

Introduction

For my master's thesis, I studied the impact of wind turbines at the Erie Shores Wind Farm (ESWF) on raptors during fall migration. Field work took place in 2006 and 2007. The ESWF started operation in May 2006 and consists of 66 turbines, with a 99MW capacity, and 1.5MW GE tubular design turbines.



Study Site

- Located on the north shore of Lake Erie extending east and west of Port Burwell
- Located in a raptor migration corridor
- Turbines spaced 300m to 816m apart
- Landscape largely agricultural with small woodlots and occasional hedgerows



Table 1 - Number of Raptors Observed at the Erie Shores Wind Farm

Species	Scientific Name	Number of Observations at Erie Shores*			Percent of all Observations (%)	Hawk Cliff Data**					
		2006	2007	Combined		13 year avg.	Max for Sept	13 year avg.	Max for Oct		
Turkey Vulture	<i>Cathartes aura</i>	507	1897	2584	37.9	445	1283	3069	2351	329	945
Northern Goshawk	<i>Accipiter gentilis</i>	4	29	33	0.5	1	8	22	39	16	46
Cooper's Hawk	<i>Accipiter cooperii</i>	95	235	336	4.9	164	188	262	480	61	133
Sharp-shinned Hawk	<i>Accipiter striatus</i>	401	1137	1538	22.5	3917	9441	3401	8934	114	222
Accipiter sp.		0	18	18	0.3						
Northern Harrier	<i>Circus cyaneus</i>	35	112	148	2.2	52	1251	370	1006	96	288
Booby-legged Hawk	<i>Buteo lagopus</i>	0	23	23	0.3	0	0	18	47	27	67
Red-tailed Hawk	<i>Buteo jamaicensis</i>	139	1057	1196	17.5	164	459	2088	3297	2163	7655
Red-shouldered Hawk	<i>Buteo lineatus</i>	20	38	58	0.9	2	10	371	910	149	646
Broad-winged Hawk	<i>Buteo platystris</i>	7	3	10	0.1	32533	830840	289	2245	0	3
Buteo sp.		37	60	97	1.4						
Golden Eagle	<i>Agelaius chrysaetos</i>	5	20	25	0.4	0	2	47	87	36	96
Bald Eagle	<i>Haliaeetus leucocephalus</i>	45	224	270	4.0	106	243	57	129	14	35
Eagle sp.		0	1	1	0.0						
Osprey	<i>Pandion haliaetus</i>	10	22	32	0.5	144	318	27	96	1	5
Peregrine Falcon	<i>Falco peregrinus</i>	8	41	49	0.7	33	77	53	118	0	1
Merlin	<i>Falco columbarius</i>	20	46	66	1.0	79	292	37	74	4	11
American Kestrel	<i>Falco sparverius</i>	146	191	337	4.9	2433	4398	558	1912	4	8
Total Number of Observations		1664	5157	6821		46553	16676		3936		

* Based on observations at all distances from turbine
** Data from Hawk Cliff Foundation from 2007, retrieved Nov 3 2009
available @ http://www.west-inc.com/reports/nine-canyon-wind-cliff_migration_numbers.htm

Results

Behavioural Observations

- 5,650 observations were made of raptors passing within 250m of turbines
- 15 species of raptor were observed including bald eagle, golden eagle and peregrine falcon, see Table 1
- Turkey vulture, sharp-shinned hawk and red-tailed hawk were found to be the most abundant species. This is largely comparable to Hawk Cliff, see Table 1
- Blade sweep height (40-118.5m) did not dominate the flight heights of migrant raptors, see Figure 1
- The majority of raptors kept out of blade sweep distance of wind turbines (0-40m), see Figure 2

