

**SPRING RAPTOR MIGRATION ON
OTTAWA NATIONAL WILDLIFE REFUGE AND SURROUNDING LAKE ERIE
MARSHES, OHIO**

PROGRESS REPORT-2008
BSBO-ONWR08-2
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INTRODUCTION

_____ Black Swamp Bird Observatory completed the 17th year of a comprehensive, long-term study to monitor the movement and dynamics of raptor migration along the southwest shore of Lake Erie. Little is known of spring raptor migration west of the Allegheny Mountains and east of the Rockies. Lake Erie represents a major physical barrier to migrating raptors resulting in measurable concentrations. The combination of the expansive water and the thermals created by the land-water interface result in definable bands of activity; yet the importance of this habitat to raptors for hunting and migration is poorly understood, but expected to be of great importance. The marshes hold large populations of small mammals, from mice to muskrats, and extremely large numbers of neotropical migrant passerines can be found during spring migration (Shieldcastle, 2004).

The wetland habitat that occurs along the shore of Lake Erie is under severe pressure from development and agriculture. Knowledge about the importance of these habitats to migrating raptors will help managers to make informed decisions about land use and habitat management. The large avian concentrations, whether it is passerines or raptors, attract many birders from March through May to the marshes. The more raptor migration is understood the more those that appreciate their presence can enjoy them.

In order to address these conservation and outreach priorities, we designed an annual spring raptor migration study. The specific objectives of this study are to monitor long term trends in migrating raptors utilizing the region; to examine the importance of habitats within Lake Erie marsh region to migrating raptors, and to examine spatial and temporal differences in migration between species. The study will also allow for environmental education to improve the public's knowledge and perception of these avian predators.

METHODS AND MATERIALS

_____ A prioritized list of observation points were developed to encompass the western basin of Lake Erie (Table 1, Figure 1). Prioritization incorporated distance from the lake proper, effects of Sandusky Bay, and Toledo. The field season commenced 24 February and counts were conducted daily, depending on weather conditions, from 1 March to 8 May at the control site located on the Magee Marsh State Wildlife Area. Weather limitations included rain, heavy snow, and fog. Count data were gathered following the guidelines established by the Hawk Migration

Association of North America (HMANA). These consisted of observations from fixed points, making visual counts of passing raptors, and identifying to species where possible. Flight direction, wind direction, wind speed, sky condition, time of observation, and length of observation were collected for each hour period. Data were collected by project personnel and volunteers assisting in the study. Two half-day workshops dealing with raptor identification and data collection were conducted for volunteers in February. Weather data were compiled at the watch sites and from hourly readings by Toledo Edison at the Davis Besse Nuclear Power Station (DBNPS). DBNPS weather data collected from 100 m above the land surface at 1000 hr was correlated with raptor movements. The 1000 hr weather data were chosen because thermals are usually formed around that time. Observation data were compiled and reported to HMANA

RESULTS AND DISCUSSION

COUNTS

Raptor counts were conducted on 67 days between 24 February and 8 May in 2008 (Table 2). One hundred and seventy-six individual trips involving 607.55 observation hours and 1,014 volunteer hours counted 8,760 raptors. The Magee Marsh tower was monitored daily, weather permitting. Other sites were manned when personnel were available. The average number of hawks observed per hour for 2008 (14.42 birds/hr) was 1% below 2007's average (14.63 birds/hr).

Much remains to be learned about raptor flight paths and their variability along Lake Erie. Weather data were compiled from hourly readings by Toledo Edison at the Davis Besse Nuclear Power Station, and count data were analyzed for correlation with wind direction. In 2008, high count dates again appeared to be positively correlated with winds from the southwest quadrant (Figure 2; these counts are shown in bold type in Table 2). Southwest winds allow raptors to tack into the wind as they migrate along the western basin. Strong movements were also observed on southeast quadrant winds. In future years, as count data becomes more systematic, migration will be correlated with wind speed, pressure cells, fronts and precipitation as well as wind direction.

