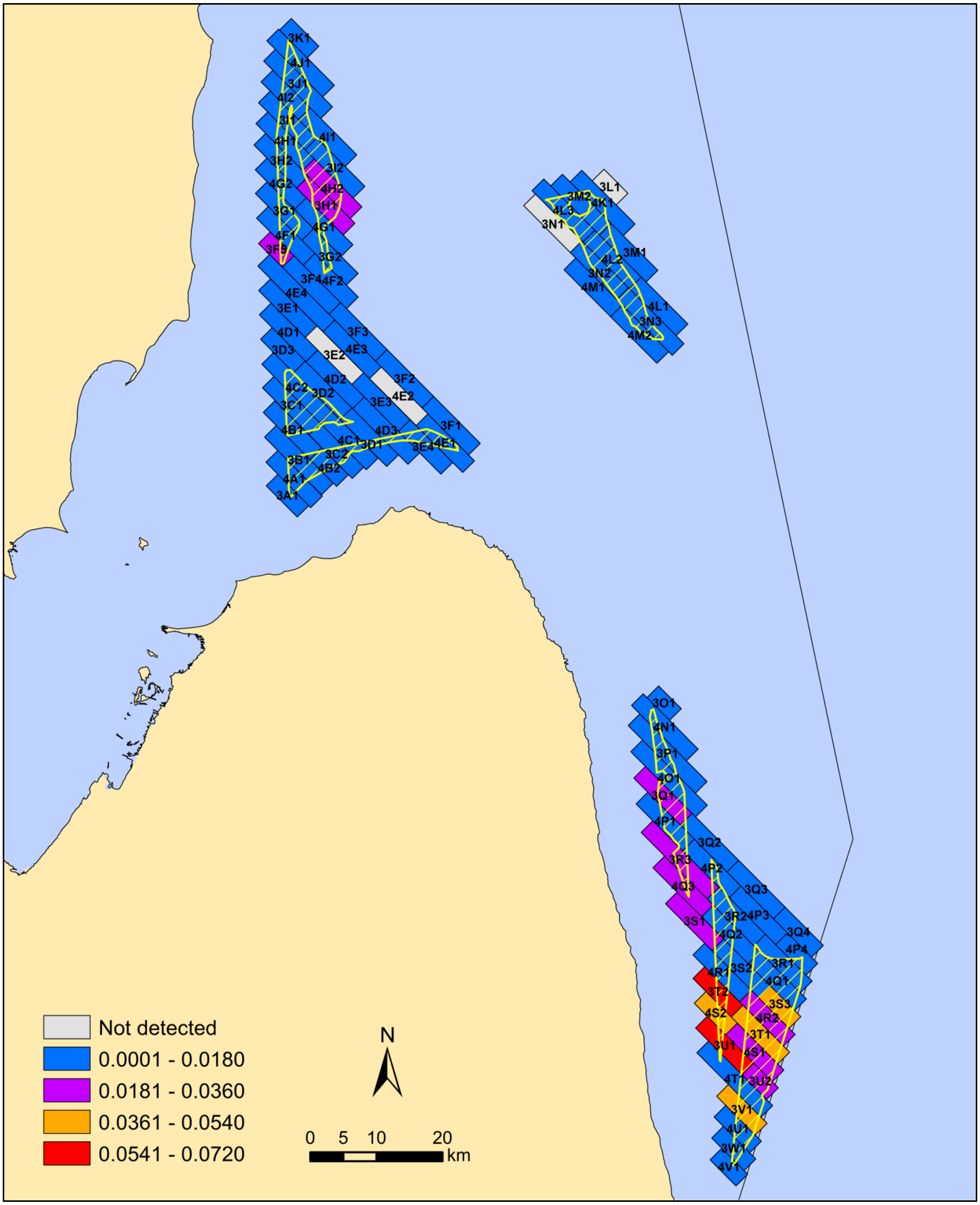

Figure 4. Estimated raw waterfowl relative abundance (detections/ha) by transect segment during aerial surveys conducted over central Lake Huron in 2012-2013. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow cross hatching.

