

Appendix I: Garden Peninsula, Michigan, Lake Michigan

This appendix provides information on the numbers and information used in selecting the Garden Peninsula, Michigan, portion of Lake Michigan as a Sea Duck Joint Venture key habitat site. All aerial survey data were collected during a project led by Kevin Kenow (U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin; Kenow et al. 2021). Additional information that assisted in designating key site boundaries, especially those consisting mainly of Long-tailed Ducks, comes from descriptions of habitat use and movements of Long-tailed Ducks (*Clangula hyemalis*) radio-marked on Lake Michigan provided by Fara (2018).

Brief Description of Aerial Surveys

Aerial surveys were conducted during September through May 2009 through 2014. Survey areas were selected to evaluate avian risk to type E botulism and to provide information on waterbird distributions to inform offshore wind energy development. Timing and selection of areas to be surveyed in a given month were focused on these issues and were highly influenced by plane availability and weather conditions. Surveys were flown along fixed-width transects. Transects generally paralleled shorelines and extended up to 32 km (20 mi) offshore. Surveys were flown at an average air speed of about 200 km/h (125 mph) and at an altitude of about 61 to 76 m (200 to 250 ft) above the water using a U.S. Fish and Wildlife Service (USFWS) fixed-wing aircraft (Partenavia P.68 Observer¹). Two observers, one on each side of the plane, identified and tallied waterbirds within 200 m wide (1/8-mi) strip transects on either side of the plane. Distances were established using a clinometer, and the portion of the transect band beneath the plane that was not observable was estimated at 70.4 m (35.2 x 2) and 88 m (44 x 2) at 61 and 76 m above ground level (AGL), respectively.

Brief Description of Appendix Contents

This appendix contains nine tables and three figures. Tables S1, S4, and S7 provide the raw counts of sea ducks observed on (within the 200 m transect) and off (beyond the 200 m transect) transect for the surveys that were encompassed by the Garden Peninsula, Michigan, Lake Michigan key site during fall (September–November), winter (December–February), and spring (March–May), respectively. Raw counts do not account for the visibility factors that may affect bird detectability during aerial surveys; therefore, we estimated the number of sea ducks using a visibility correction factor (Hodges et al. 2008) and present those numbers in tables S2, S5, and S8 for fall, winter, and spring, respectively. Tables S3, S6, and S9 provide the transect distance, observed area within the 200-m transect width at 61 m AGL, and the density of all sea ducks for both the raw and visibility-corrected counts for fall, winter, and spring, respectively. Figures 1, 2, and 3 illustrate the distribution of sea ducks by month for the fall, winter, and spring seasons, respectively. In addition, all figures outline the aerial survey areas encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

References

- Fara, L. J. 2018. Migration patterns, habitat use, prey items, and hunter harvest of Long-tailed Ducks (*Clangula hyemalis*) that overwinter on Lake Michigan. MS thesis, Southern Illinois University Carbondale, Carbondale, Illinois.
- Hodges, J. I., D. J. Groves, and B. P. Conant. 2008. Distribution and abundance of waterbirds near shore in Southeast Alaska. *Northwestern Naturalist* 89:85–96.
- Kenow, K. P., Fox, T. J., Houdek, S. C., Fara, L. J., and Lubinski, B. 2021. Lake Michigan Sea Duck Survey Data, 2009-2014: U.S. Geological Survey data release, <https://doi.org/10.5066/P9FGR77R>.

¹ Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. government.

Table S1. Raw counts of sea ducks, by species,¹ observed on and off transect during aerial surveys conducted over Lake Michigan during fall (September–November). Survey areas listed are only those encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