Magee Marsh Wildlife Area continues to function as a control site for the study. Table 3 shows observer hours, raptors observed, and raptors counted per hour for each site utilized. In 2008, County Line, Turtle Creek, SR 590, Maumee Bay State Park, and South Bass Island provided highly productive counts when manned. Being operated daily, the tower site average is moderated by the number of days in which conditions are unfavorable for migration. Under these conditions alternate sites rarely have observers.

An observation point along the Magee Marsh beach is utilized to better assess falcon movement which is theorized to be heaviest along the lake edge; however, this site had few observer hours in 2008. The Magee location was chosen over the Ottawa NWR beach because it is open to the public and there was an active eagle nest site on Ottawa NWR. The sledding hill at Maumee Bay State Park should be representative of the volume of birds crossing near the mouth of the Maumee river. The Cullen Park site may be useful in actual crossing determination of the birds on the western end of Lake Erie.

Pickercreek Wildlife Area was chosen to assess the movement along the south side of Sandusky Bay but was not monitored in 2008. It is thought that this may be a different group of

migrants than appear on the Ottawa NWR complex. South Bass Island will identify the potential of island hopping by various species. Ft. Meigs and S.R. 590 sites have been the sole representatives for movements a considerable distance from the lake shore. A continued increase in monitoring will be important in addressing questions concerning these inland flight lines. The balance of the observation sites are designed to fill in and refine data on the flight paths.

The total raptors counted are shown in Tables 4 (accipiters), 5 (buteos), 6 (falcons), and 7 (miscellaneous species). To more accurately compare species and for future year to year comparisons unknown accipiters and buteos were statistically assigned to species. This was done assuming that the unidentified birds were representative of the identified birds for that day or neighboring days. Table 8 shows bird/hour by species during the project history. The following species accounts document the individual species totals, peaks by number observed as well as average per hour, and a summary of that species during the season.

1) Turkey Vulture (5,510) Peak: 24 March (764 birds and 59.92 birds/hr). The first observation was 1 March and this species appeared consistently from mid-March into mid-May. It averaged 9.07 individuals per hour of observation in 2008, a decrease of 7 percent from 2007 (9.74 birds/hr) (Table 8). Turkey Vultures were counted on 78% of the count days. Turkey Vultures are almost completely dependent on the thermals to migrate and are normally seen migrating in small kettles. An increase in observation points will better define the area used by this species.

2) Red-tailed Hawk (1,217) Peak: 7 April (158 birds and 11.22 birds/hr). The first observation was 24 February. Red-tails were encountered on 85% of the count days and averaged 2.00 individuals per hour of observation, 31% above 2007's 1.53. Breeding birds continue to cause some confusion for observers but should have little effect on overall data.

3) Broad-winged Hawk (500) Peak: 25 April (346 and 37.40 birds/hr). Broad-wings are late migrators and were first observed on 31 March. This species depends heavily on thermals and migrates in large kettles. Broad-wings were counted on 28% of the count days. An average of 0.82 individuals per hour was up 105% from 2007 (0.40).

4) Sharp-shinned Hawk (414) Peak: 11 April (57 birds) and 16 April (5.08 birds/hr). March 5 was the first observation date for this species and it was consistently seen mid-March into mid-May. The average number recorded per observation hour was 0.68 individuals. This was down from the 0.89 in 2007 (-24%). This species actively feeds throughout migration, consequently they are less dependent on thermals and have a more general movement. It was observed on 63% of the count days.

5) Bald Eagle (371) Peak: 7 April (66 birds 4.7 birds/hr). The migration of the Bald Eagle is complicated by the resident population of breeding eagles and an increasing number of non-breeders. The first sighting was 24 February and was consistent into early May. It was reported on 72% of the count days. The average per observer hour for 2008 was 0.61, an increase of 97% from 2007 (0.31).

6) Cooper's Hawk (254) Peak: 7 April (35 birds and 2.48 birds/hr). The first observation of this species was 1 March. It was consistently seen mid March to early May. It averaged 0.42 individuals per observation hour compared to 0.42 in 2007 (no change). It was observed on 67% of the count days.

7) Red-shouldered Hawk (191) Peak: 24 March (33 birds) and 23 March (3.00 birds/hr).