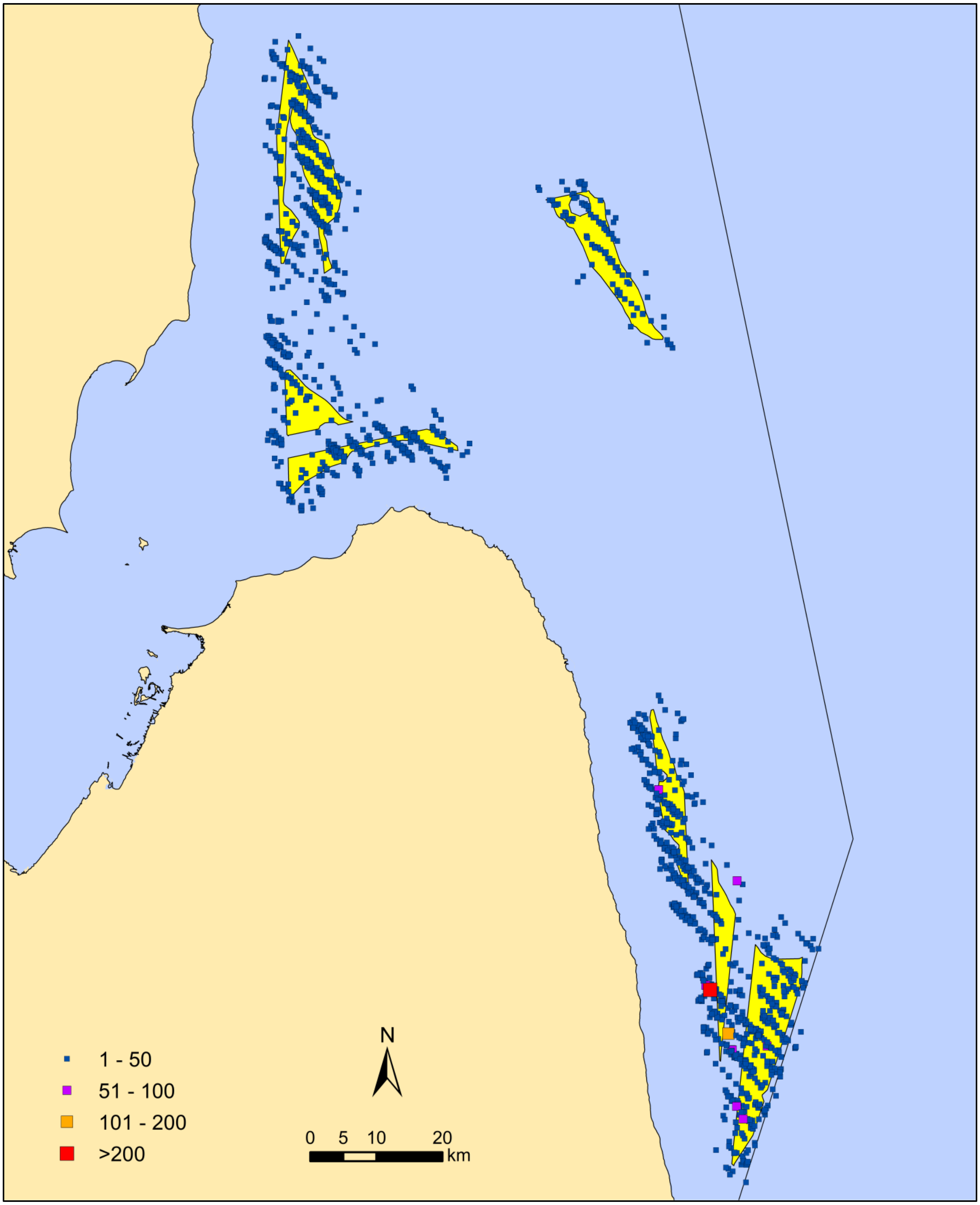

Figure 5. Approximate locations and relative abundance of waterfowl observed during aerial surveys conducted over central Lake Huron in 2012-2013. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

Sea ducks were the dominant waterfowl species observed, so patterns of sea duck relative abundance (Figure 6) and distribution (Figures 7) followed those observed for all waterfowl combined (Figures 4 and 5). Sea ducks were observed across the study area, but Bufflehead, Common Goldeneye, and mergansers were observed more regularly on the Central Lake Huron North, Central Lake Huron South, and Sanilac County WRAs compared to Central Lake Huron East (Figure 8). Although swan observations were sporadic, we detected them only on the Central Lake Huron South and Sanilac County WRAs (Figure 8).