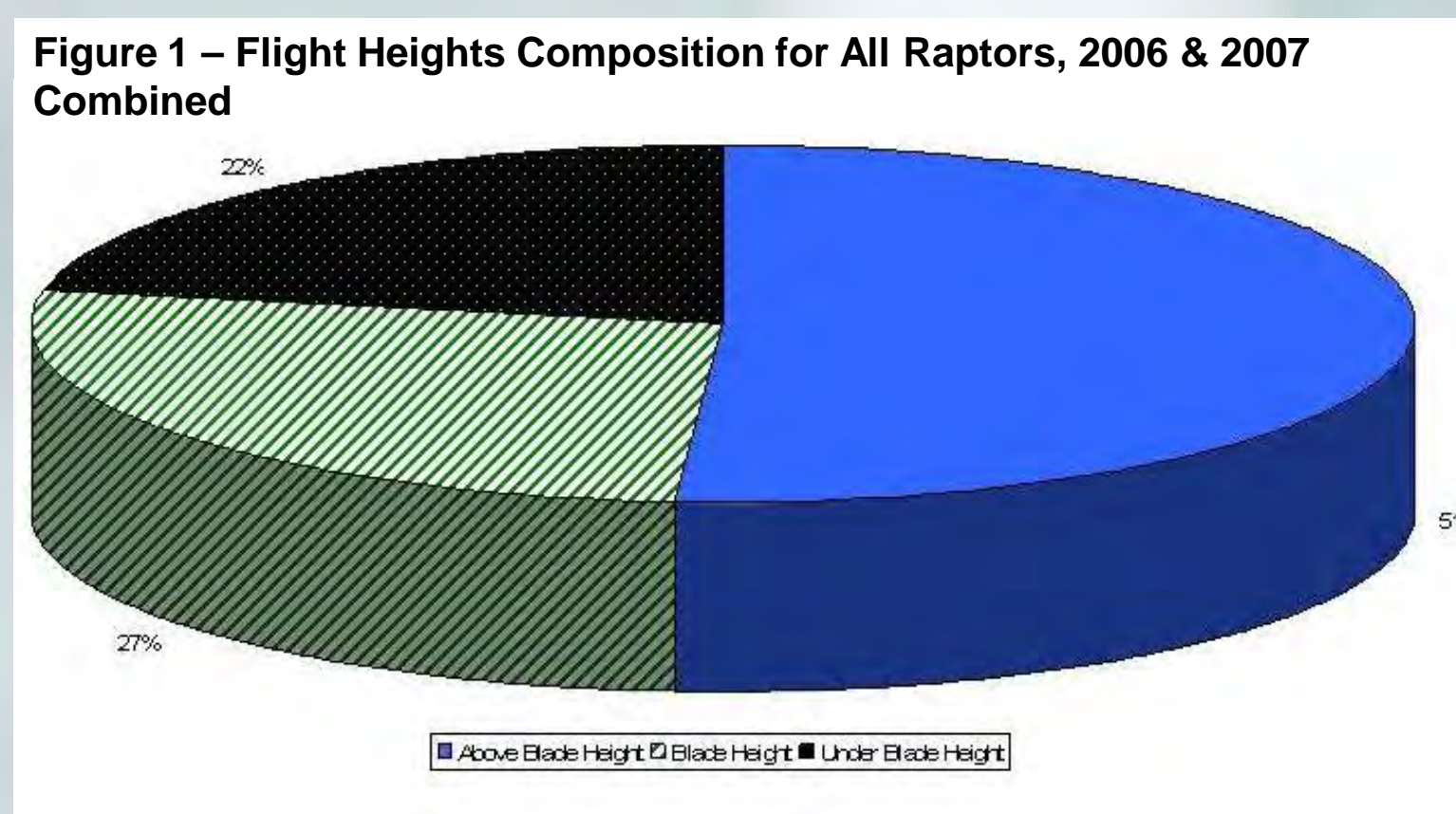