March 4 was the first observation date. They were consistently recorded from mid-March to mid-April. For 2008, Red-shoulders averaged 0.31 individuals per observer hour. This was 68% below the 0.97 average of 2007. Red-shoulders were observed on 42% of the count days.

8) Northern Harrier (167) Peak: 11 April (11 birds) and 21 March (1.22 birds/hr). The harrier is another common wintering bird in the region. The first migrating bird was recorded 1 March. It was consistently recorded until late April and was observed on 70% of the count days. The harrier was seen at 0.27 individuals per observer hour compared to 0.21 in 2007.

9) Osprey (29) Peak: 27 April (7 birds and 0.53 birds/hr). The Osprey was first recorded on 5 April and was fairly consistent through early May. It was seen at 0.05 individuals per observer hour which was a 150% increase from 2007.

10) American Kestrel (28) Peak: 6 April (5 birds) and 7 April (0.28 birds/hr). This species was first recorded 11 March and was fairly consistent in April. Kestrels were seen at a rate of 0.05 individuals per observation hour. Kestrel counts have fallen over the life of the project.

11) Rough-legged Hawk (27) Peak: 17 March (3 birds and 0.31 birds/hr). The species was first recorded on 24 February. The 0.04 birds per observer hour was identical to the 2007 rate. Many Rough-legged Hawks may have passed through to the north before field work began this year. Warm fronts in January and February should have taken many birds north following snow melt.

Other species observed but in low numbers were the Merlin (8), Peregrine Falcon (3), and Golden Eagle (5).

EDUCATION

_____ Educational programming was supplied upon request. Two public workshops were given in 2008 to over 100 persons. The workshops were designed to give prospective volunteers background knowledge in raptor movement and identification, and guidance in completing field work. A volunteer picnic was held at the Black Swamp Bird Observatory office to thank the volunteers for their hours of effort and to discuss future plans.

CONCLUSIONS

The 2008 field season produced valuable data that will add to our understanding of the migrational timing, habitat use, and long-term population trends of migrating raptors. It also allowed us to continue making strides in improvement of count procedures and results. The workshops continue to be a very important and successful tool towards meeting the education objectives of this project.

The prioritized site list appears match monitoring needs and will be evaluated each year. The study along the south shore of Lake Erie has benefitted from having more than one count site in order to follow the shifts in thermals followed by the soaring raptors. The use of multiple marshes also allows an assessment of broad qualities of wetlands. Protection of this vanishing habitat type requires accumulation of data such as these. It is hoped that additional sites can be

manned on more days next season, however it will be extremely important that the tower continues to be sampled daily. It will be the means of making daily, yearly and location comparisons.

Because these raptors are so dependent on weather conditions, the past 17 years have produced some information on movement and timing, but has not been able to address the population trends very well. It is still expected to take several years to approach full implementation of the project.

Study results to date have been utilized for informing the public on where and when to observe migrating hawks. These analyzes will also provide guidance for land managers in the Lake Erie marsh region for implementing management schemes for this group of migrating birds.

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LITERATURE CITED

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Table 1. Priority list for observation sites, 2008.

RANK	WATCH SITE LOCATIONS	SITE #
1)	Magee Marsh Tower	1
2)	Turtle Ck. (Lick.-Har.)	3
3)	Magee Beach	5
4)	Pickeral Ck W/A	7
5)	County Line Rd.	14
6)	Maumee Bay St Park	9
7)	S. Bass Island	29
8)	Port Clinton (Fulton St/SR2)	10
9)	SR 590 at Portage River	21
10)	Ft Meigs - Wood Co.	22
11)	Oak Harbor Golf Course	11
12)	SR 579 Golf Course	24
13)	Barrett Rd (Bay Point)	8
14)	Cullen Pk (Toledo)	23
15)	Wildwood Metropark	28
16)	Kelley's Island	13
17)	Metzger Marsh (west)	19
18)	Anchor Pt. Public access	15
19)	Darby Unit (ONWR)	16
20)	Ottawa NWR parking lot	4
21)	Ottawa NWR (pool 2)	17
22)	Toussaint W/A	18
23)	Metzger Marsh (pier)	20

Table 2. Survey counts of raptors and predominant wind direction in the Lake Erie marsh region, 2008.