Waterbirds accounted for a small (6.6%) proportion of the total birds recorded (Table 1). Gulls were the dominant waterbird group detected and accounted for 85.7% of the total waterbirds observed. Although we did not attempt to identify gulls to species, 98.6% of the gulls detected were categorized as large gulls (Table 1). Loons were the next most common group of waterbirds observed, but only accounted for 10.3% of the total waterbirds detected. Double-crested Cormorant accounted for 2.7% of the waterbirds recorded and grebes and terns each made up less than one percent of all waterbirds detected.

Relative abundance (detections/ha) of waterbirds was low throughout the study area, but tended to be greatest on segments near the Central Lake Huron South and Sanilac County WRAs (Figure 9). Waterbirds were widespread and detected in small numbers across the study area (Figure 10). We did not observe any pattern in the locations of waterbird observations, regardless of waterbird taxonomic group (Figure 11).

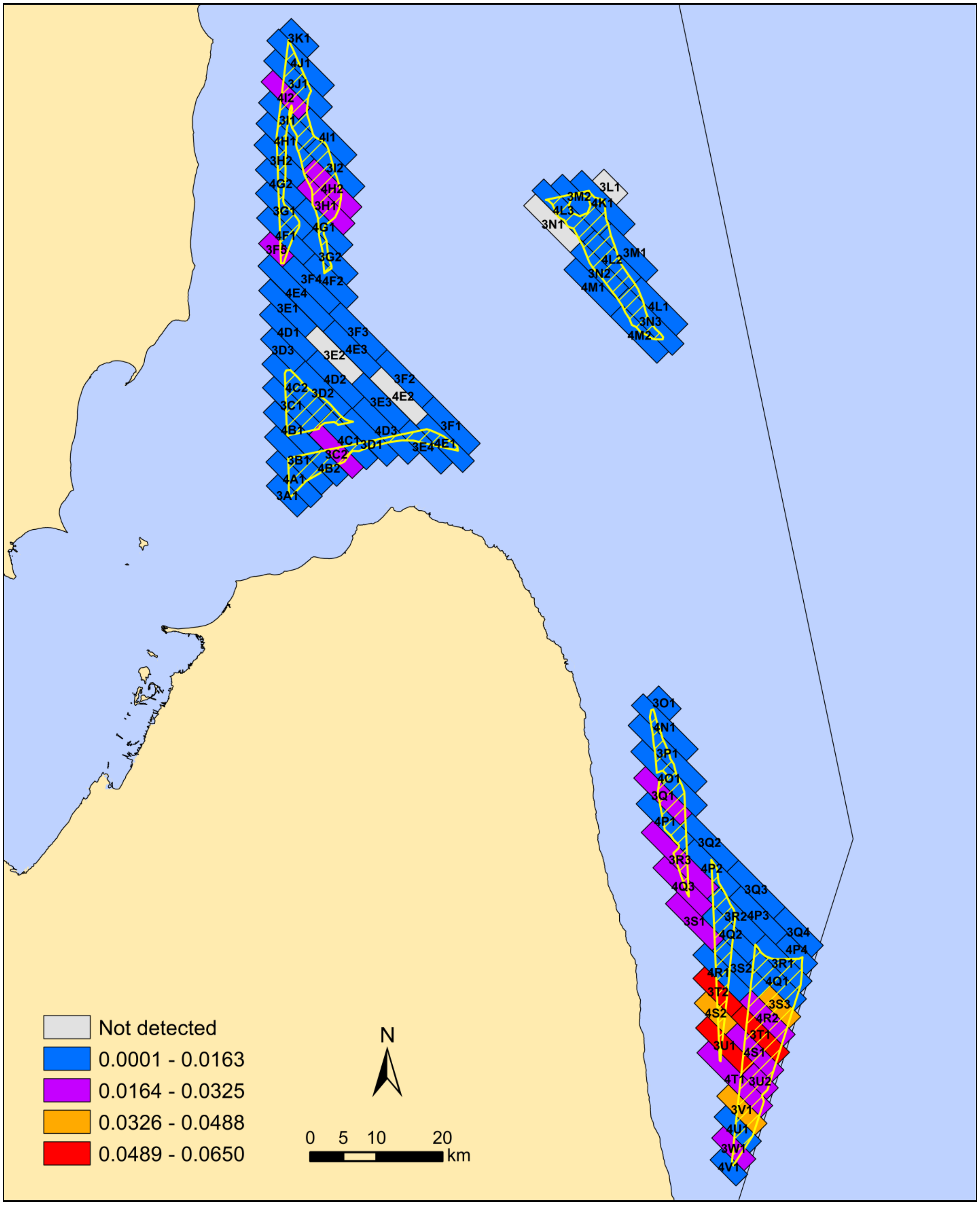

Figure 6. Estimated raw sea duck relative abundance (detections/ha) by transect segment during aerial surveys conducted over central Lake Huron in 2012-2013. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow cross hatching.