Survey area	Survey date	On/Off transect	LTDU	WWSC	BLSC	SUSC	SCOT	COME	RBME	HOME	MERG	COGO	BUFF	Total sea ducks
Door County–Garden Peninsula	16–17 Sep 2010	On	0	18	0	0	0	24	0	0	0	0	0	42
		Off	0	1	0	0	0	60	0	0	0	0	0	61
Door County–Garden Peninsula	7–8 Oct 2010	On	36	28	0	0	0	476	0	0	0	0	0	540
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Door County–Garden Peninsula	9–11 Nov 2010	On	848	406	0	0	0	287	9	0	0	52	153	1,755
		Off	75	0	0	0	0	0	0	0	0	0	0	75
Door County–Garden Peninsula	13 Sep 2011	On	80	0	0	0	0	281	0	0	0	0	0	361
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Door County–Garden Peninsula	5 Oct 2011	On	0	2	0	0	0	27	0	0	0	4	0	33
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Door County–Garden Peninsula	27 Sep 2012	On	0	0	0	0	2	0	20	0	15	0	0	37
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Door County–Garden Peninsula	29 Nov 2012	On	583	4	57	0	0	69	9	0	213	36	1	972
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Door County–Garden Peninsula	17–18 Sep 2013	On	0	0	0	0	0	44	0	0	32	0	0	76
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Door County–Garden Peninsula	23–24 Oct 2013	On	90	0	0	0	21	20	123	0	130	12	0	396
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Manistique Bay ²	16 Sep 2014	On	0	6	0	0	0	0	3	0	57	2	0	68
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Manistique Bay ²	21 Oct 2014	On	4686	4	0	0	5	0	68	0	44	0	0	4807
		Off	925	0	0	0	0	0	0	0	0	0	0	0
Total Garden Peninsula		On	6323	468	57	0	28	1228	232	0	491	106	154	9087
Lake Michigan key site		Off	1000	1	0	0	0	60	0	0	0	0	0	925

¹ LTDU = Long-tailed Duck (*Clangula hyemalis*), WWSC = White-winged Scoter (*Melanitta deglandi*), BLSC = Black Scoter (*Melanitta americana*), SUSC = Surf Scoter (*Melanitta perspicillata*), SCOT = unidentified scoter species, COME = Common Merganser (*Mergus merganser*), RBME = Red-breasted Merganser (*Mergus serrator*), HOME = Hooded Merganser (*Lophodytes cucullatus*), MERG = unidentified merganser species, COGO = Common Goldeneye (*Bucephala clangula*), and BUFF = Bufflehead (*Bucephala albeola*).

² Manistique Bay is a shortened version of the Door County–Garden Peninsula survey. Transects start at the southern end of the Garden Peninsula and run north, parallel to the peninsula.

Table S2. Estimated counts of sea ducks, by species or species groups,¹ observed on and off transect during aerial surveys conducted over Lake Michigan during fall (September–November) using a visibility correction factor (Hodges et al. 2008). Correction factor multipliers are shown in parentheses under each species or species group. Survey areas listed are only those encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

Survey area	Survey date	On/Off transect	LTDU (3.46)	SCOTERS (1.74)	MERGANSERS (1.45)	COGO (1.60)	BUFF (3.26)	Total sea ducks
Door County– Garden Peninsula	16–17 Sep 2010	On	0	31	35	0	0	66
		Off	0	2	87	0	0	89
Door County– Garden Peninsula	7–8 Oct 2010	On	125	49	690	0	0	863
		Off	0	0	0	0	0	0
Door County– Garden Peninsula	9–11 Nov 2010	On	2934	706	429	83	499	4562
		Off	260	0	0	0	0	260
Door County– Garden Peninsula	13 Sep 2011	On	277	0	407	0	0	684
		Off	0	0	0	0	0	0
Door County– Garden Peninsula	5 Oct 2011	On	0	3	39	6	0	49
		Off	0	0	0	0	0	0
Door County– Garden Peninsula	27 Sep 2012	On	0	3	51	0	0	54
		Off	0	0	0	0	0	0
Door County– Garden Peninsula	29 Nov 2012	On	2017	106	422	58	3	2606
		Off	0	0	0	0	0	0
Door County– Garden Peninsula	17–18 Sep 2013	On	0	0	110	0	0	110
		Off	0	0	0	0	0	0
Door County– Garden Peninsula	23–24 Oct 2013	On	311	37	396	19	0	763
		Off	0	0	0	0	0	0
Manistique Bay ²	16 Sep 2014	On	0	10	87	3	0	101
		Off	0	0	0	0	0	0
Manistique Bay ²	21 Oct 2014	On	16,214	16	162	0	0	16,392
		Off	3201	0	0	0	0	3201
Total Garden Peninsula		On	21,878	961	2828	169	502	26,340
Lake Michigan key site		Off	3461	2	87	0	0	3550

¹ LTDU = Long-tailed Duck (*Clangula hyemalis*), SCOTERS = Scoter species, MERGANSER = Merganser species, COGO = Common Goldeneye (*Bucephala clangula*), and BUFF = Bufflehead (*Bucephala albeola*).