DATE	RAPTORS	NUM. OF HOURS	RAPTORS/HOUR* <small>*heavy movements in bold</small>	WIND DIRECTION
Feb. 24	7	1.00	7.00	SW
Mar. 1	8	8.00	1.00	WNW
2	14	13.00	1.08	SSE
3	1	2.00	0.50	SSW
4	17	9.25	1.84	NE
5	3	4.83	0.62	SW
6	6	8.00	0.75	SW
7	2	5.00	0.40	NNE
8	RAIN			N
9	6	7.00	0.86	WSW
10	4	6.83	0.59	SE
11	36	8.75	4.11	WSW
12	16	8.00	2.00	NW
13	104	13.33	7.80	SSW
14	19	7.58	2.51	SW
15	11	6.33	1.74	N
16	39	13.50	2.89	N
17	129	9.67	13.34	ENE
18	21	3.00	7.00	SSW
19	RAIN			N
20	116	11.58	10.02	NW
21	19	5.75	3.30	E
22	24	7.58	3.17	NE
23	643	10.00	64.30	WSW
24	900	12.75	70.59	SW
25	179	6.00	29.83	S
26	321	11.67	27.51	W
27	0	2.00	0	ENE
28	9	8.50	1.06	N
29	140	13.50	10.37	ESE
30	18	13.33	1.35	ENE
31	816	15.58	52.37	S
Apr. 1	70	10.00	7.00	WSW
2	195	10.17	19.17	NE
3	77	12.17	6.33	E
4	RAIN			
5	635	13.92	45.62	S
6	264	24.67	10.70	E
7	794	14.08	56.39	S
8	201	9.08	22.14	NE
9	166	7.67	21.64	WSW
10	147	7.42	19.81	ENE
11	399	21.08	18.93	SSW

Table 2. Survey counts of raptors and predominant wind direction in the Lake Erie marsh region, 2008.

DATE	RAPTORS	NUM. OF HOURS	RAPTORS/HOUR* <small>*heavy movements in bold</small>	WIND DIRECTION
12	52	6.25	8.32	SSW
Apr. 13	1	9.00	0.11	N
14	8	5.50	1.45	NE
15	76	10.75	7.07	SSW
16	216	10.83	19.94	S
17	252	10.75	23.44	SSW
18	224	11.33	19.77	SW
19	87	7.58	11.48	N
20	41	10.50	3.90	N
21	38	3.50	10.86	W
22	126	18.33	6.87	S
23	25	9.00	2.78	WNW
24	23	5.85	3.93	E
25	473	9.25	51.13	SE
26	96	6.75	14.22	SW
27	99	13.33	7.43	S
28	15	13.50	1.11	NE
29	12	5.58	2.15	SSE
30	13	6.00	2.17	N
May 1	14	6.85	2.04	NE
2	0	1.67	0	SSW
3	39	6.42	6.07	SSW
4	92	9.00	10.22	SW
5	71	5.83	12.18	SW
6	33	5.92	5.57	ESE
7	49	8.00	6.13	SSW
8	6	6.68	0.90	NE
TOTAL	8,760	607.55	14.42	

Table 3. Observer hours and count totals for count sites, 2008.

SITE	HOURS OBSERVED	RAPTORS COUNTED	AVERAGE RAPTORS/HR
Tower	369.97	4,567	12.34
Turtle Creek	26.83	251	9.36
Magee Beach	0.42	2	4.76
Pickeral Creek			
Maumee Bay SP	62.00	2,208	35.61
County Line	33.75	405	12.00
S.R. 590	49.00	343	7.00
Cullen Park	46.00	221	4.80
Wildwood	10.67	64	6.00
Pipe Creek	0.33	28	84.85
Metzger Marsh			
South Bass Is	8.58	671	78.21
TOTAL	607.55	8,760	14.42

Table 4. Total accipiter hawks counted in the Lake Erie marsh region, 2008.