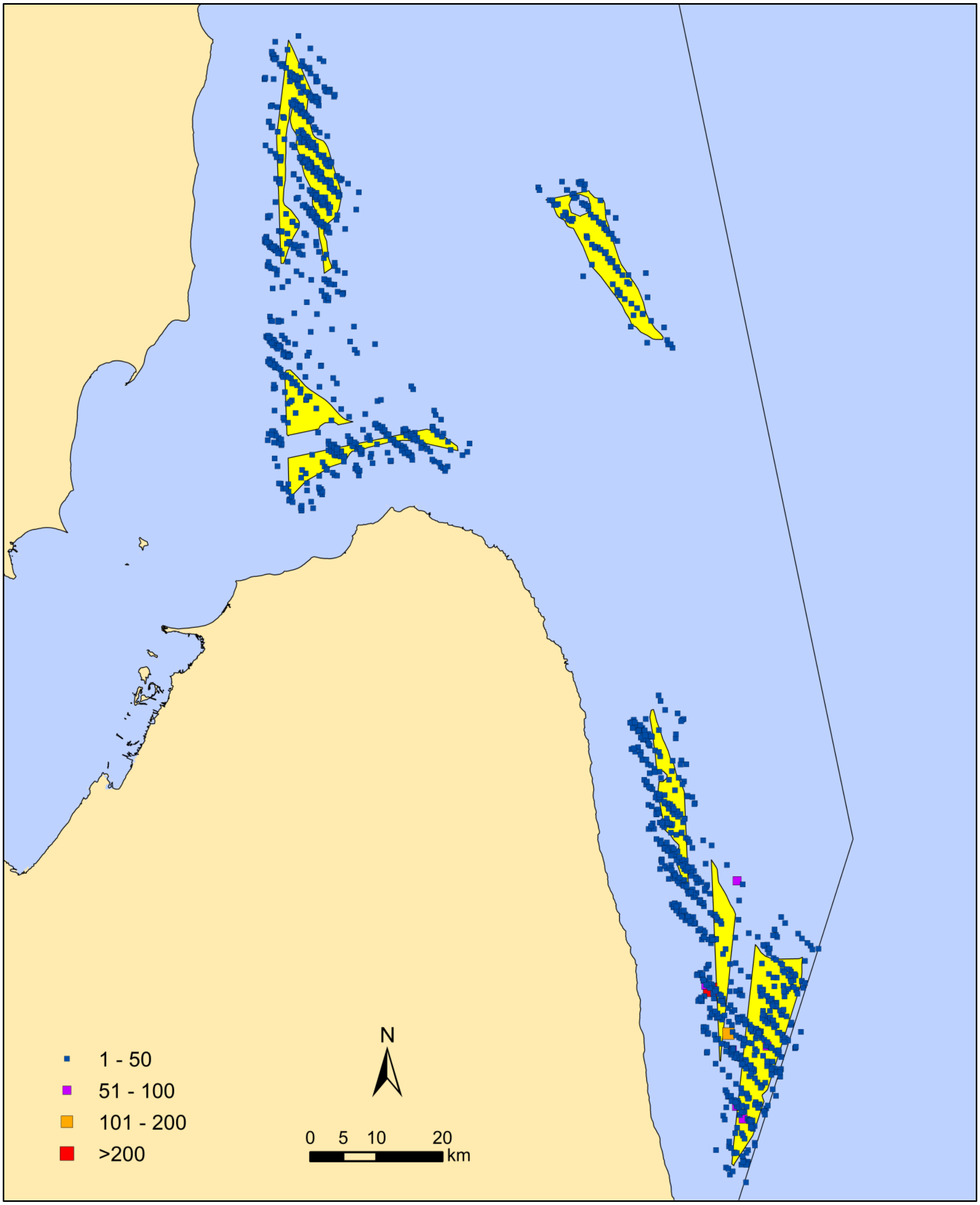

Figure 7. Approximate locations and relative abundance of sea ducks observed during aerial surveys conducted over central Lake Huron in 2012-2013. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