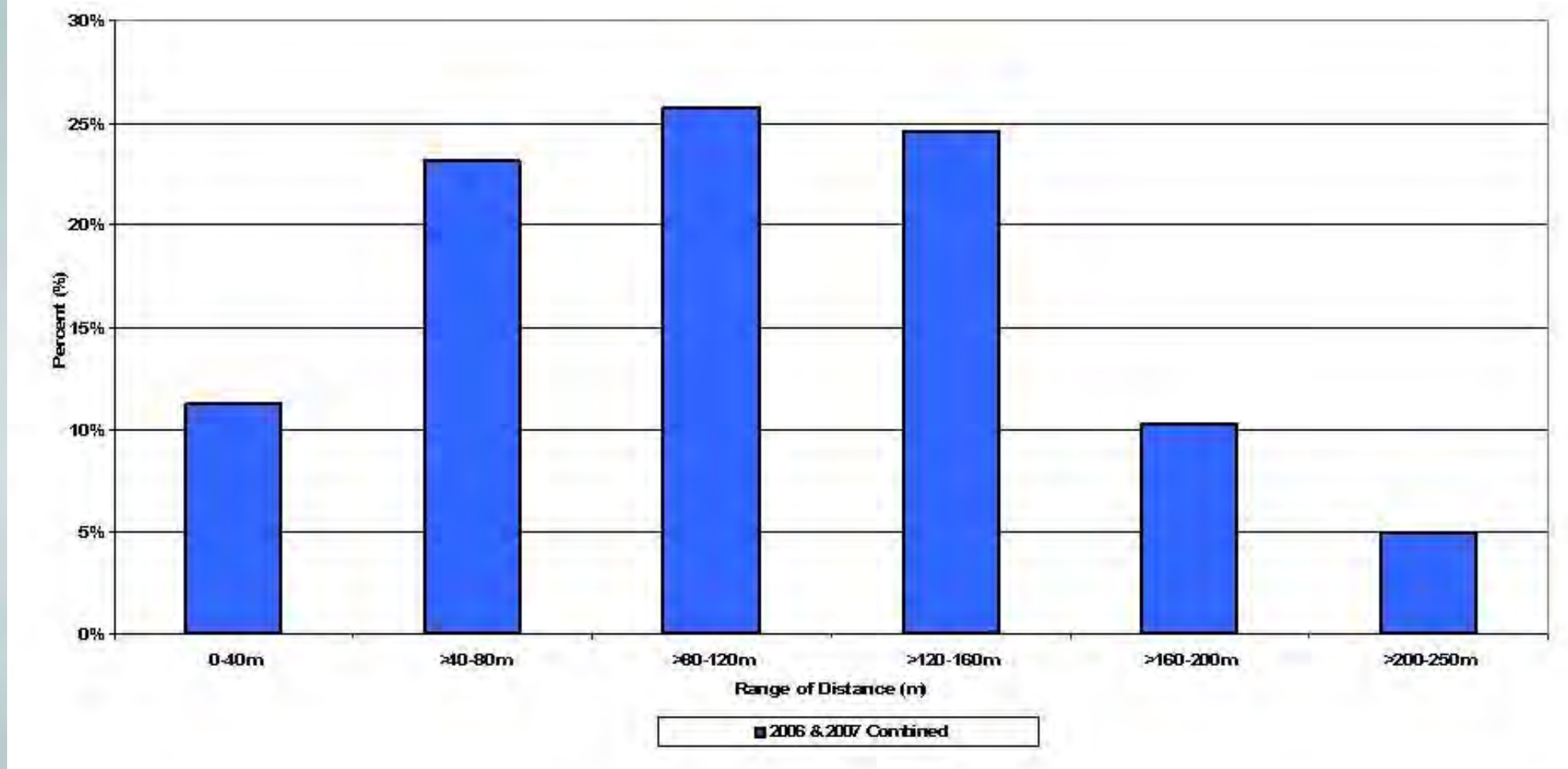