DATE	SHARP-SHIN HAWK*	COOPER'S HAWK*	NORTHERN GOSHAWK	UNIDENT. ACCIPITER	TOTAL
Feb. 24					0
Mar. 1		(1)		1	1
2		1			1
3					0
4		1			1
5	1	1			2
6		2			2
7					0
8					RAIN
9		1			1
10					0
11	1	1 (2)		1	3
12					0
13	1				1
14					0
15					0
16		(1)		1	1
17	1	2			3
18		6			6
19					RAIN
20	1 (2)	3 (7)		5	9
21		1			1
22					0
23		5 (7)		2	7
24	2 (4)	5 (9)		6	13
25	1	3			4
26	1	5 (6)		1	7
27					0
28	1				1
29	3 (4)	2		1	6
30	1	1			2
31	16 (18)	31 (34)		5	52
Apr. 1		3 (5)		2	5
2	1	3 (4)		1	5
3	2 (4)			2	4
4					RAIN
5	3	13 (14)		1	17
6	2	3			5
7	34 (41)	29 (35)		13	76

Table 4. Total accipiter hawks counted in the Lake Erie marsh region, 2008.

DATE	SHARP-SHIN HAWK*	COOPER'S HAWK*	NORTHERN GOSHAWK	UNIDENT. ACCIPTER	TOTAL
Apr. 8	5 (7)			2	7
9	4	5			9
10	16	1			17
11	55 (57)	17		2	74
12	9	7			16
13					0
14					0
15	4	1			5
16	54 (55)	10		1	65
17	50	26			76
18	14 (15)	1		1	16
19	23	1			24
20		1			1
21	(1)	2 (3)		2	4
22	1	3			4
23	1	1			2
24	2				2
25	19 (20)	15 (16)		2	36
26	7 (9)	3 (4)		3	13
27	8	2			10
28		1			1
29	1	1			2
30					0
May 1	1				1
2					0
3	25				25
4	4				4
5	2	1			3
6	5	1			6
7	6	1			7
8	1				1
TOTAL	389 (414)	223 (254)	0	56	668

* Numbers in () include statistically assigned unknowns.

Table 5. Total buteo hawks counted in the Lake Erie marsh region, 2008.

DATE	RED-SHOUL. HAWK	BROAD- WING HAWK	RED-TAIL HAWK	ROUGH-LEG HAWK	UNIDENT. BUTEO	TOTAL
Feb. 24			3	1		4
Mar. 1			5			5
2			6 (7)		1	7
3			1			1
4	1		5			6
5						0
6			1			1
7						0
8						RAIN
9			2	2		4
10			1			1
11			15 (16)		1	16
12	2		2			4
13	2		16 (18)	1	2	21
14	1		2 (3)	1	1	5
15	3		3			6
16			5 (10)		5	10
17	7		15 (17)	3	2	27
18	1					1
19						RAIN
20	12 (13)		21 (23)	1	3	37
21			2			2
22						0
23	23 (30)		30 (39)	2 (3)	17	72
24	26 (33)		53 (68)	1	22	102
25			9 (11)	1	2	12
26	1		126			127
27						0
28						0
29	2		23 (26)	1	3	29
30	2		3			5
31	19 (23)	2	63 (76)	1	17	102
Apr. 1			3 (8)		5	8
2	3 (4)		19 (22)	3	4	29
3	1 (3)		5 (15)		12	18
4						RAIN
5	7 (8)		107 (114)	1	8	123
6	1		30 (32)		2	33
7	22 (26)	4 (5)	136 (158)	3	27	192

Table 5. Total buteo hawks counted in the Lake Erie marsh region, 2008.