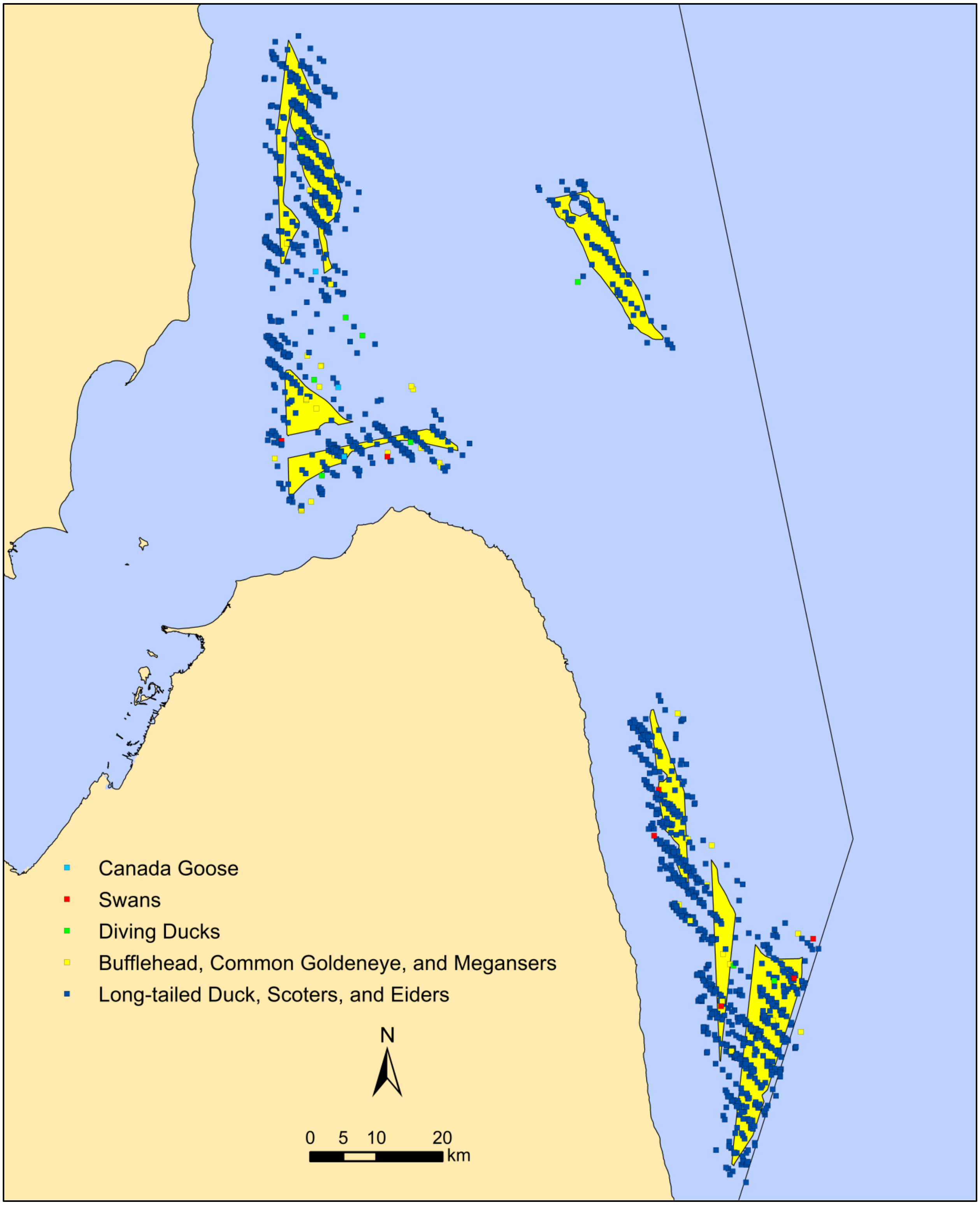

Figure 8. Approximate locations of waterfowl within five species groupings during aerial surveys conducted over central Lake Huron in 2012-2013. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

