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CENTER FOR CONSERVATION BIOLOGY
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A STUDY OF WATERBIRDS IN SHANKS CREEK: AN INVESTIGATION ON SMITH ISLAND

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A Cooperative Project By:

A&N Electric Cooperative
Hunton & Williams
U.S. Fish and Wildlife Service
College of William and Mary

The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within todays social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

A&N Electric Cooperative provides electrical power to the communities of Smith Island via a distribution line that runs above water for approximately 1.8 miles along Shanks Creek. In 1999, a waterman reported observing a large number of Brown Pelicans falling from the power line near the mouth of Shanks Creek. The opinion was expressed that these birds may have been electrocuted when their weight caused two wires to make contact and complete the circuit. It has been further suggested that fish concentrations under the power lines may have led the pelicans to use them as hunting perches. The area surrounding Shanks Creek supports one of the largest communities of colonial waterbirds in the Chesapeake Bay. A report that power lines may pose a hazard to waterbirds has led to concerns on the part of both A&N Electric and the U.S. Fish and Wildlife Service. The broad objective of this study was to assess the magnitude and nature of the use that the distribution line receives from waterbirds.

The association of waterbirds to electrical structures in Shanks Creek was monitored during 36 three-hour observation periods distributed among the relevant phases of the breeding cycle and tidal stages. A total of 3,623 observations of birds perched on electrical structures was made during the course of 432 surveys. Nearly 90% of these birds were perched on power poles and associated wooden structures with virtually all of the remainder perching on the top wire. The top wire serves as a guide and does not carry electrical current. Estimated loads experienced by wires averaged 2.1 Kg with a maximum observed load of 5.04 Kg. These loads are relatively insignificant and no visible depression of wires was observed. During 72 hours of direct observation, more than 4,000 birds were observed to fly across the power line within a distance of 10 m. None of these birds was observed to fly between wires or to strike any wire.

There is no indication that waterbirds within and surrounding the Shanks Creek area experience any elevated risk of mortality compared to birds associated with the thousands of miles of exposed power lines found throughout the Chesapeake Bay and the broader mid-Atlantic Coastal Plain. No birds were observed to be electricuted during survey periods, no dead birds were detected during fieldwork, and no burn marks were observed along distribution lines. The suggestion that large numbers of Brown Pelicans are attracted to Shanks Creek for foraging and that they collectively perch hunt from wires was not supported by the observations made during the breeding season of 2000. In more than 100 hours of observation across the breeding season, only two pelicans were observed to contact any electrical structure. These included two young of the year birds that landed on the top wire for a period of approximately 10 seconds. Although many pelicans were observed to forage in Shanks Creek, they used the traditional methods of plunge diving and “seigning” in the shallows. The highest number of birds observed to be perched on a single wire span was three Double-crested Cormorants. These birds would have resulted in a combined load of 5.04 Kg. This load appears to be inadequate to result in a significant increase in the probability of a wire to wire contact.

BACKGROUND

Context

A&N Electric Cooperative provides electrical power to communities on Tangier and Smith Islands. Power is distributed to the Smith Island communities of Ewell, Rhodes Point, and Tylerton via a distribution line from a substation on Tangier Island. The majority of this power line was placed underground in the late 1970's. The remaining above-ground portion emerges near the north end of Sedges Island in the mouth of Shanks Creek and runs approximately 1.8 miles north within Shanks Creek to Rhodes Point. Distribution lines along this exposed span are configured according to national codes.

The area around the mouth of Shanks Creek is known to support a large number of waterbirds during the breeding season. A survey conducted during the summer of 1993 by the Center for Conservation Biology recorded significant populations of nesting colonial waterbirds including Brown Pelicans, Double-crested Cormorants, Royal Terns, Caspian Terns, Great Black-backed Gulls, Herring Gulls, Great Egrets, Snowy Egrets, and Black-crowned Night-herons. The Brown Pelican colony represents one of only 2 colonies in Virginia. The colony of Double-crested Cormorants represents 1 of 6 in the state. In addition, the area supports a diverse community of marsh-nesting birds.

In late August of 1999 a local resident reported observing a large number of Brown Pelicans falling from the electrical distribution line near its point of emergence in the mouth of Shanks Creek. Although no direct evidence has been presented, the opinion has been expressed that completing the circuit between two wires may have electrocuted these birds. The belief has also been expressed by some local watermen that the channel near the mouth of Shanks Creek may serve to concentrate some fish species. Local residents have postulated further that fish concentrations under the power lines may lead the pelicans to use the lines as hunting perches.

Suggestions that the area in the immediate vicinity of exposed power lines may represent a significant foraging area for waterbirds has led to concerns for the safety of these birds on the part of both A&N Electric and the United States Fish and Wildlife Service. These concerns have led to discussions about possible actions that may minimize future risks to local waterbirds. However, no information is currently available that documents the nature and extent of this potential hazard. Information is needed to determine whether any modifications to the power system are warranted. In the event that actions are deemed necessary, information is also needed to provide guidance in designing an appropriate solution.

Objectives

The broad objective of this study was to assess the magnitude and nature of the use that the exposed distribution line receives from waterbirds. Specifically, our objectives were:

1) to determine the number and types of birds that occur in the immediate vicinity of the distribution lines

2) to determine the spatial pattern of use along the exposed portion of the trans-mission line

3) to determine specifically how birds are interacting with the distribution lines

METHODS

Study Area

This study was focused on the exposed power lines running along the length of Shanks Creek on the southern end of Smith Island, MD (Figure 1). Shanks Creek is a broad, shallow embayment that averages less than 1 m in depth during normal low tides. The creek bottom is covered with patches of submerged aquatic vegetation and is used extensively by local watermen for dredging blue crabs and other commercial species. The power line emerges in the mouth of the creek near Sedges Island and runs north above the water to the community of Rhodes Point.