DATE	RED-SHOUL. HAWK	BROAD- WING HAWK	RED-TAIL HAWK	ROUGH-LEG HAWK	UNIDENT. BUTEO	TOTAL
Apr. 8			62 (64)		2	64
9	1		9			10
10	2		11 (14)		3	16
11	10 (11)	4	40 (44)		5	59
12	1 (2)		3 (4)		2	6
13						0
14	1		1 (2)	1	1	4
15	1		21			22
16	6	6	35 (36)		1	48
17		30	17	2		49
18		72 (77)	22 (23)		6	100
19		1 (2)	13 (24)		12	26
20	2 (3)	1 (2)	2 (3)	1	3	9
21			6			6
22		2 (3)	14 (19)		6	22
23		1	2			3
24						0
25		345 (346)	34		1	380
26	1	7 (8)	3		1	12
27		2	11 (12)		1	14
28			2			2
29		(3)	(2)		5	5
30		1	2			3
May 1		1	1			2
2						0
3			3			3
4		(5)	19 (25)		11	30
5		1	17 (18)		1	19
6			9			9
7		1	1			2
8						0
TOTAL	161 (191)	481 (500)	1072 (1217)	26 (27)	195	1,935

* Numbers in () include statistically assigned unknowns.

Table 6. Total falcons counted in the Lake Erie marsh region, 2008.

DATE	AMER. KESTREL*	MERLIN	PEREGRINE FALCON	UNIDENT. FALCON	TOTAL
Feb. 24					0
Mar. 1					0
2					0
3					0
4					0
5					0
6					0
7					0
8					RAIN
9					0
10					0
11	1				1
12					0
13					0
14					0
15					0
16	(1)			1	1
17					0
18					0
19					RAIN
20					0
21					0
22					0
23					0
24					0
25					0
26					0
27					0
28			1		1
29					0
30					0
31	3				3
Apr. 1					0
2					0
3	1				1
4					RAIN
5					0
6	5				5
7	4	2			6
8			1		1
9	1	1			2
10	1				1
11	3	1	1		5

Table 6. Total falcons counted in the Lake Erie marsh region, 2008.

DATE	AMER. KESTREL*	MERLIN	PEREGRINE FALCON	UNIDENT. FALCON	TOTAL
Apr. 12	1				1
13					0
14					0
15					0
16	1	2			3
17		1			1
18					0
19	1				1
20					0
21	1				1
22	1				1
23					0
24					0
25	2				2
26	1				1
27					0
28					0
29					0
30					0
May 1		1			1
2					0
3					0
4					0
5					0
6					0
7					0
8					0
TOTAL	27 (28)	8	3	1	39

Table 7. Total vultures, ospreys, eagles, harriers and unidentified raptors counted in the Lake Erie marsh region, 2008.

DATE	TURKEY VULTURE	OSPREY	BALD EAGLE	GOLDEN EAGLE	NO. HARRIER	UNIDENT. RAPTOR
Feb. 24			3			
Mar. 1	1				1	
2			6			
3						
4			5		5	
5			1			
6					3	
7					2	
8						
9					1	
10			2		1	
11	11		4		1	
12			10		2	
13	66		13		3	
14	8		6			
15					5	
16	14		12		1	
17	78		18		3	
18	14					
19						
20	53		10		7	3
21			9		7	
22	20		1		3	
23	541		18		5	
24	764		16		3	2
25	155		3			5
26	168		2			
27						
28	3				4	
29	86		13	1	5	
30	5		6			
31	640		9		10	
Apr. 1	49		3		5	
2	143		16		2	
3	45		4		4	1
4						
5	482	1	3		9	
6	209		5		5	2
7	443	1	66		10	
8	123		4		2	
9	143		2			
10	111		1		1	

Table 7. Total vultures, ospreys, eagles, harriers and unidentified raptors counted in the Lake Erie marsh region, 2008.

DATE	TURKEY VULTURE	OSPREY	BALD EAGLE	GOLDEN EAGLE	NO. HARRIER	UNIDENT. RAPTOR
Apr. 11	230	1	18	1	11	
12	25	1			3	
13			1			
14	4					
15	45		2		2	
16	97	1			2	
17	98	1	24		3	
18	90		7	2	9	
19	33	1	1		1	
20	25	2	2		1	
21	27					
22	86	1	9		3	
23	17		2		1	
24	17		3		1	
25	31	1	10		7	6
26	64	2			4	
27	64	7	4			
28	4	2	5		1	
29	5					
30	9		1			
May 1	4		3		3	
2						
3	10				1	
4	50	3	3		2	
5	46		2		1	
6	17	1				
7	33	3	3	1		
8	4				1	
TOTAL	5510	29	371	5	167	36

Table 8. Birds per hour of observation of major species and total raptors, 1991 - 2008.