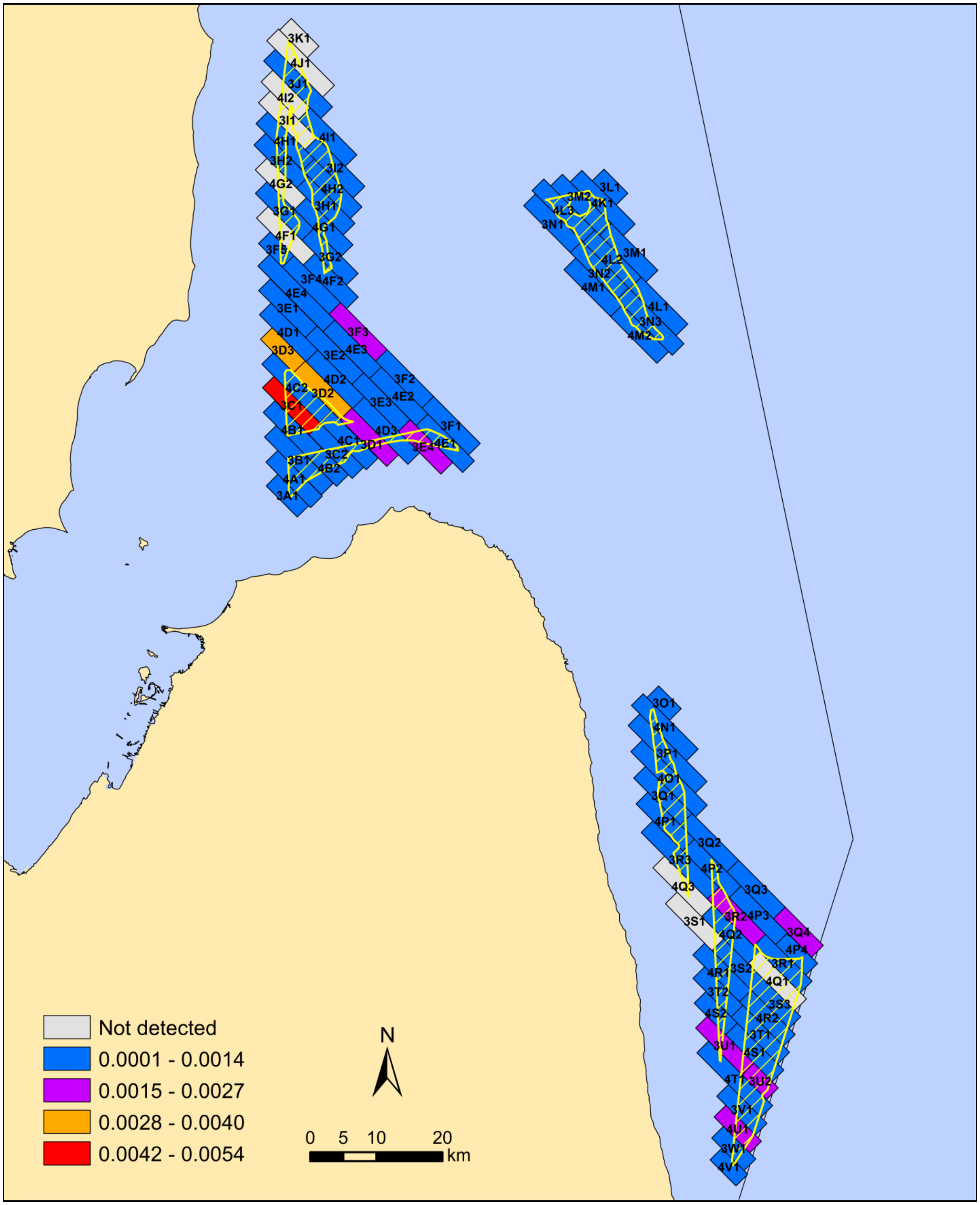

Figure 9. Estimated raw waterbird relative abundance (detections/ha) by transect segment during aerial surveys conducted over central Lake Huron in 2012-2013. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow cross hatching.