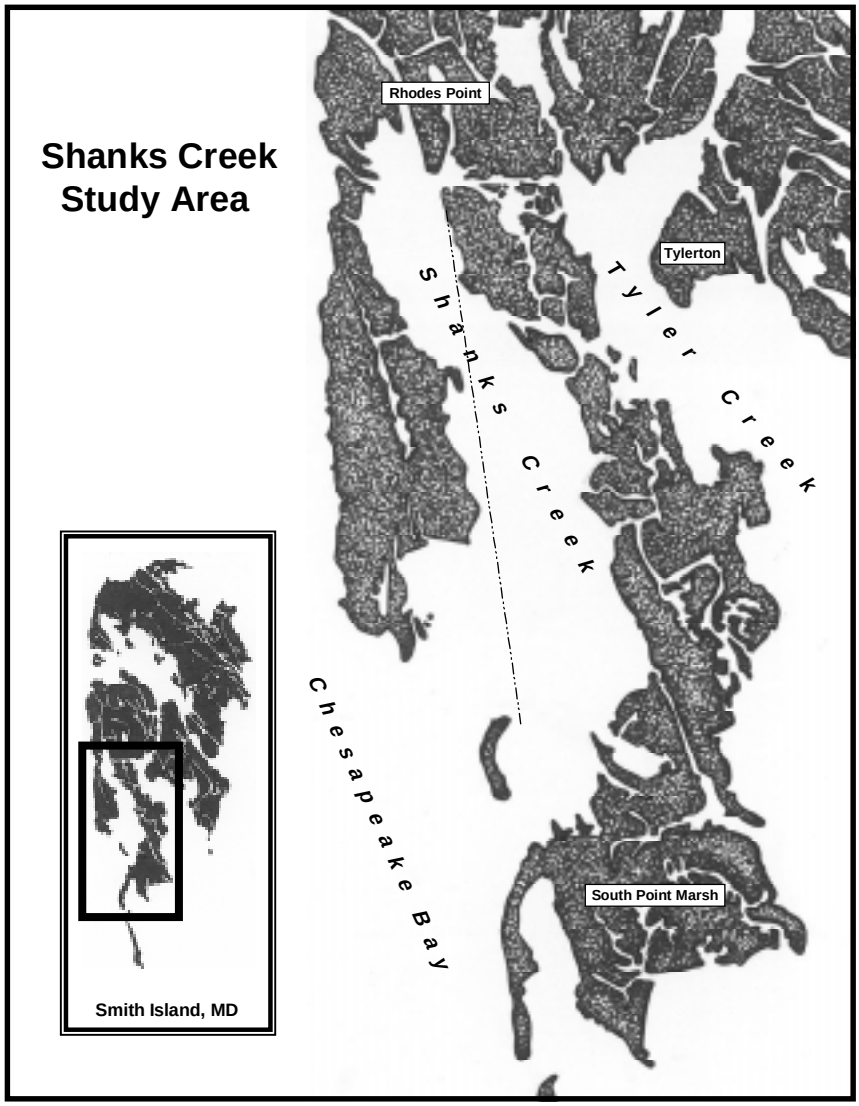


Figure 1. Map of the southern end of Smith Island, MD indicating the lcoation of the Shanks Creek Study Area. The dashed line indicates the approximate location of exposed power lines.

Shanks Creek and the surrounding tidal marshes and islands likely support the largest community of breeding waterbirds within the Chesapeake Bay. The creek is bordered to the east and west by extensive tidal salt marshes dominated by smooth cordgrass (*Spartina alterniflora*) and black needlerush (*Juncus roemerianus*). The marshes themselves are very productive and support large breeding populations of Seaside Sparrows and Clapper Rails. Other less abundant breeding species include the Northern Harrier and the American Black Duck. In addition to species that nest directly in the marshes, many species utilize the marshes for foraging. These species include waterfowl, gulls, migrant shorebirds, and numerous herons.

Colonial Waterbird Colonies

Two major waterbird colonies occur in the area surrounding the lower portion of Shanks Creek. These include a pelican/cormorant/gull colony located on the South Point Marsh/ Cheeseman Island complex and a mixed heronry located within the Hog Neck hummock. The breeding area supporting pelicans, cormorants, and gulls was subdivided into 3 subcolonies positioned on topographic highs within the complex (Figure 2). The South Point Marsh colony was surveyed to assess size and breeding stage between 9 and 11 June, 2000. Observers systematically walked through each subcolony and counted all nests detected of each species present. The number of eggs and/or young was recorded for each nest. The estimated age of young was recorded in weekly intervals. The age of young was determined by previous experience and using descriptions of chick development presented in Palmer (1962). No attempt was made to assess quantitatively colony size and species status within the Hog Neck hummock heronry. However, the species composition of this colony was determined by observing herons flying to and from the colony site.

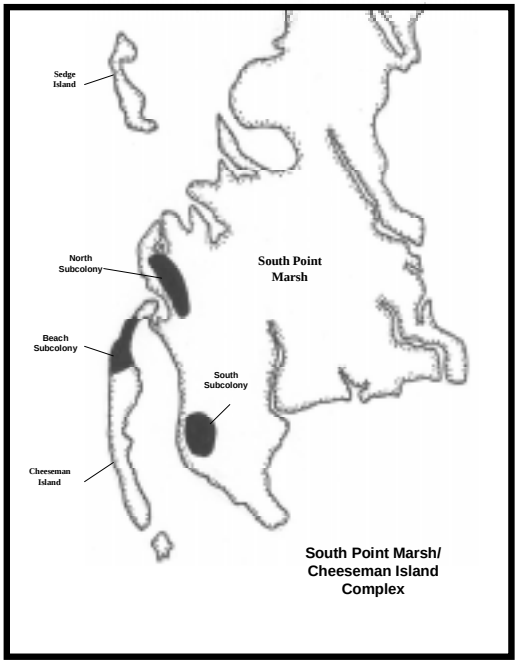


Figure 2. Map of South Point Marsh/ Cheeseman Island Complex on the southern end of Smith Island. Map illustrates the location of the three subcolonies.

Behavioral Observations

Study Design - Many factors influence the activity patterns of breeding birds. For the majority of species, phase of the breeding cycle is one of the most important determinants of foraging activity. For example, just prior to clutch formation, females of many species will increase the time devoted to foraging in order to build the energy reserves needed for egg production. During the incubation phase, time devoted to foraging is at its lowest as adults spend considerable time to protect and incubate the eggs. Foraging time is at its highest during the brood rearing phase as adults must provide for the increasing energetic demands of growing chicks. Foraging is also high during the post-fledging period as adults provision young and as young learn to forage on their own. The post-fledging period is also the time of highest mortality as young learn to interact with their environment. In addition to phase of the breeding cycle, birds that depend on aquatic resources in coastal systems are greatly influenced by tidal stage.

In order to represent a complete view of the use that the exposed power lines receive from adjacent waterbird colonies, a simple two-way design was used with breeding phase and tidal stage as primary factors (see Table 1). The design included an increase in temporal replication throughout the breeding cycle to reflect expected foraging activity. Information collected on the stage of breeding during the initial colony assessment (see above) was used to estimate when observation periods should be scheduled. However, the colony exhibited considerable asynchrony both within and among species such that the incubation period contained some nests in the early brooding phase and the brood rearing period contained some incubating birds. Post-fledging observations were delayed to insure that all nests had failed or fledged. Replicate observations considered to be during the incubation period were conducted from 5 through 14 June (APPENDIX Ia-Ib). Replicate observations considered to be during the brood rearing period were conducted from 11 July through 10 August. Replicate observations considered to be during the post-fledging period were conducted from 23 August through 16 September.

Table 1. Proposed study design. Numbers indicate replicate observation periods.

	Incubation	**Brood Rearing**	**Post Fledging**
Low Tide	**4**	**6**	**8**
High Tide	**4**	**6**	**8**

Tidal stage was estimated using NOAA projections (http://marineweather.com / BanNOAATides.html) for the tide station located in Ewell. For the purposes here, low tide refers to the six-hour period including the second half of the outgoing tide and the first half of the incoming tide. High tide refers to the six-hour period including the second half of the incoming tide and the first half of the outgoing tide. It should be noted here that both breeding phase and tidal stage were included in this study to insure adequate coverage of foraging activity during relevant periods of time. The intent was not to perform a focused study on the influence of these factors on foraging behavior. For this reason, presentation of these factors in the results will be limited to areas where their inclusion seems appropriate.

Field Protocols - Field observations were made during 3-hr time blocks. As much as possible, these time blocks were centered on projected times of low and high tide. Three types of information were collected during field observations. These include, field conditions, substrate use, and bird movements. Field conditions included several weather parameters and the number of boats within Shanks Creek. Substrate use information included the number and species contacting electrical structures, where they were located (i.e. position along the distribution line) and what type of structures they were contacting. Bird movement information included number and species of birds crossing power lines within 10 m and where they were located.

Field Conditions – Thirteen measurements of field conditions were made during each 3-hr time block. Measurements were made during the initial 5-min period of each 15-min time segment and at the end of the 3-hr time block. Parameters measured included ambient temperature, wind speed, wind direction, cloud cover, and the number of boats within Shanks Creek. Temperature was measured with a quick-read thermometer to the nearest 1ºC. Wind speed was measured by orienting a portable anemometer into the wind and recording the average reading to a resolution of 0.1 mph. Wind direction was measured by orienting a compass into the wind and recording the direction in 1º increments. Cloud cover was visually estimated as the percentage of sky occluded in 5% intervals. The number of boats within Shanks Creek was determined by scanning the surface of the creek and counting the number detected. Information has been summarized and presented in APPENDICES Ia-Ib. This information is presented as background but was not used in the general analysis of bird patterns.