Figure 2 - Percent of all Observations at Different Ranges of Distance out from Turbines, 2006 & 2007 Combined



- Figure 3 & 4 show comparisons of raptor abundance on specific survey dates where one observer was at an inland turbine and one was at a lakeshore turbine (the same turbines being used in each figure).
- 159 raptors (3%) were observed to be flying within the risk zone (41.5-118.5m above ground and 0-40m out from the turbine base).
- Raptor movement south of lakeshore turbines was found to be concentrated 20m on either side of the lakeshore bluffs, see Figure 5 & 6

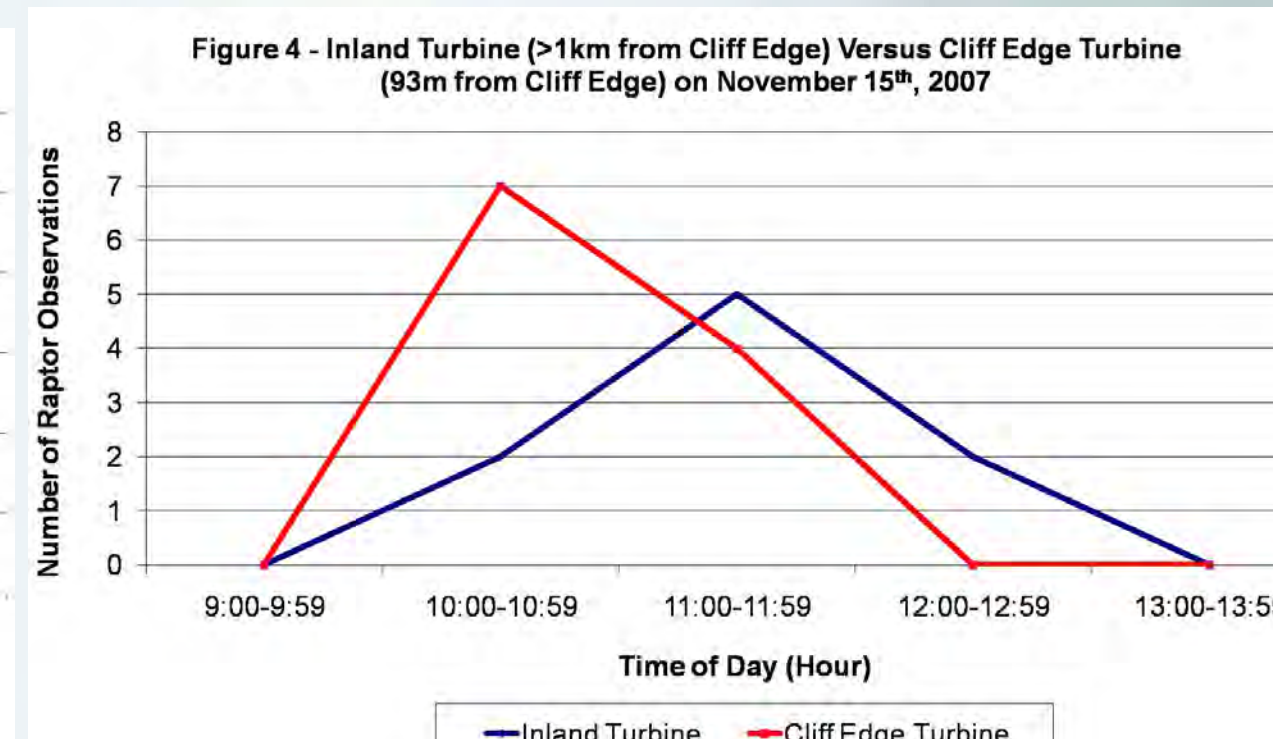
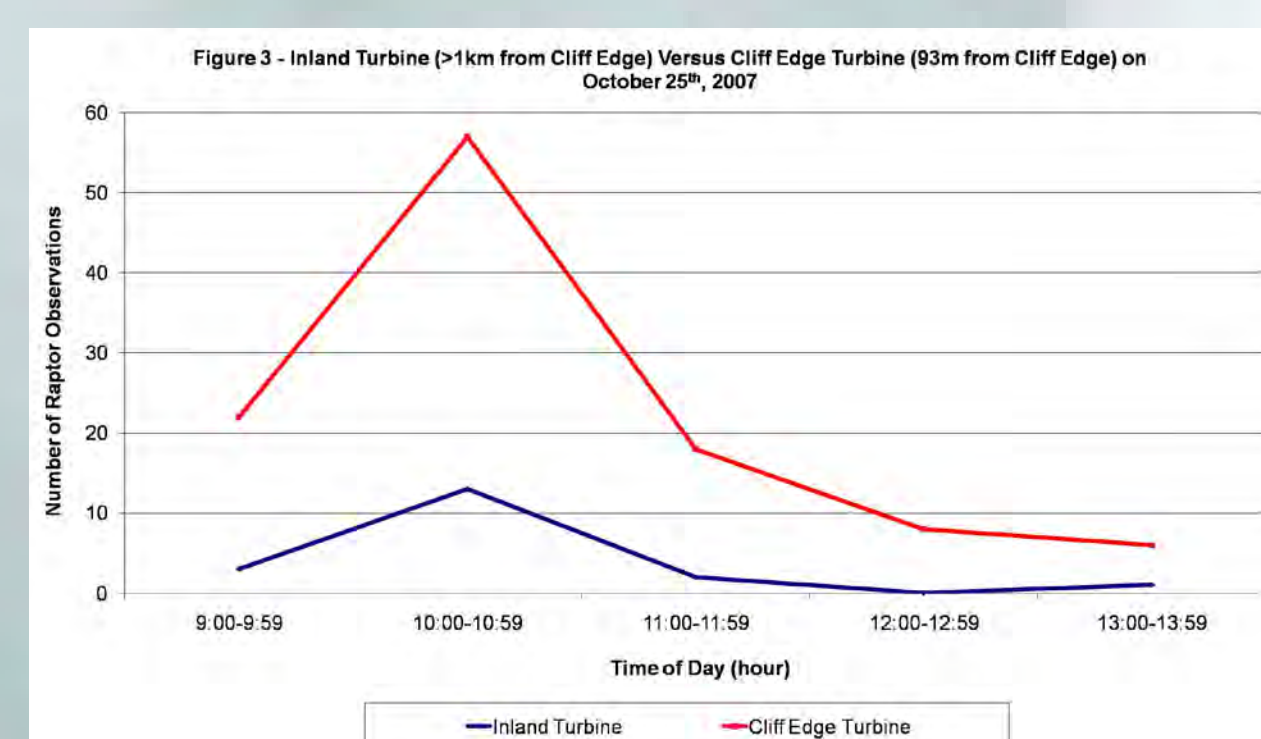
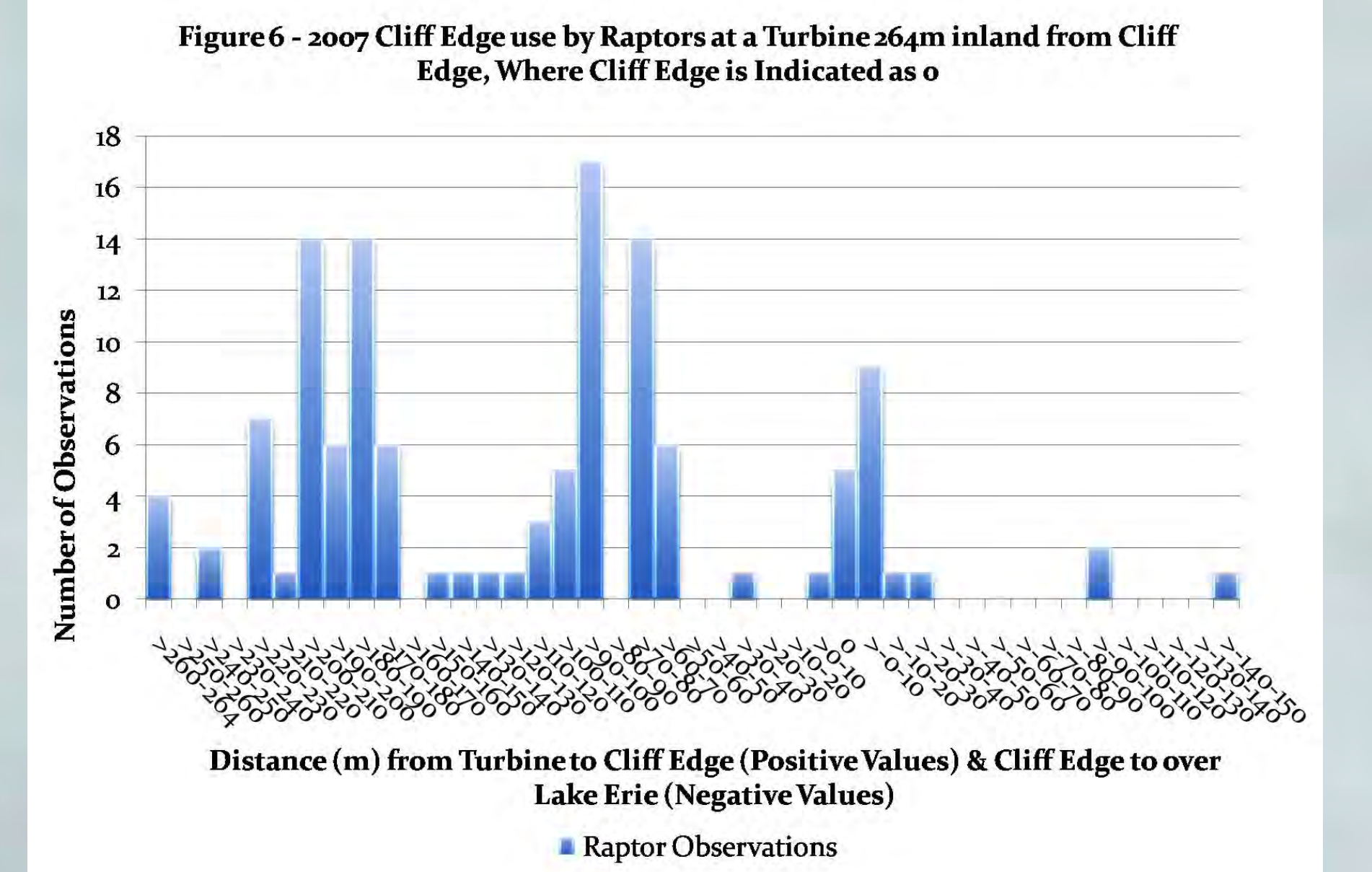
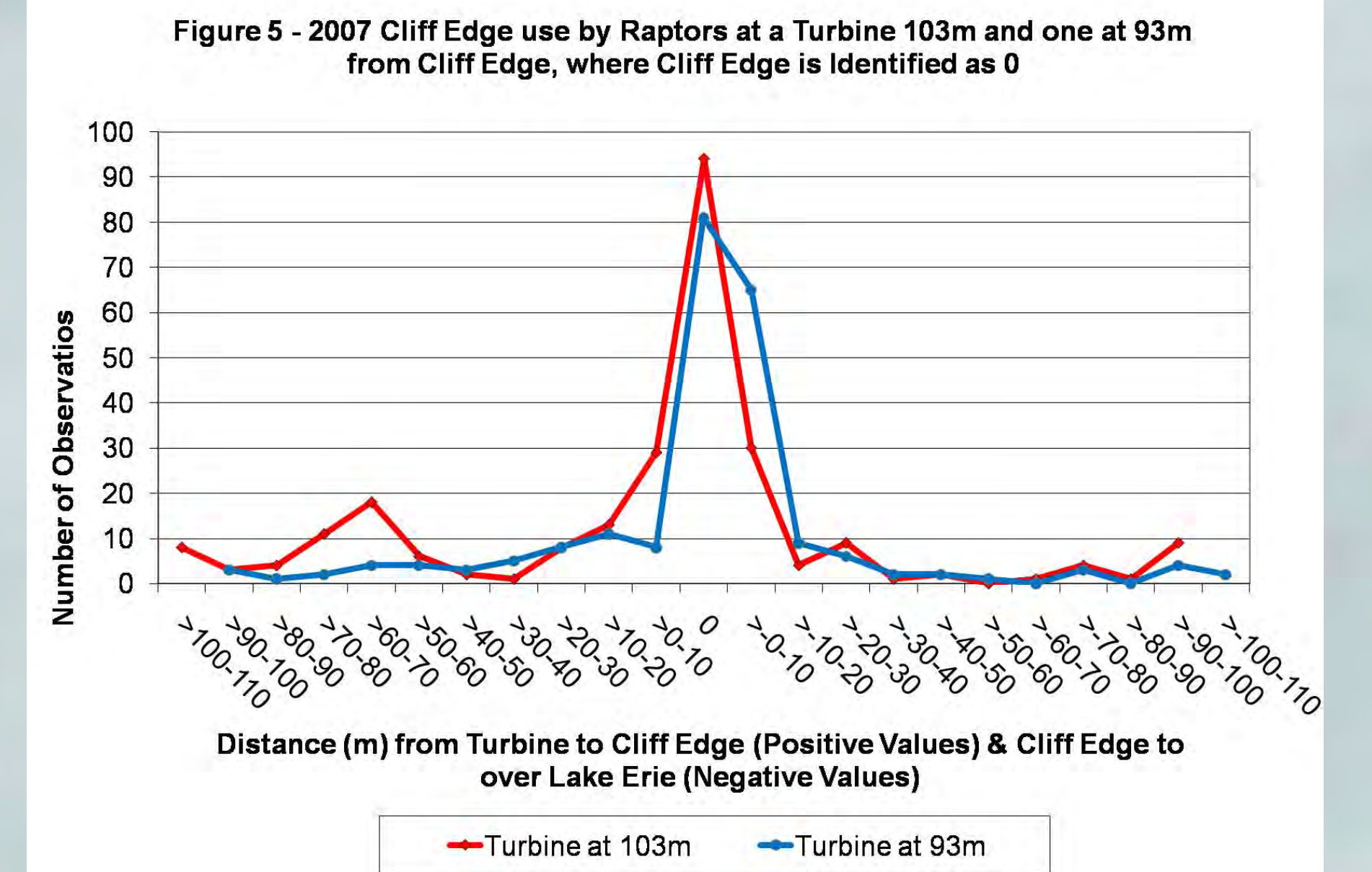