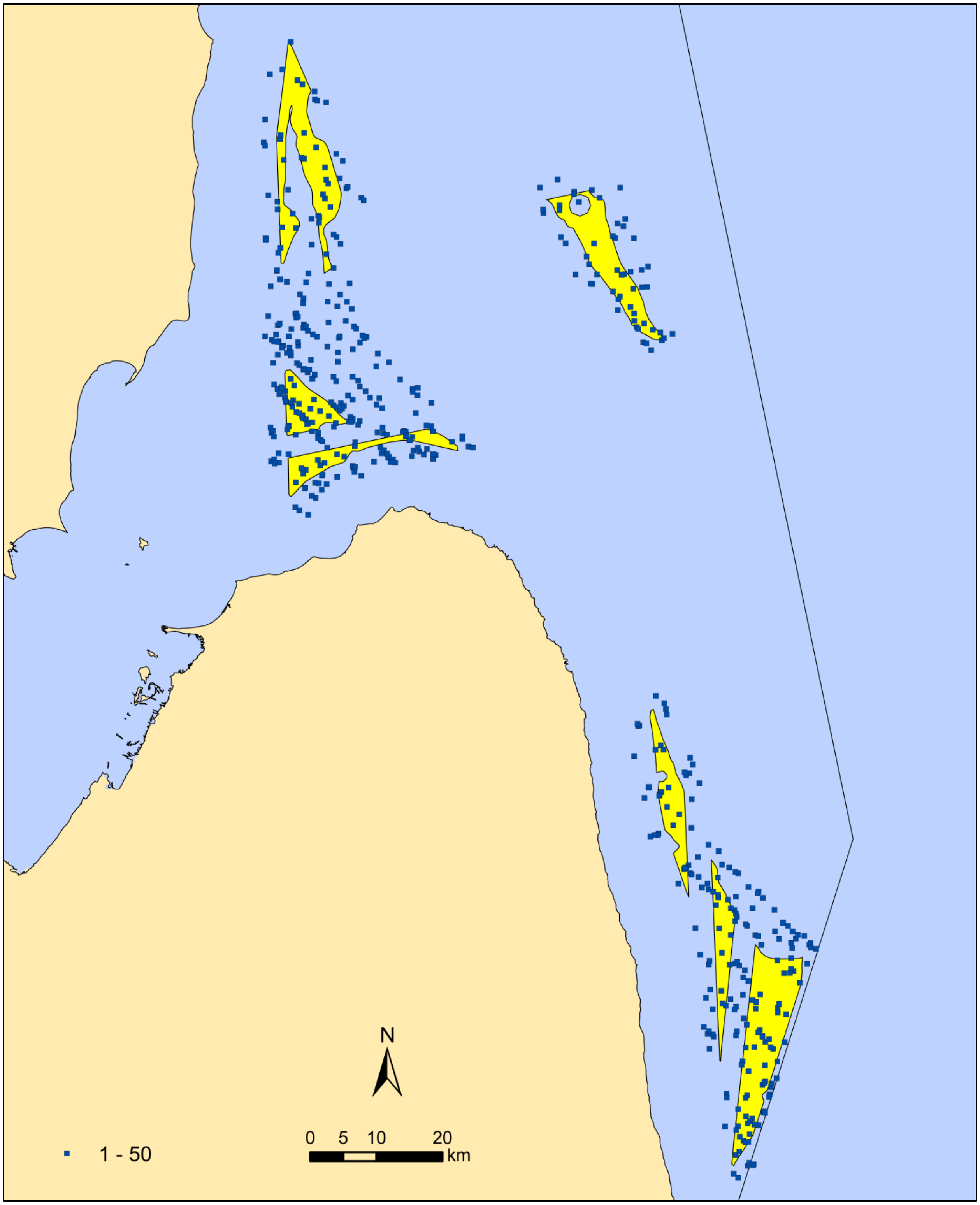

Figure 10. Approximate locations and relative abundance of waterbirds observed during aerial surveys conducted over central Lake Huron in 2012-2013. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