² Manistique Bay is a shortened version of the Door County–Garden Peninsula survey. Transects start at the southern end of the Garden Peninsula and run north, parallel to the peninsula.

Table S3. Fall (September–November) density estimates for all sea ducks combined using both raw counts and visibility corrected (Hodges et al. 2008) count estimates for observations on transect. Survey areas listed are only those encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

Survey area	Survey date	Transect distance (km)	Transect area (km ²) at 61 m AGL	Raw count density (sea ducks/km ²)	Corrected count density (sea ducks/km ²)
Door County–Garden Peninsula	16–17 Sep 2010	584.3	192.6	0.2	0.3
Door County–Garden Peninsula	7–8 Oct 2010	974.4	321.2	1.7	2.7
Door County–Garden Peninsula	9–11 Nov 2010	961.0	316.7	5.5	14.7
Door County–Garden Peninsula	13 Sep 2011	916.7	302.1	1.2	2.3
Door County–Garden Peninsula	5 Oct 2011	970.6	319.9	0.1	0.2
Door County–Garden Peninsula	27 Sep 2012	607.9	200.4	0.2	0.3
Door County–Garden Peninsula	29 Nov 2012	420.3	138.5	7.0	18.8
Door County–Garden Peninsula	17–18 Sep 2013	558.6	184.1	0.4	0.6
Door County–Garden Peninsula	23–24 Oct 2013	424.3	139.8	2.8	5.5
Manistique Bay ¹	16 Sep 2014	551.7	181.8	0.4	0.6
Manistique Bay ¹	21 Oct 2014	550.5	181.4	26.5	90.4
Total Garden Peninsula Lake Michigan key site		7520.3	2478.6	3.7	10.6

¹ Manistique Bay is a shortened version of the Door County–Garden Peninsula survey. Transects start at the southern end of the Garden Peninsula and run north, parallel to the peninsula.

Table S4. Raw counts of sea ducks, by species¹, observed on and off transect during aerial surveys conducted over Lake Michigan during winter (December–February). Survey areas listed are only those encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

Survey area	Survey date	On/Off transect	LTDU	WWSC	BLSC	SUSC	SCOT	COME	RBME	HOME	MERG	COGO	BUFF	Total sea ducks
Door County–Garden Peninsula	13 Jan 2011	On	1023	10	0	0	0	2454	73	0	0	239	14	3813
		Off	130	0	0	0	0	0	0	0	0	0	0	130
Door County–Garden Peninsula	6 Dec 2011	On	1582	0	0	0	24	83	3	0	20	14	6	1732
		Off	675	0	0	0	0	0	0	0	0	0	0	675
Door County–Garden Peninsula	14 Feb 2012	On	179	5	0	0	0	227	119	0	27	238	17	812
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Total Garden Peninsula		On	2784	15	0	0	24	2764	195	0	47	491	37	6357
Lake Michigan key site		Off	805	0	0	0	0	0	0	0	0	0	0	805

¹ LTDU = Long-tailed Duck (*Clangula hyemalis*), WWSC = White-winged Scoter (*Melanitta deglandi*), BLSC = Black Scoter (*Melanitta americana*), SUSC = Surf Scoter (*Melanitta perspicillata*), SCOT = unidentified scoter species, COME = Common Merganser (*Mergus merganser*), RBME = Red-breasted Merganser (*Mergus serrator*), HOME = Hooded Merganser (*Lophodytes cucullatus*), MERG = unidentified merganser species, COGO = Common Goldeneye (*Bucephala clangula*), and BUFF = Bufflehead (*Bucephala albeola*).

Table S5. Estimated counts of sea ducks, by species or species groups,¹ observed on and off transect during aerial surveys conducted over Lake Michigan during winter (December–February) using a visibility correction factor (Hodges et al. 2008). Correction factor multipliers are shown in parentheses under each species or species group. Survey areas listed are only those encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