Substrate Use - Information pertaining to substrate use was collected by scanning all electrical structures for associated birds with binoculars or spotting scopes. Only structures within the first 15 spans (moving south to north) were included in the survey. This represents a distance of more than 1.5 km. This limitation was imposed to insure the reliability of species identification. Within 3-hr time blocks, single scans were performed during each of the 12, 5-min time segments (the same time periods used to measure weather conditions). All birds that were in contact with any of the electrical power structures were identified to species and recorded. Each bird was also mapped according to location along the distribution line. For this purpose, the distribution line was broken up into numbered sections moving south to north. Each section included the power pole and the span of wire to the north. In addition to species and location the associated structure was recorded. Structures considered included the elements

of the pole assembly and the four wires. Pole structures included the 1) pole, 2) top cross arm, and 3) lower cross arm (Figure 3). Wires included the 1) top wire, 2) east wire, 3) west wire, and 4) bottom wire.

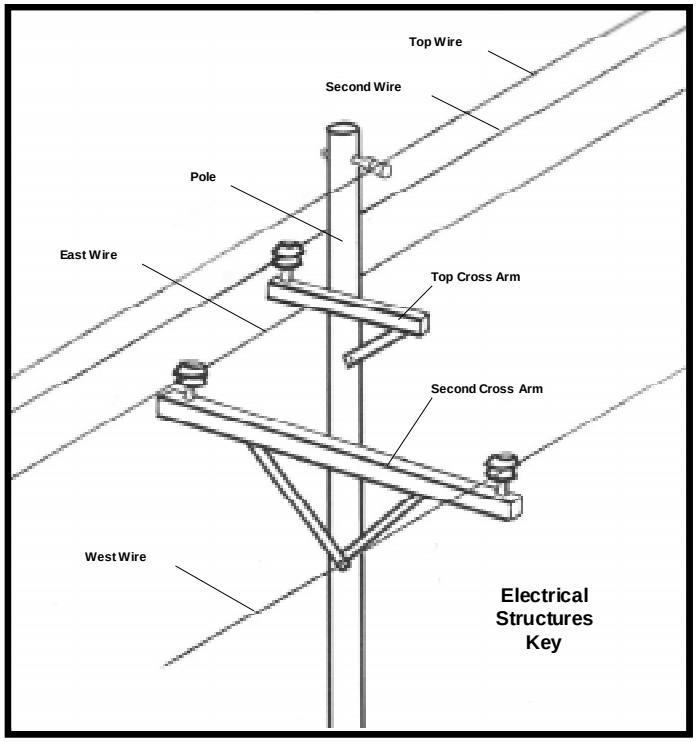


Figure 3. Illustration of electrical structures monitored in substrate use and movement observations. Elements are not drawn to scale.

Bird Movement – Flying birds were surveyed by scanning back and forth along the southern 15 sections of power line (see description of area above). Scans were performed continually during the 12, 10-min time segments within each 3-hr time block. The result of this procedure is that flying birds were under direct observation during 2 hr of each 3-hr time block. Flying birds were recorded if they were observed to 1) cross above or below and within 10 m of exposed wires or 2) land on some electrical structure (categories of structures described above). Birds flying more than 10 m above wires were not included in surveys. All birds observed to cross within 10 m of wires were identified as to species and recorded. Age was recorded for Brown Pelicans observed as either "hatching-year" or adult. Location of crossing along the transmission line was recorded using the same designations as described for substrate use observations. In addition to location, the position of birds relative to wires was also recorded. Birds were recorded as crossing either within 2 m of wires or beyond 2 m and within 10 m of wires.

RESULTS

Colonial Waterbird Colonies

South Point Marsh Colony – The breeding colony on the South Point Marsh/ Cheeseman Island complex supported at least 1,773 pairs of four species including Brown Pelican, Double-crested Cormorant, Herring Gull, and Great Black-backed Gull (Table 2) (See APPENDIX I for list of all species referenced in results). This colony represents the largest known colony in the Chesapeake Bay for Brown Pelicans and Double-crested Cormorants. Descriptions of subcolonies are given below.

Table 2. Summary of South Point Marsh/Cheeseman Island colony survey. Empty gull nests could not be identified to species.

Subcolony	Species	Occupied Nests	Empty Nests
South			
	Brown Pelican	247	12
	Double-crested Cormorant	59	2
	Herring Gull	155	31
	Great Black-backed Gull	7	
North			
	Brown Pelican	666	3
	Double-crested Cormorant	256	13
	Herring Gull	133	3
	Great Black-backed Gull	31	
Beach			
	Brown Pelican	0	0
	Double-crested Cormorant	0	0
	Herring Gull	206	16
	Great Black-backed Gull	3	
Total			
	Brown Pelican	913	15
	Double-crested Cormorant	315	15
	Herring Gull	494	50
	Great Black-backed Gull	51	

Northern Marsh Subcolony – The northern subcolony was located along a network of spoil dikes apparently created when narrow ditches were dug through the tidal marsh. These dikes formed two polygons and provided nesting birds with topographic highs that allowed birds to nest above spring tides. Nests of both Brown Pelicans and Double-crested Cormorants were restricted to these dikes. Nests of both gull species were present on dikes but were also placed on salt meadow hay (*Spartina patens*) within the surrounding high marsh. This subcolony supported the largest number of Brown Pelicans, Double-crested Cormorants, and Great Black-backed Gulls. Based on the stage of nests and nestlings (Table 3), this subcolony was initiated 2-3 weeks earlier in the spring compared with the other subcolonies.

Table 3. Summary of breeding stage for colonial waterbirds within the South Point Marsh/Cheeseman Island Complex.

Subcolony	Species	Eggs	1 wk	2 wk	3 wk	4wk
South						
	Brown Pelican	365	153	61	14	-----
	Double-crested Cormorant	170	1	-----	-----	-----
	Herring Gull	228	78	3	-----	2
	Great Black-backed Gull	13	2	-----	-----	-----
North						
	Brown Pelican	602	328	233	209	153
	Double-crested Cormorant	185	235	247	123	4
	Herring Gull	269	19	3	-----	-----
	Great Black-backed Gull	72	6	-----	-----	-----
Beach						
	Brown Pelican	-----	-----	-----	-----	-----
	Double-crested Cormorant	-----	-----	-----	-----	-----
	Herring Gull	482	70	9	-----	-----
	Great Black-backed Gull	9	-----	-----	-----	-----
Total						
	Brown Pelican	967	481	294	213	153
	Double-crested Cormorant	355	236	247	123	4
	Herring Gull	979	167	15	-----	-----
	Great Black-backed Gull	94	8	-----	-----	-----

Southern Marsh Subcolony – The southern subcolony was located along a smaller network of spoil dikes that were similar in structure to those described for the northern subcolony. Nests were also located on a high sandy berm along the western edge of the marsh. This berm appeared to have been formed by sand deposition resulting from extreme tides. As with the northern subcolony, pelican and cormorant nests were restricted to topographic highs and gull nests were more widely placed. This subcolony supported the remaining pelican and cormorant nests and the majority of the remaining Great Black-backed Gull nests. Pairs were in an early stage of breeding compared to the northern subcolony and nests were not as densely packed within the available substrate. This suggests that the colony may have continued to add breeding pairs after the colony was assessed.