SPEC	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991
TUVU	9.07	9.74	3.99	6.57	7.97	9.48	6.33	3.91	3.64	5.73	10.06	6.46	4.17	3.38	5.36	4.11	3.55	2.76
OSPR	0.05	0.02	0.02	0.04	0.09	0.05	0.07	0.08	0.03	0.03	0.04	0.03	0.16	0.03	0.04	0.11	0.09	0.05
BAEA	0.61	0.31	0.41	0.22	0.39	0.21	0.19	0.15	0.16	0.16	0.22	0.16	0.12	0.09	0.10	0.11	0.12	0.02
NOHA	0.27	0.21	0.15	0.13	0.33	0.19	0.15	0.19	0.13	0.19	0.13	0.14	0.33	0.16	0.23	0.24	0.28	0.54
SSHA	0.68	0.89	0.40	0.69	2.20	1.06	1.32	1.22	0.55	0.54	0.93	1.03	1.66	0.52	0.97	1.07	1.12	1.81
COHA	0.42	0.42	0.20	0.24	0.61	0.38	0.26	0.21	0.16	0.30	0.23	0.24	0.26	0.17	0.43	0.32	0.52	0.91
RSHA	0.31	0.97	0.25	0.38	1.17	0.77	0.71	0.38	0.51	0.76	0.57	0.16	0.44	0.41	0.50	1.07	0.79	0.32
BWHA	0.82	0.40	0.29	1.61	5.78	1.43	3.45	2.30	1.04	0.17	1.39	0.51	1.17	0.75	1.10	2.71	1.92	1.47
RTHA	2.00	1.53	0.99	1.16	2.52	2.25	1.62	1.01	1.09	1.85	2.11	1.90	1.89	1.24	2.41	2.01	2.07	1.63
RLHA	0.04	0.04	0.05	0.05	0.07	0.05	0.03	0.05	0.07	0.16	0.03	0.05	0.27	0.06	0.08	0.10	0.35	0.06
AMKE	0.05	0.07	0.05	0.05	0.18	0.13	0.09	0.11	0.09	0.11	0.12	0.10	0.14	0.11	0.10	0.11	0.17	0.30
Total hrs	607.6	589.5	644.9	647.3	608.1	781.1	886.9	980.2	938.0	876.1	924.48	987.30	1029.7	1064.2	1209.3	611.25	575.92	392.25
Total raptors	8760	8622	4418	7224	13003	12519	12580	9493	7096	8875	14720	10789	11051	7517	14067	7642	6362	3931
Total raptors/Hr	14.42	14.63	6.85	11.16	21.38	16.03	14.18	9.68	7.56	10.13	15.92	10.93	10.73	7.06	11.63	12.5	11.05	10.02

Figure 1. Raptor count locations by site #.