Survey area	Survey date	On/Off transect	LTDU (3.46)	SCOTERS (1.74)	MERGANSERS (1.45)	COGO (1.60)	BUFF (3.26)	Total sea ducks
Door County–Garden Peninsula	13 Jan 2011	On	3540	17	3664	382	46	7649
		Off	450	0	0	0	0	450
Door County–Garden Peninsula	6 Dec 2011	On	5474	42	154	22	20	5711
		Off	2336	0	0	0	0	2336
Door County–Garden Peninsula	14 Feb 2012	On	619	9	541	381	55	1605
		Off	0	0	0	0	0	0
Total Garden Peninsula		On	9633	68	4359	785	121	14,965
Lake Michigan key site		Off	2786	0	0	0	0	2786

¹ LTDU = Long-tailed Duck (*Clangula hyemalis*), SCOTERS = Scoter species, MERGANSER = Merganser species, COGO = Common Goldeneye (*Bucephala clangula*), and BUFF = Bufflehead (*Bucephala albeola*).

Table S6. Winter (December–February) density estimates for all sea ducks combined using both raw counts and visibility corrected (Hodges et al. 2008) count estimates for observations on transect. Survey areas listed are only those encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

Survey area	Survey date	Transect distance (km)	Transect area (km ²) at 61 m AGL	Raw count density (sea ducks/km ²)	Corrected count density (sea ducks/km ²)
Door County–Garden Peninsula	13 Jan 2011	876.2	288.8	13.2	26.5
Door County–Garden Peninsula	6 Dec 2011	702.7	231.6	7.5	24.7
Door County–Garden Peninsula	14 Feb 2012	433.4	142.8	5.7	11.2
Total Garden Peninsula Lake Michigan key site		2012.3	663.2	9.6	22.6

Table S7. Raw counts of sea ducks, by species,¹ observed on and off transect during aerial surveys conducted over Lake Michigan during spring (March–May). Survey areas listed are only those encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

Survey area	Survey date	On/Off transect	LTDU	WWSC	BLSC	SUSC	SCOT	COME	RBME	HOME	MERG	COGO	BUFF	Total sea ducks
Door County–Garden Peninsula	8 Apr 2011	On	7475	2	0	0	0	489	0	0	0	402	5	8373
		Off	2100	0	0	0	0	0	0	0	0	0	0	2100
Door County–Garden Peninsula	5 Apr 2012	On	47	1	0	0	0	538	226	0	96	59	3	970
		Off	0	0	0	0	0	0	0	0	0	0	0	0
Total Garden Peninsula		On	7522	3	0	0	0	1027	226	0	96	461	8	9343
Lake Michigan key site		Off	2100	0	0	0	0	0	0	0	0	0	0	2100

¹ LTDU = Long-tailed Duck (*Clangula hyemalis*), WWSC = White-winged Scoter (*Melanitta deglandi*), BLSC = Black Scoter (*Melanitta americana*), SUSC = Surf Scoter (*Melanitta perspicillata*), SCOT = unidentified scoter species, COME = Common Merganser (*Mergus merganser*), RBME = Red-breasted Merganser (*Mergus serrator*), HOME = Hooded Merganser (*Lophodytes cucullatus*), MERG = unidentified merganser species, COGO = Common Goldeneye (*Bucephala clangula*), and BUFF = Bufflehead (*Bucephala albeola*).

Table S8. Estimated counts of sea ducks, by species or species groups,¹ observed on and off transect during aerial surveys conducted over Lake Michigan during spring (March–May) using a visibility correction factor (Hodges et al. 2008). Correction factor multipliers are shown in parentheses under each species or species group. Survey areas listed are only those encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

Survey area	Survey date	On/Off transect	LTDU (3.46)	SCOTERS (1.74)	MERGANSERS (1.45)	COGO (1.60)	BUFF (3.26)	Total sea ducks
Door County–Garden Peninsula	8 Apr 2011	On	25,864	3	709	643	16	27,236
		Off	7266	0	0	0	0	7266
Door County–Garden Peninsula	5 Apr 2012	On	163	2	1247	94	10	1516
		Off	0	0	0	0	0	0
Total Garden Peninsula		On	26,027	5	1956	737	26	28,752
Lake Michigan key site		Off	7266	0	0	0	0	7266

¹ LTDU = Long-tailed Duck (*Clangula hyemalis*), SCOTERS = Scoter species, MERGANSER = Merganser species, COGO = Common Goldeneye (*Bucephala clangula*), and BUFF = Bufflehead (*Bucephala albeola*).

Table S9. Spring (March–May) density estimates for all sea ducks combined using both raw counts and visibility corrected (Hodges et al. 2008) count estimates for observations on transect. Survey areas listed are only those encompassed by the Garden Peninsula, Michigan, Lake Michigan key site.