Beach Subcolony – The beach subcolony was located along the northern end of Cheeseman Island. Cheeseman Island is an unconsolidated sandy ridge that serves as a barrier island to South Point Marsh. Gull nests were built within the remnant dunes that represent the high points along the island. The majority of nests present within this subcolony were Herring Gull nests in the egg stage.

Hog Neck Rookery – The Hog Neck Rookery was located within the hummock along the western shoreline of Shanks Creek just north of the Virginia/Maryland state line. This hummock is approximately 1/3 ha in area and is situated on a topographic high within the extensive tidal marsh of Hog Neck. The area is similar to several such hummocks found on Smith Island that appear to have formed on sites of former spoil deposition. The hummock is composed primarily of loblolly pine (*Pinus taeda*), black cherry (*Prunus serotina*), and hackberry (*Celtis occidentalis*). The rookery supported 9 different species of breeding herons, egrets, and ibises. These included Great Blue Heron, Great Egret, Snowy Egret, Little Blue Heron, Tricolored Heron, Green-backed Heron, Yellow-crowned Night-heron, Black-crowned Night-heron, and Glossy Ibis. This single colony supported every species of heron known to breed in Maryland with the exception of the Cattle Egret.

Substrate Use Patterns

Species Composition - A total of 432 surveys of electrical structures were conducted during the study period. Surveys resulted in 3,623 detections of individual birds perched on electrical structures. Only 9 species were observed actually contacting structures during surveys (Table 4). Four of these species including the Herring Gull, Great Black-backed Gull, Double-crested Cormorant, and Osprey accounted for more than 98% of all observations. A large majority of these birds appeared to use structures as short-term roosts. A few birds such as the Peregrine Falcon and Royal Tern appeared to utilize the structures for perch hunting. The Osprey was the only species that frequently carried prey to structures for consumption.

Table 4. List of species and number of individuals observed during substrate use surveys.

Species	Number observed	Percentage of total
Herring Gull	1,422	39.25
Great Black-backed Gull	1,066	29.42
Double-crested Cormorant	593	16.37
Osprey	481	13.28
Fish Crow	51	1.41
Peregrine Falcon	5	0.14
Laughing Gull	2	0.06
Royal Tern	2	0.06
Sharp-shinned Hawk	1	0.03

Substrate Type – All of the electrical structures were used, at least once, during observations (Table 5). Use of wooden structures including the power pole and cross arms collectively accounted for nearly 90% of all observations. Use of the power pole alone accounted for nearly 83% of all observations. The top wire was also used consistently. Remaining wires (second, east and west) were rarely used. Collectively, these wires only accounted for one tenth of 1% of all observations. The low incidence of use presumably reflects the difficulty of flying into and landing on these wires.

Table 5. Patterns of use for the different electrical structures monitored during substrate surveys.

Species	Pole	Top Cross Arm	Second Cross Arm	Top Wire	Second Wire	West Wire	East Wire
Herring Gull	1,337	57	20	8	0	0	0
Great Bl-backed Gull	1,041	19	2	4	0	0	0
D-crested Cormorant	227	40	0	325	0	0	1
Osprey	365	54	4	56	2	0	0
Fish Crow	22	5	7	16	0	1	0
Peregrine Falcon	3	1	0	1	0	0	0
Laughing Gull	2	0	0	0	0	0	0
Royal Tern	0	0	2	0	0	0	0
Sharp-shinned Hawk	0	0	0	1	0	0	0
Total	2,997	176	35	411	2	1	1

Species differed in their use of the various electrical structures. The gull species were, for the most part, restricted to roosting on the top of power poles. Many individuals were regularly observed competing for access to unoccupied poles. Gulls that were observed perching on wires typically only did so for periods of 10-15 sec. Only the Double-crested Cormorant and Osprey was observed to use the top wire consistently. These two species are clearly capable of sustained perching on wires.

Distribution – Birds utilized electrical structures along the entire length of the study area (Figure 4). Based on the 432 surveys conducted, 12 of 15 segments of the distribution line had

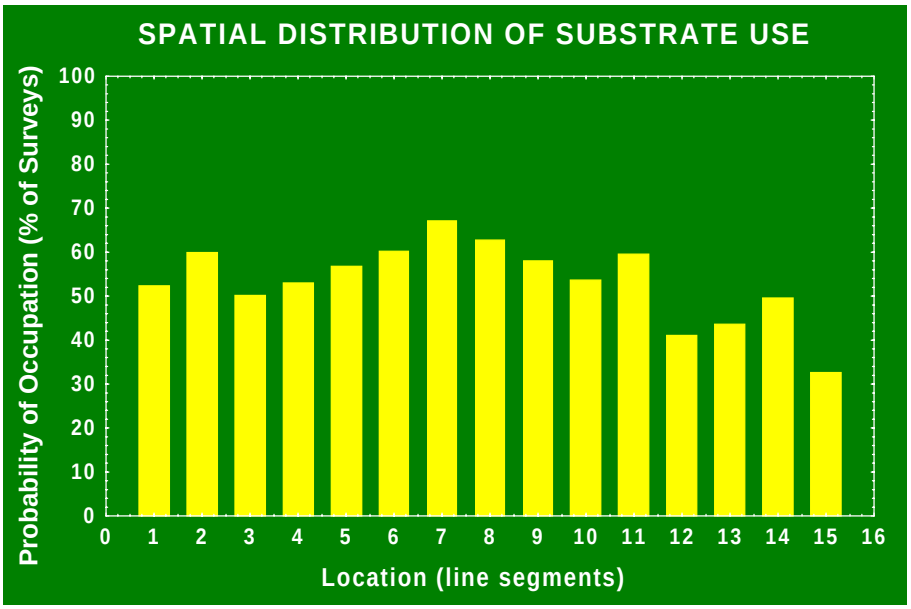


Figure 4. Distribution of substrate use observations along power line segments. Segments are numbered south to north. Probability of occupation was based on the number of surveys where birds were observed to occupy segment/total surveys. A total of 432 surveys of structures were conducted.

more than a 50% chance of being occupied. Remaining segments had a greater than 30% chance of being occupied. When all birds are considered together, distribution along the distribution line was relatively even. However, individual species did exhibit some variation in use along the line (APPENDIX II). Both Ospreys and Fish Crows were skewed to the southern segments. Double-crested Cormorants were skewed away from the southern segments. Both Herring and Great Black-backed Gulls were more frequently observed perched in the middle segments.

Estimated Loads – Birds observed on wires represented relatively small loads. The average load estimated on single spans of wire was 2.1 ± 0.054 (mean ± SE) Kg (equal to 4.63 pounds). The largest load observed during substrate surveys was 5.04 kg (11.1 pounds). This occurred when 3 Double-crested Cormorants perched on the same span of the top wire. The most common loads observed were from single Osprey or Double-crested Cormorants (Figure 5).