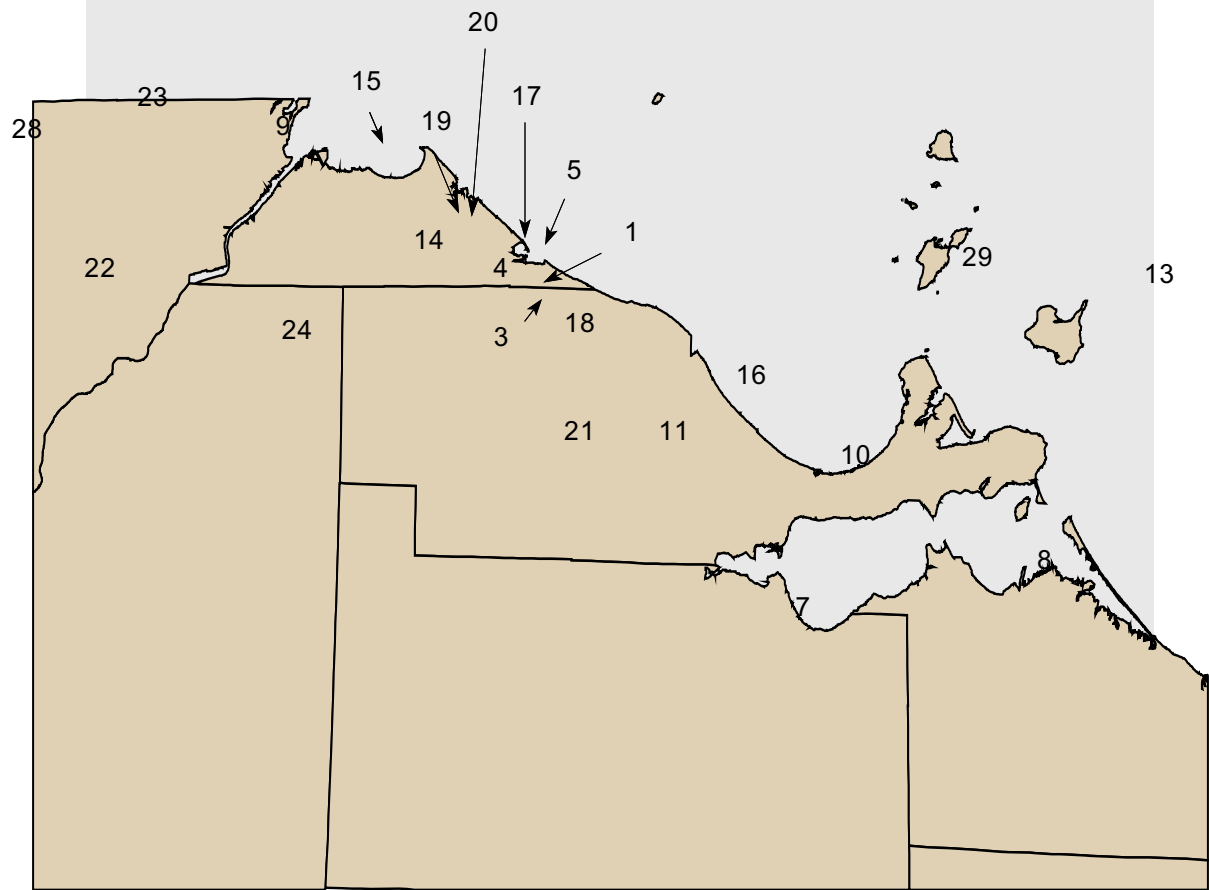
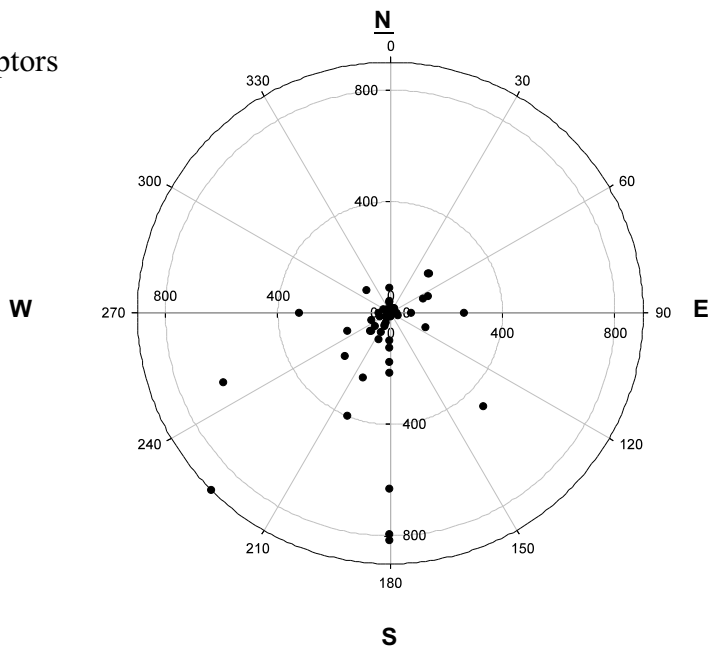


Figure 2. Effect of wind direction on 2008 raptor counts: (a) total raptors observed by wind direction, and (b) raptors per hour by wind direction.

(a) Total raptors



(b) Raptors per hour