Survey area	Survey date	Transect distance (km)	Transect area (km ²) at 61 m AGL	Raw count density (sea ducks/km ²)	Corrected count density (sea ducks/km ²)
Door County–Garden Peninsula	8 Apr 2011	870.9	287.0	29.2	94.9
Door County–Garden Peninsula	5 Apr 2012	432.6	142.6	6.8	10.6
Total Garden Peninsula Lake Michigan key site		1303.5	429.6	21.7	66.9

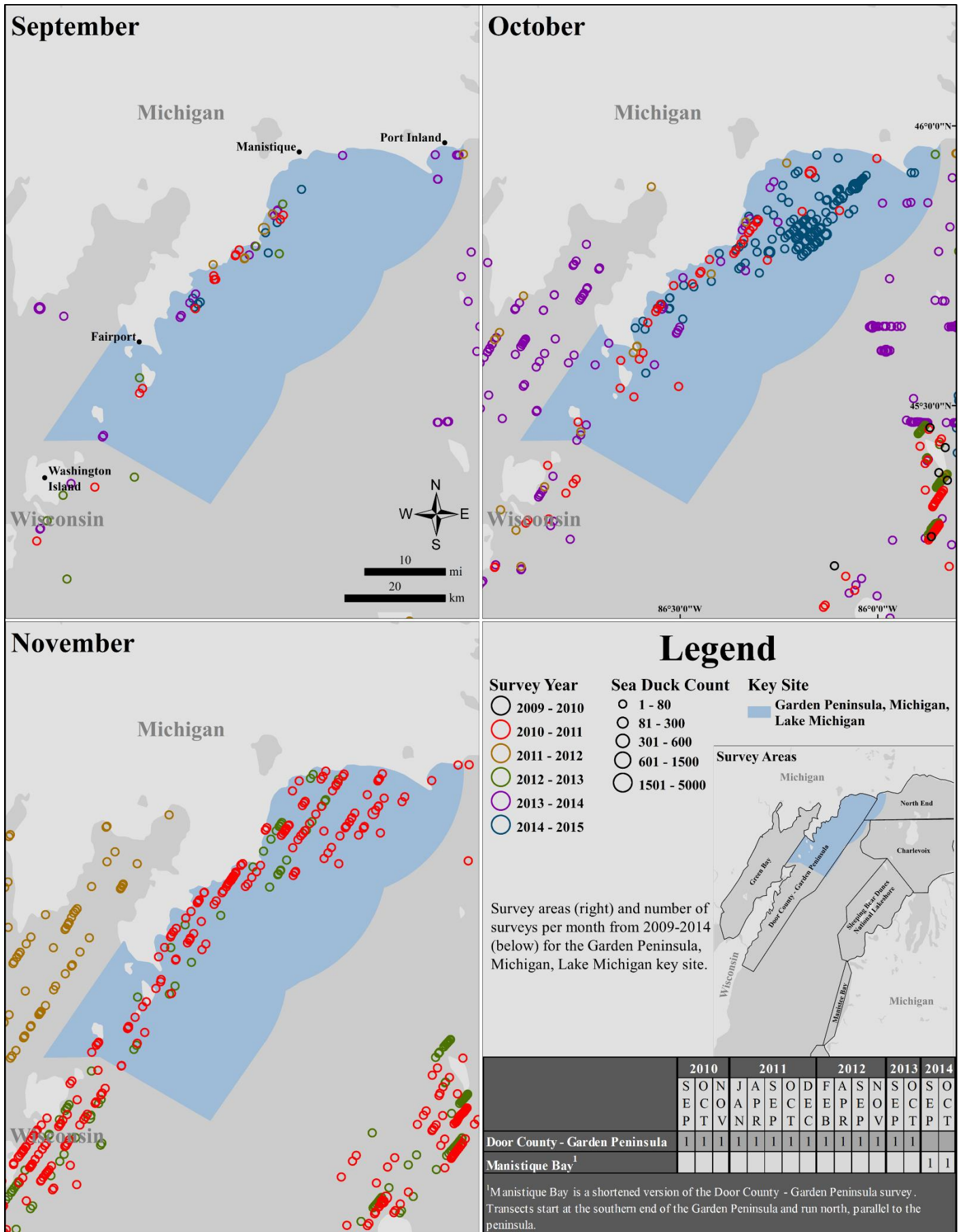


Figure S1. Maps depict sea duck counts from aerial surveys conducted over Lake Michigan from 2009–2014 during fall (September–November) for the Garden Peninsula, Michigan, Lake Michigan key site, by month.