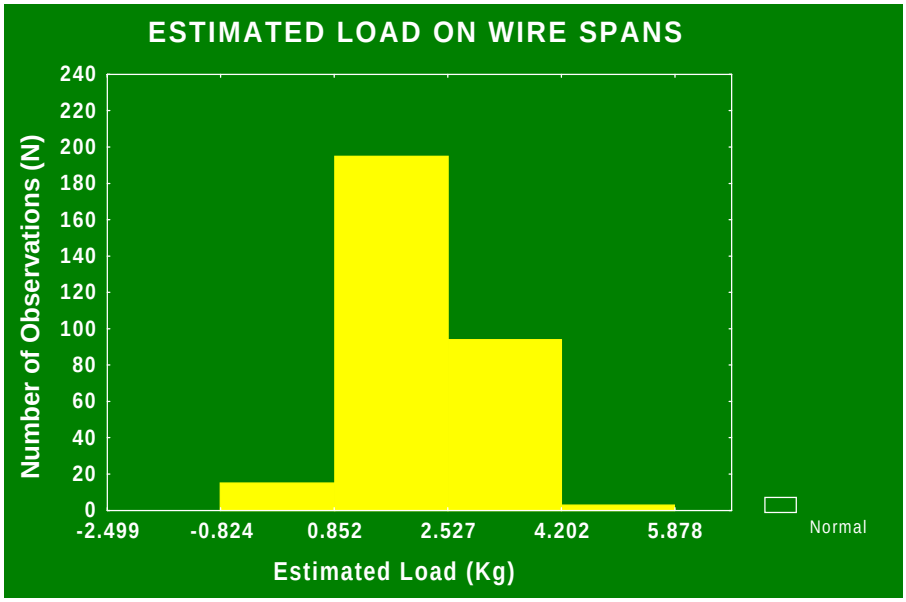


Figure 5. Frequency distribution of estimated loads on single wire spans (N = 307 estimates). Loads were caculated as the total mass of birds using the same wire span. Mass for individual species is given in APPENDIX I.

Movement Patterns

Waterbirds within Shanks Creek were under direct observation for a total of 72 hr (2 hr each of the 36, 3 hr time blocks). During this time 4,164 observations were made of individuals flying across the distribution lines within a distance of 10 m above or below. This frequency equates to an average crossing rate of 57.8 ± 3.11 (mean ± standard error) birds/hr. The majority (70.4%) of these birds crossed above rather than below the lines (Appendix IV). The majority (91.4%) of these birds were also estimated to be more than 2 m above or below the wires when crossing. No individuals were ever observed flying through the set of wires or striking any wires.

Species Patterns – During observation periods, 29 different species were observed to fly across distribution lines (Table 6). As with observations of substrate use, relatively few species accounted for the majority of crossings. Nine species including the Herring Gull, Brown Pelican, Great Black-backed Gull, Double-crested Cormorant, Osprey, Fish Crow, Royal Tern, Great Egret, and Laughing Gull accounted for nearly 92% of all observations. Only 12 of the 29 species were estimated to fly within 2 m of the wires when crossing. Even for these 12 species, crossings within 2 m of the wires were not common. Crossing within a close distance typically represented less than 10% of the total crossings (Table 6, APPENDIX IV).

Table 6. Summary of observations from movement surveys. Percent within 2 m indicates the proportion of birds observed to cross that were within 2 m of the wires.

Species	**Movent Rate (birds/hr) Mean ± SE**	**Percent within 2 m**	**Total**
Herring Gull	22.2 ± 2.22	9.1	1,600
Brown Pelican	8.8 ± 1.07	14.2	635
Great Black-backed Gull	6.8 ± 0.92	8.6	490
Double-crested Cormorant	5.2 ± 0.67	6.1	374
Osprey	2.9 ± 0.36	4.8	210
Fish Crow	2.5 ± 0.36	7.3	177
Royal Tern	1.9 ± 0.29	12.3	138
Great Egret	1.5 ± 0.31	0.9	106
Laughing Gull	1.4 ± 0.32	4.0	100
Common Tern	1.0 ± 0.17	2.9	69
American Black Duck	0.7 ± 0.19	3.8	52
Little Blue Heron	0.7 ± 0.16	0	50
Snowy Egret	0.5 ± 0.11	2.9	35
Great Blue Heron	0.4 ± 0.08	0	31
Tricolored Heron	0.3 ± 0.09	0	23
Mute Swan	0.3 ± 0.22	0	22
American Oystercatcher	< 0.2	0	9
Canada Goose	< 0.2	0	8
Forrester's Tern	< 0.2	0	6
Willet	< 0.2	0	6
Glossy Ibis	< 0.2	0	4
Yellow-crowned Night-heron	< 0.2	0	4
Boat-tailed Grackle	< 0.2	0	4
Short-billed Dowitcher	< 0.2	0	2
Northern Harrier	< 0.2	0	2
Sharp-shinned Hawk	< 0.2	0	2
Peregrine Falcon	< 0.2	0	2
Mallard	< 0.2	0	1
Merlin	< 0.2	0	1
		0	
Total	**57.8 ± 3.11**	**8.6**	**4,164**

Based on observations of the different species within and around Shanks Creek there appear to be several reasons why birds cross the distribution line. Several species such as the American Black Duck, Northern Harrier, and Willet that are strongly tied to the tidal marshes for foraging and breeding appear to cross the lines just in the process of moving between the marshes on either side of Shanks Creek. Other species such as the herons and egrets move out to the grass beds in the middle of Shanks Creek to forage at low tide. The shallowest areas occur around the power lines and birds move back and forth to these areas with the changing tides. Other species such as the Brown Pelicans, Osprey, Royal Terns, and Common Terns forage in the deeper water within the creek and will cross the lines as they move back and forth to different foraging areas. Finally, the large sand bar that remains of Sedge Island in the mouth of Shanks Creek is a significant roost area for many species. Several thousand birds may be seen roosting on this site during late summer. Many birds cross the distribution lines as they fly to or from this roost site.

Spatial patterns – Birds were observed to cross all 15 of the line segments that were monitored during survey periods. However, if we examine movement rates by individual segments, it is clear that birds crossed the southern line segments with higher frequency (Figure 6). In fact, 75% of all crossings occurred within the first 5 line segments. This same skew in crossing rates was observed for the most abundant species (Figure 7). However, some of the minor species did exhibit different spatial patterns (APPENDIX V). For example, most of the heron species crossed segments 3-7 with higher frequencies compared with other segments. This pattern corresponds to the location of the most shallow ridge in Shanks Creek that lies under these line segments. Many of the heron species foraged along this ridge during low tide.