Table 2 - Mortality Rate Estimates at Various Wind Facilities

Wind Farm	# of Turbines	Mortality Rate (raptors/MW/year)	Estimated #/Individuals/year
Combine Hills, OR	41	0	0
Top of Iowa	89	0.01	0.89/yr
Nine Canyon, WA	37	0.05	2.59/yr
Erie Shores	66	0.027	2.64/yr
Melancthon I 2006	45	0.013	0.9/yr
2007	45	0.047	3.15/yr
Tarifa, Spain	256	0.19 to 3.3	12.54 to 627/yr
Altamont Pass, California	5400	0.75-1.9	1,127 to 2,277/yr

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Ross James – Gateways Centre Ornithology/Natural Systems
Lyle Friesen – Canadian Wildlife Service
Stephen Murphy – University of Waterloo



Mortality

- 2006: 1 sharp-shinned hawk; 1 turkey vulture
- 2007: 1 red-tailed hawk; 1 Cooper's hawk
- Mortality rate is calculated to be 0.04 raptors/turbine/year or 0.027 raptors/MW/year (calculation included a red-tailed hawk corpse found in the spring of 2007 by James)

Conclusions

- The ESWF does not act as a barrier to migrant raptors
- Figures 3 & 4 show that later in the migration period greater abundances were found at the farther inland turbine later in the day, and is likely reflective of the raptor species composition at that time as more Buteo species migrate at that time and they use the thermals that develop inland
- The bluff edge itself was found to be an area of concentrated raptor movement, see Figures 5 & 6
- High raptor abundance does not necessarily equate to high mortality at the modern generation wind facility at Erie Shores
- Raptor mortality at the ESWF is low compared to 'old generation' facilities and equivalent or low compared to other 'new generation' facilities, despite being in a migratory corridor, see Table 2
- The low raptor mortality found at Erie Shores, indicates a much different situation than in California, Norway and Spain where significant mortality has been found
- High raptor abundance (due to the presence of a major migration corridor) does not automatically equate to high levels of collision mortality.

Work Cited

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Study Design & Techniques

- 12 of 66 turbines were selected based on a pre-determined set of criteria and were then chosen randomly from that subset
- 8 turbines were located between 93m and 264m from the bluff edge, 4 turbines were >264m to 1.5km inland
- Ground cover varied between different agricultural crops, cultural meadow and woodland edge
- Surveys took place on 22 days in the fall of 2006 and 47 days in the fall of 2007 (September-December)

Behavioural Observations

- observations of raptors were recorded
- Monitoring was conducted given day and took place between late-August and early-November.
- Surveys took place between 8am and 3pm and were conducted on dates under various weather conditions and particularly dates ideal for large raptor movements.



Mortality Searches

- mortality searches were conducted at least once a week by Ross James at all turbines within the wind farm (James 2008)
- I conducted mortality searches at the 12 turbines used in my study to supplement the regular searches by James'
- Scavenger removal studies and searcher efficiency trials were conducted to address search bias'
- Carcass searches under each of the 12 turbines used in my study were conducted in expanding circles 5-6m apart. Both James and myself searched approximately a 40m radius out from the turbine base



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