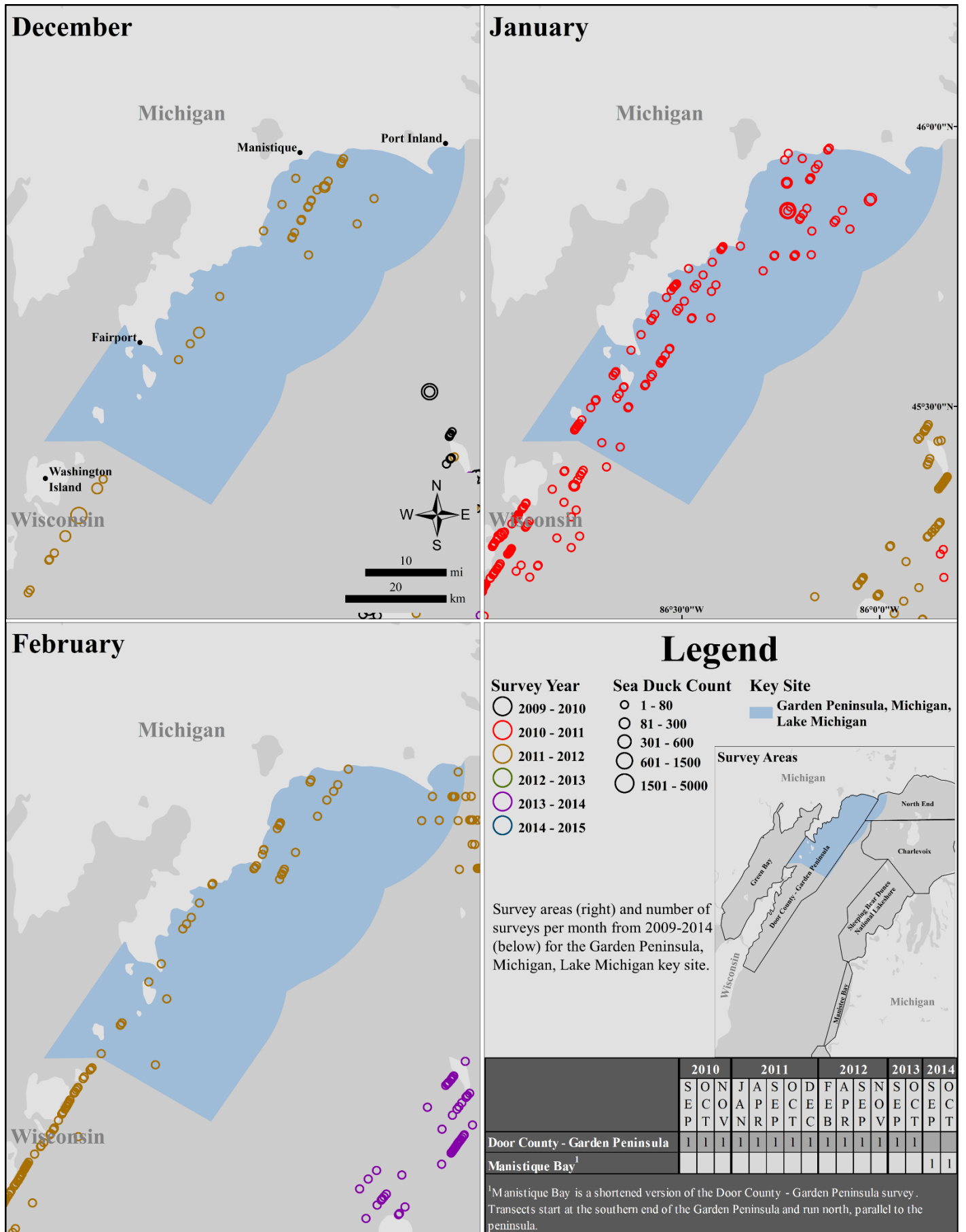


Figure S2. Maps depict sea duck counts from aerial surveys conducted over Lake Michigan from 2009–2014 during winter (December–February) for the Garden Peninsula, Michigan, Lake Michigan key site, by month.