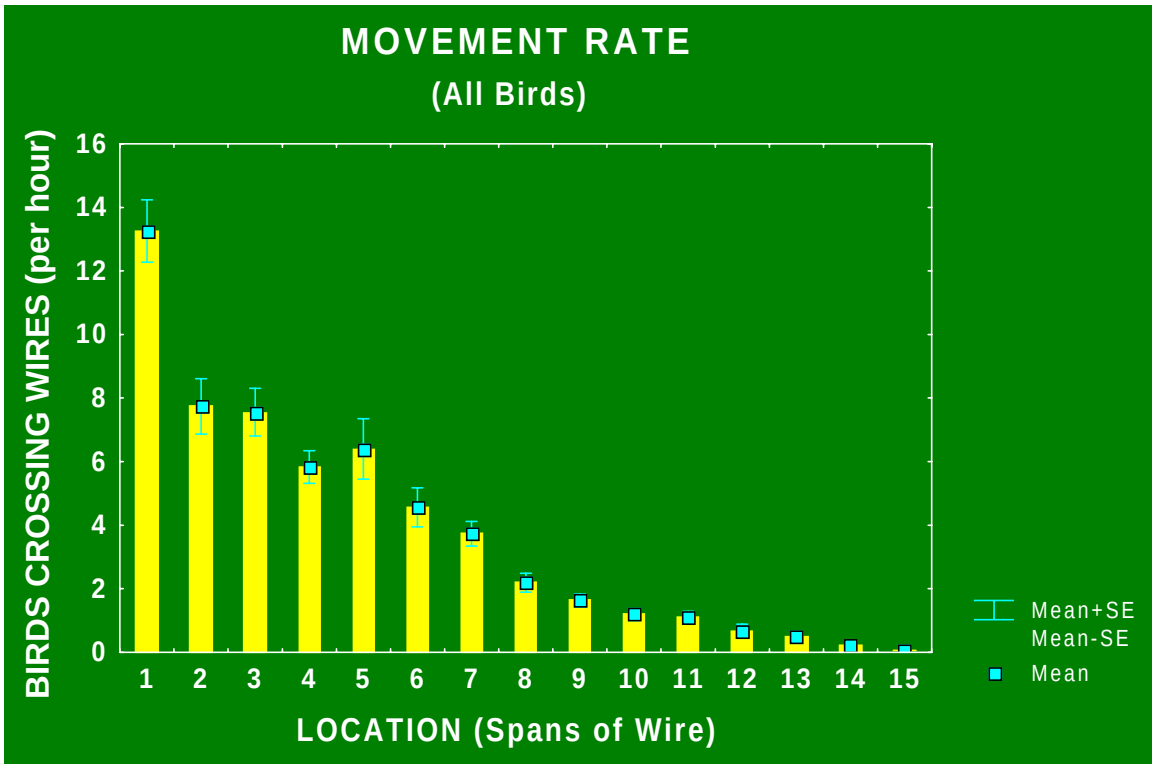
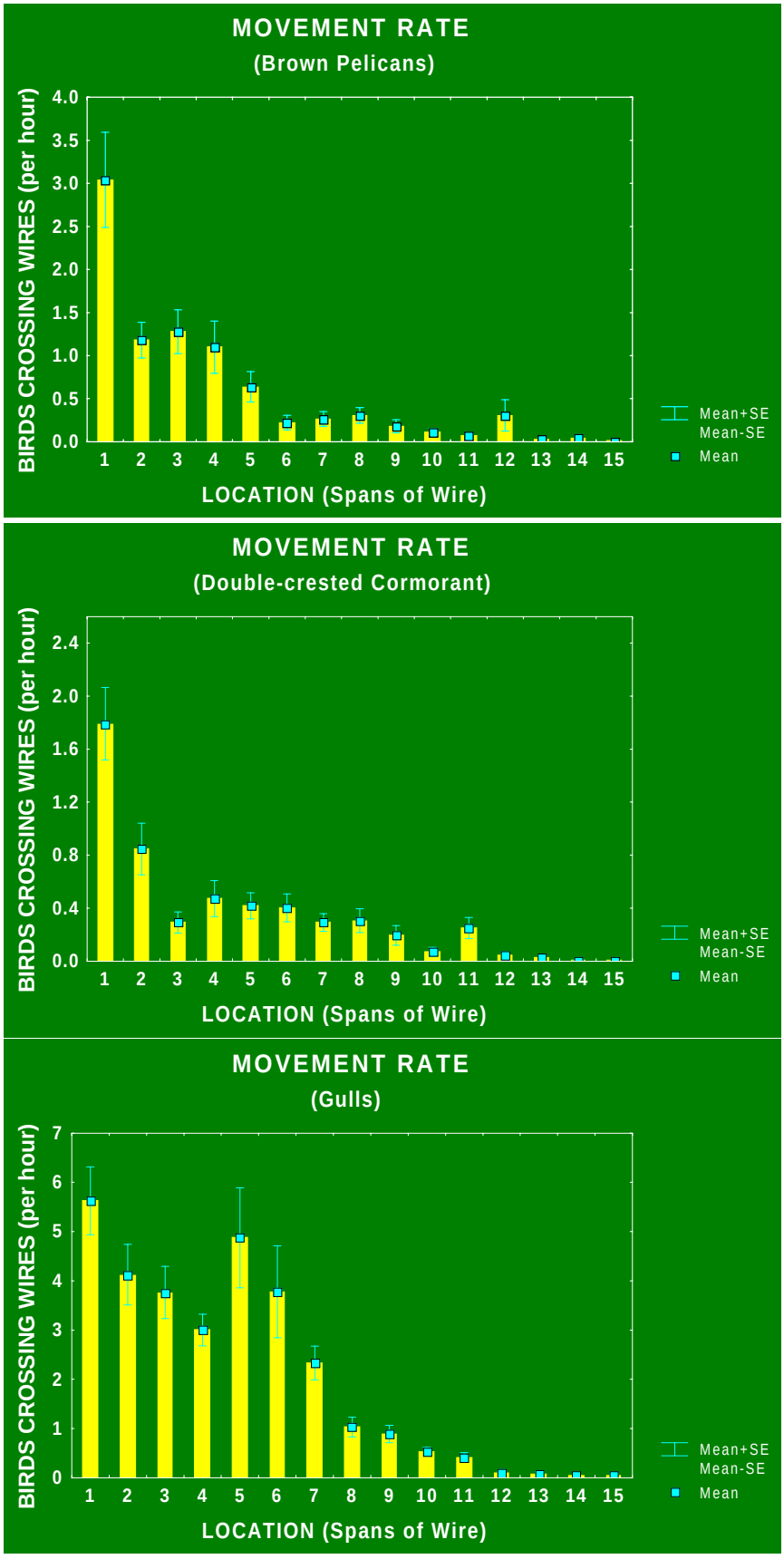


Figure 6. Movement rate of birds crossing respective spans of wires. Units are birds/hr.



Figuare 7. Distribution of movement rates for most common birds observed during substrate surveys.

The skew in movement rates toward the southern line segments appears to reflect the distribution of foraging birds and the presence of Sedge Island. Several of the plunge-diving species such as the Brown Pelican, Osprey , Royal Tern and Common Tern seem to forage a great deal near the mouth of Shanks Creek. These species frequently cross back and forth over the southern segments. As was indicated previously, Sedge Island is a gathering site for roosting birds. Many species cross the southern segments of line while moving to or from this island.

Landing Observations – Of the 29 species identified during movement observations, 10 were observed to land on electrical structures during the observation periods (Table 7). In general, these species correspond to those recorded during substrate surveys. Observations were dominated by Herring Gulls, Great Black-backed Gulls, Ospreys, Fish Crows and Double-crested Cormorants. However, 2 species were observed to land on structures that were not detected during substrate surveys. These included the Brown Pelican and Great Blue Heron. Two hatching-year Brown Pelicans were observed to glide up to the top wire and land for a period of less than 10 sec before flying off again. A similar observation was made of 2 Great Blue Herons that glided down to land on the top wire for a period of less than 15 sec. As the two birds flew off the wire one of the birds dropped down to land on the second cross arm for a brief moment.