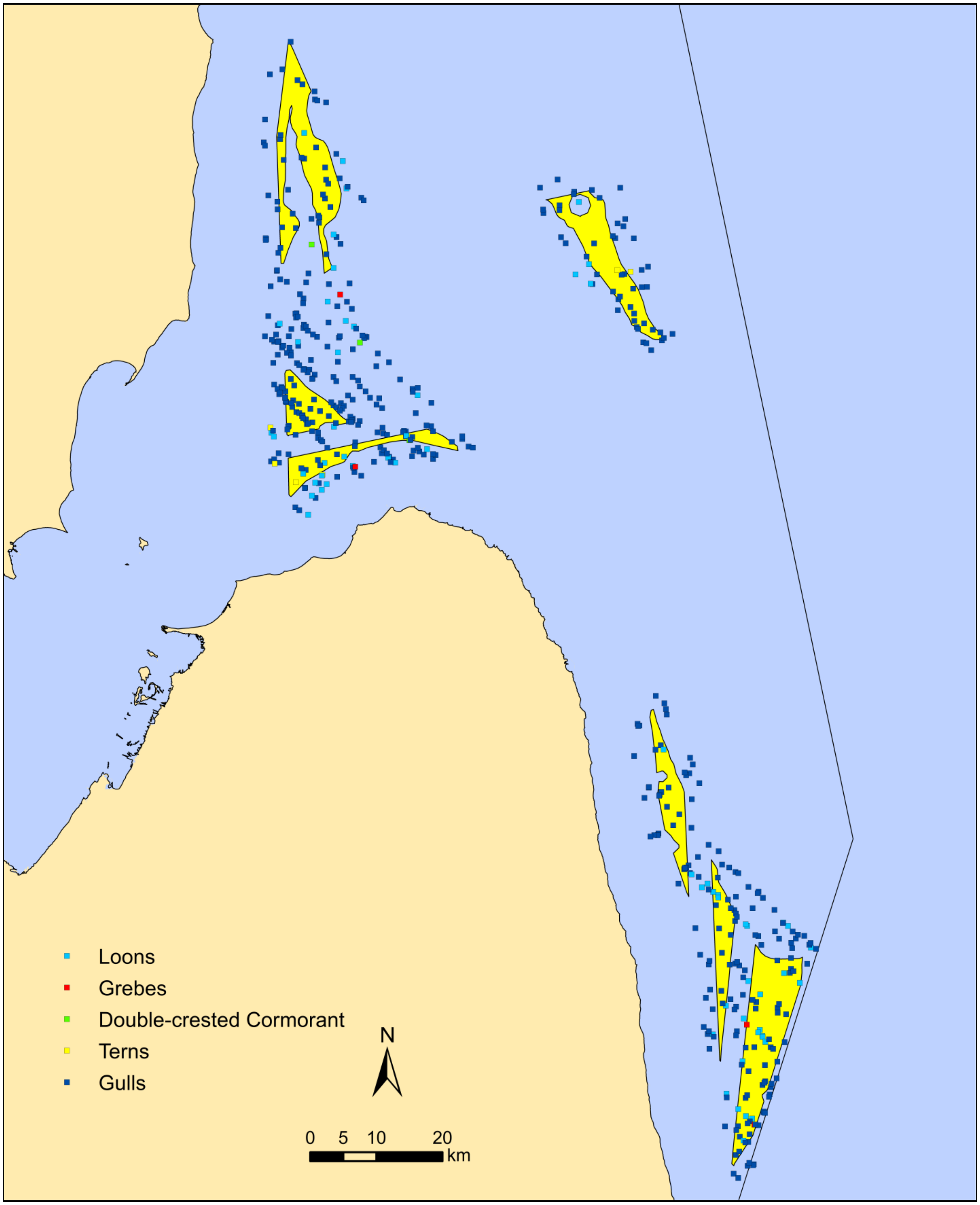

Figure 11. Approximate locations of waterbirds within five species groupings during aerial surveys conducted over central Lake Huron in 2012-2013. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

DISCUSSION

Our observations were consistent with those of similar surveys conducted in recent years over parts of the Great Lakes. During aerial surveys conducted by the MNFI over other portions of Lake Huron, Monfils and Gehring (2012, 2013) similarly observed widespread use of the lake by sea ducks and gulls. Researchers conducting surveys over both nearshore and offshore portions of the Great Lakes 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). In 2006 as part of the Lower Great Lakes January Waterfowl Survey, 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 to include additional transects located 2, 4, 10, and 20 km offshore. 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 the central Lake Huron WRAs located far from shore.

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 distance sampling analysis (Buckland et al. 2001) be conducted 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. Researchers could also use the spatial data collected for bird locations to help build models to predict bird occurrence on the Great Lakes based on habitat conditions (e.g., water depth, distance from shoreline). With the recent increase in the number of aerial bird surveys being conducted on various parts of the Great Lakes, there may be opportunities to pool data sets and conduct large-scale analyses that address knowledge gaps about bird use of offshore waters.

ACKNOWLEDGEMENTS

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