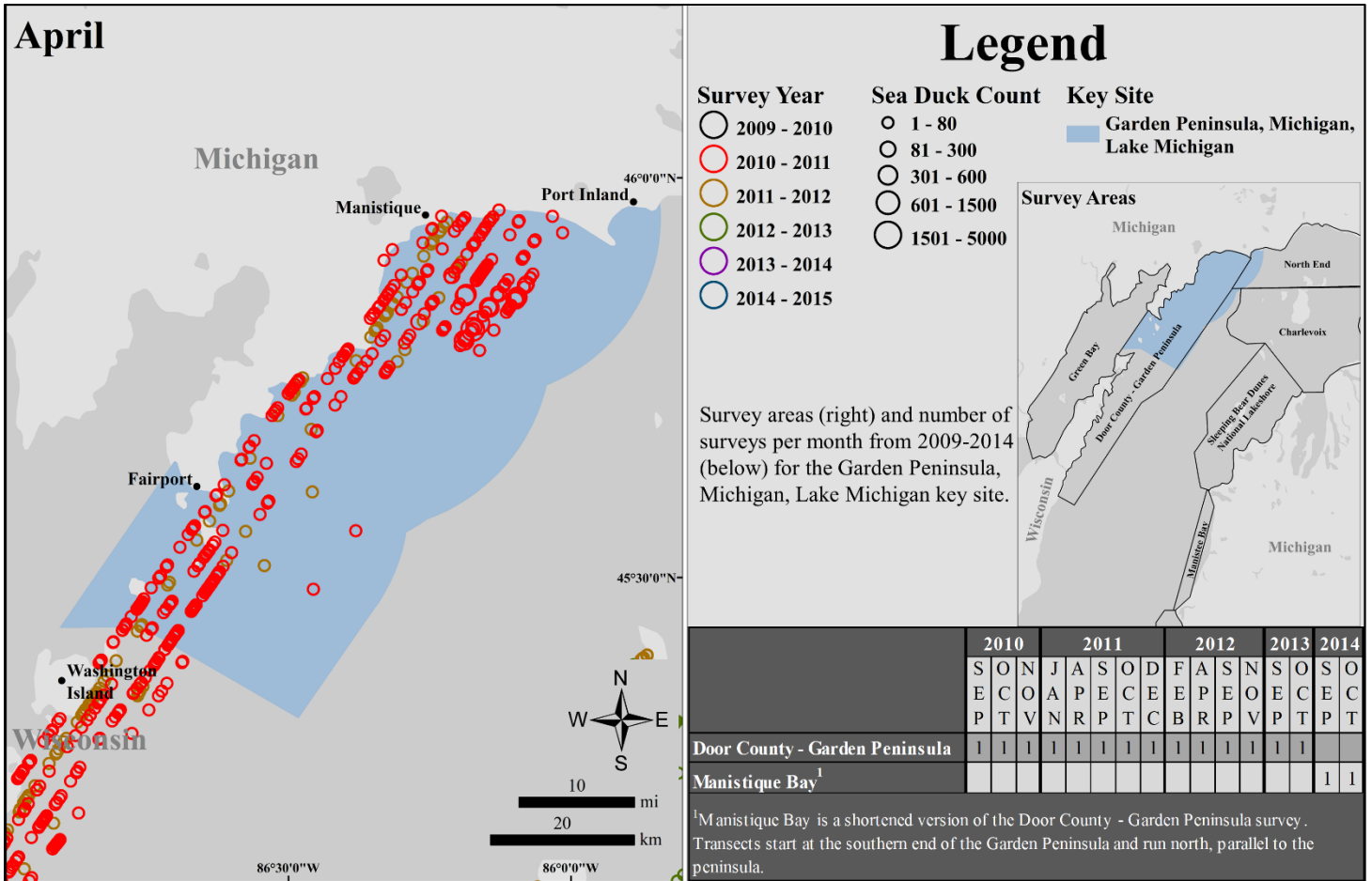


Figure S3. Maps depict sea duck counts from aerial surveys conducted over Lake Michigan from 2009–2014 during spring (March–May) for the Garden Peninsula, Michigan, Lake Michigan key site, by month. March and May are not depicted as no surveys were conducted in this key site during those months.