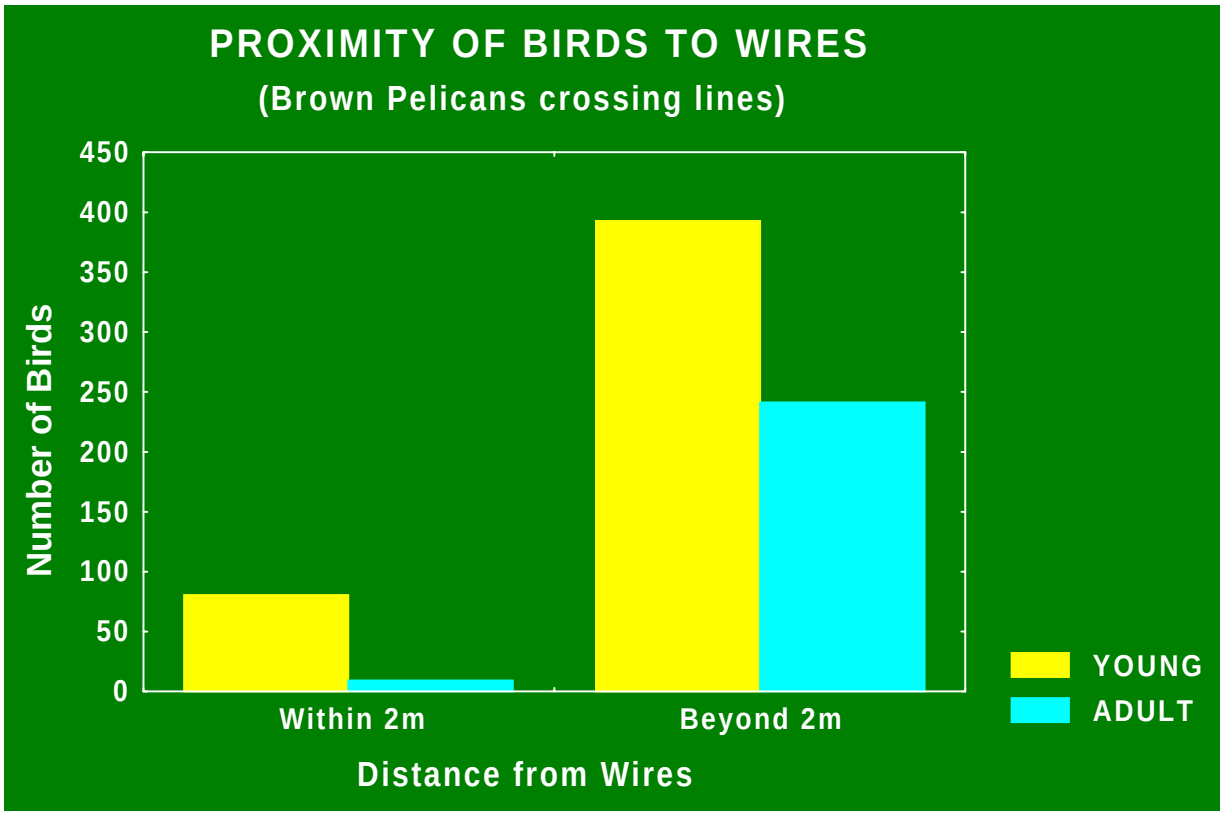
Table 7. Summary of substrate use by birds observed landing during movement observations.

Species	Pole	Top Cross Arm	Second Cross Arm	Top Wire	Second Wire	West Wire	East Wire
Herring Gull	135	9	0	19	0	0	0
Great Bl-back Gull	138	9	0	2	0	0	0
D-crest Cormorant	12	0	1	12	2	0	0
Osprey	30	30	2	8	0	0	0
Fish Crow	13	6	2	29	1	0	0
Peregrine Falcon	0	1	0	1	0	0	0
Great Blue Heron	0	1	0	3	0	0	0
Royal Tern	1	0	0	0	0	0	0
Brown Pelican	0	0	0	2	0	0	0
Total	329	56	5	76	3	0	0

Spatial patterns of birds observed landing on electrical structures were similar to those derived from substrate surveys. Substrate use patterns were also similar. Birds landed primarily on the power pole and associated wooden structures. Birds landing on wires used the top wire almost exclusively.

Brown Pelicans – Brown Pelicans were abundant within Shanks Creek and in the surrounding waters. During the height of the breeding season, birds were observed moving in all directions. Large roosting areas containing hundreds of individuals were recorded on what remains of Sedge Island, on the outer beach of Cheeseman Island, and within the breeding colonies on South Point Marsh. Early in the summer, birds recorded during movement observations were exclusively adults. It was not until early July that young of the year began to be recorded crossing distribution lines. Numbers of young recorded relative to adults continued to build through early September. During the months of August and September, young of the year represented 87.8% of all the pelicans observed crossing over distribution lines.

Young of the year Brown Pelicans appear to be more likely to fly across power lines as compared to adults. Although adult pelicans flew throughout Shanks Creek regularly, they often would fly the length of the power lines and around the end rather than cross over or under. Young pelicans often foraged under power lines and would frequently fly back and forth over or under the lines. This difference in behavior between age classes is further reflected in the proportion of birds crossing structures that were estimated to fly within 2 m of the lines. Only 4.1% of adult pelicans that crossed power lines were estimated to fly within 2 m compared to 20.4% of young pelicans (Figure 8).



Figuare 8. Patterns of estimated distances from wires for pelicans of different ages.

DISCUSSION

The four species of colonial waterbirds that nest on South Point Marsh are relatively recent arrivals to Virginia and the Chesapeake Bay. The Herring Gull has nested in the region much longer than the other three. In 1948, a single nest was found near Cobb Island on the seaside of the Delmarva (Murray 1952). By 1977, 9 colonies containing >2,600 pairs were reported (Erwin and Korschgen 1979). In 1993, a survey of the entire coastal plain located 35 colonies supporting an estimated 8,800 pairs (Watts and Byrd 1998). Although no recent surveys have been conducted for this species, the population is continuing to expand. The Great Black-backed Gull was first found breeding on Fisherman's Island in 1970 (Scott and Cutler 1970). Since the 1970's, this species has colonized several Bay islands. The species now occurs in low numbers in many Herring Gull colonies on both the seaside and the bayside of the Delmarva Peninsula. By 1993 there were 514 pairs scattered in 26 colonies (Watts and Byrd 1998). Breeding of the Double-crested Cormorant was first confirmed in Virginia in 1978 on a small vegetated island in the James River (Scott 1978). Breeding was sporadic there until 1984 when 8 pairs nested. Since this time, the coastal population has increased rapidly with an additional colony located in 1991, two in 1993, one in 1995, and one in 1999. The state population increased from 8 pairs in 1985 to 402 by 1995 (Watts and Bradshaw 1996). More than 900 pairs were counted during the breeding season of 2000 (Watts unpubl. Data). Nesting of Brown Pelicans was first documented in two locations on the barrier islands in 1987 (Williams 1989). Since that year the population was restricted to Fisherman's Island at the mouth of the Bay until Cheeseman Island was colonized in 1992. In 1993, 364 pairs were documented (Watts and Byrd 1998). The population is now approaching 2,000 pairs (Watts unpubl. Data).

Since the early 1990's the growth of the waterbird colony on the South Point Marsh/ Cheeseman Island Complex has been tremendous. Both the Herring and Great Black-backed Gull populations have doubled within this colony between 1993 and 2000. Brown Pelicans apparently colonized Cheeseman Island in 1992 (D. Brinker and G. Costanzo pers. Comm.). This population was surveyed by Watts and Byrd in 1993 and contained 53 pairs. At this time, the colony was restricted to the remnant dune system on Cheeseman Island. Since that time, the island has changed dramatically and the colony has relocated over to the topographic highs on South Point Marsh. Between 1993 and 2000, this population doubled several times to 913 pairs. The population appears to have doubled in just the last 2 years. It is now the largest breeding colony of Brown Pelicans in the mid-Atlantic region. Double-crested Cormorants were first documented to breed within the Shanks Creek area in 1993. During that year, Watts and Byrd (1998) documented 6 breeding pairs. The colony was situated within the pelican colony on Cheeseman Island. Since that year, the population has doubled several times to 315 pairs. This colony is now the largest in Virginia.

The growth of the colonial waterbird populations within the South Point Marsh/ Cheeseman Island Complex will likely continue over the next few years. Although nests occurred in fairly high densities, there still appeared to be room for expansion. Success within these populations is the result of a predator-free environment that is strategically located near good foraging areas. This colony site also appears to be located within productive waters that

provide rich food resources. How rapidly the populations will grow into the future and how large they will ultimately become is not clear. The significant jump in the Brown Pelican population appears to exceed that expected by local recruitment. The rapid growth may have been fueled by immigration from the Outer Banks of North Carolina. The growth in the remaining three species may be a more equitable mix of local recruitment and immigration from other colonies in Virginia and Maryland.

Smith Island supports several mixed heronries located on hummocks within extensive marshes. The colony on Hog Neck has been known since at least the 1960's. Whether or not this colony has increased in size or changed in species composition since that time is not known.

A considerable number of waterbirds were observed to use Shanks Creek during the breeding season. These birds utilized the Creek as a foraging area, roosting or loafing area, or as merely a movement corridor. However, these birds represented a very small fraction of the total birds within the South Point Marsh/Cheeseman Island Complex. All four of these species have a very large foraging range and draw their resources from an extensive area. Brown Pelicans, for example, were repeatedly observed to fly up out of the colonies, and spiral upward on thermals out of sight. These birds are likely foraging throughout the Bay and over into the Atlantic Ocean. This colony likely accounts for the increasing number of pelican observations during the breeding season within the western rivers of the Chesapeake Bay and within the Chincoteague area. Shanks Creek does not appear to be a very significant foraging area for this population. This point is further supported by the reduction in pelicans observed in the creek during the period of brood rearing. This is typically the most energetically demanding time of the breeding season for pairs. Pairs appeared to primarily feed out over the open Bay and beyond at this time. Similar movement patterns were observed for the gulls and cormorants. Shanks Creek does not appear to be the primary reason underlying the location of the waterbird colonies on the South Point Marsh/Cheeseman Island Complex.

Species nesting in the Hog Neck heronry depend heavily on Shanks Creek and the surrounding marshes. These species have a much smaller foraging range compared with the species breeding within the South Point Marsh colony. Most of the heron species feed within a relatively short distance of the colony site. They feed extensively along the tidal creeks of the marshes, along the shoreline of Shanks Creek and within the shallows of Shanks Creek during low tide periods.

Of the numerous species observed within and around the Shanks Creek area, relatively few were actually observed to come in contact with the electrical structures. A large portion of the individuals actually observed on structures were Herring Gulls, Great Black-backed Gulls, Double-crested Cormorants, or Ospreys. These species regularly used structures for roosting. Only Double-crested Cormorants and Ospreys consistently perched on wires. Virtually all of these observations were of birds perching on the top wire. This wire is used as a guide and does not carry electrical current. The loads experienced by these wires were relatively insignificant. The maximum load observed within a single span was 5.04 Kg or just over 11 pounds. The average load was 2.1 Kg or just over 4.5 pounds. Most of the birds observed perching on wires were near power poles rather than near the midpoint of wire spans. No visible depression of the wires was ever detected.

The observations of substrate use made within Shanks Creek are consistent with patterns observed in other areas throughout the mid-Atlantic where exposed power lines cross water, marshes, or other open areas. Such open areas have a lack of available perch sites making power poles and lines attractive. Similar situations occur and are very visible along the Chincoteague Causeway on the seaside of the Eastern Shore, along the roadway in Saxis Marsh on the Bayside of the Eastern Shore, within Newpoint Comfort Marsh on the western shore, throughout the sounds of the Outer Banks, etc. In less dramatic ways, these same observations may be made within any of the coastal cities near water throughout the mid-Atlantic region.

A considerable number of birds regularly fly across Shanks Creek or move back and forth above the water surface. A small portion of these birds cross the distribution lines within a distance of 10 m. A smaller portion still cross the distribution lines within a distance of 2 m. Of the more than 4,000 birds observed crossing the lines within 10 m, none was ever observed to fly between the four wires and none was observed to strike a wire. Birds appear to be aware of the wires and take actions necessary to avoid strikes. Young of the year pelicans did exhibit a higher probability of flying close to lines compared to adults suggesting that judgment may improve with age.

Birds flying across distribution lines were skewed to the south where the line extends into the mouth of Shanks Creek. The increased crossing rate in this area reflects the high level of bird activity within the creek mouth. Much of this activity seemed to be focused on the loafing area on the sand bar at Sedge Island. Birds continually flew to and from this location, often crossing power lines. For some species, the mouth of the creek also seemed to be a preferred foraging area.

There is no indication that waterbirds within and surrounding the Shanks Creek area experience any elevated risk of mortality compared to birds associated with the thousands of miles of exposed power lines found throughout the Chesapeake Bay and the broader mid-Atlantic Coastal Plain. The suggestion that large numbers of Brown Pelicans are attracted to Shanks Creek for foraging and that they collectively perch hunt from wires was not supported by the observations made during the breeding season of 2000. Perch-hunting by Brown Pelicans is rare. Although many pelicans were observed to forage in Shanks Creek, they used the traditional methods of plunge diving and “seigning” in the shallows. In more than 100 hours of observation across the breeding season, only two pelicans were observed to contact any electrical structure. These included two young of the year birds that landed on the top wire for a period of approximately 10 seconds. The largest number of birds observed to be perched on a single span was three Double-crested Cormorants. These birds would have resulted in a combined load of 5.04 Kg. This load appears to be inadequate to result in a significant increase in the probability of a wire to wire contact.

CONCLUSIONS

1) The South Point Marsh/Cheeseman Island waterbird colony is one of the largest and most significant within the Chesapeake Bay watershed. The colony has exhibited explosive growth over the past several years.

2) Although birds from the South Point Marsh/Cheeseman Island colony forage within Shanks Creek, it appears to represent only a small portion of a much larger foraging range. The creek itself does not appear to be the principal reason for the colony's location.

3) Several bird species utilize the electrical structures within Shanks Creek as perch sites. Nearly 90% of these birds perched on power poles or associated wooden structures.

4) Virtually all of the birds observed to contact wires were perched on the top wire. The top wire carries no electrical current. Estimated loads placed on wires by birds were relatively insignificant.

5) More than 4,000 birds were observed to fly across power lines within a distance of 10 m. None of these birds was observed to fly between wires or to strike any wire.

6) There is no indication that birds within the Shanks Creek area are experiencing any elevated risk of mortality compared to other areas throughout the Chesapeake Bay where exposed power line occur. No dead birds were detected during field work. No evidence of electricutions was observed.

LITERATURE CITED

Dunning, J. B. Jr. 1984. Body weights of 686 species of North American birds. Western Bird Banding Association Monograph No. 1, 39pp.

Erwin, R. M. and C. E. Korschgen. 1979. Coastal waterbird colonies: Maine to Virginia, 1977. An atlas showing colony locations and species composition. U.S. Fish and Wildlife Service FWS/OBS-79/08.

Murray, J. J. 1952. A checklist of the birds of Virginia. Virginia Society of Ornithology.

Palmer, R. S. 1962. Handbook of North American birds: Volume 1 Loons through Flamingos. Yale University Press, New Haven, CT.

Scott, F. R. 1978. Middle Atlantic Coast Region. American Birds 32:988-91.

Scott, F. R. and D. A. Cutler 1970. Middle Atlantic Coast region. American Birds 24:668-670.

Watts, B. D. and D. S. Bradshaw. 1996. Population expansion by Double-crested Cormorants in Virginia. Raven 67:75-78.

Watts, B. D. and M. A. Byrd. 1998. Status and distribution of colonial waterbirds in coastal Virginia. Raven 69:20-31.

Williams, B. 1989. The first breeding record of the Brown Pelican in Virginia: a chronology. Raven 60:1-3.

APPENDIX I. List of species detected during field observations. Species weights were taken from Dunning 1984.

Common Name	**Species Name**	**Weight (g)**
Great Black-backed Gull	*Larus marinus*	1,658
Herring Gull	*Larus argentatus*	1,135
Laughing Gull	*Larus atricilla*	325
Royal Tern	*Sterna maxima*	470
Forster's Tern	*Sterna forsteri*	158
Common Tern	*Sterna hirundo*	120
Double-crested Cormorant	*Phalacrocorax auritus*	1,679
Brown Pelican	*Pelecanus occidentalis*	3,392
Mallard	*Anas platyrhyncos*	1,082
American Black Duck	*Anas rubripes*	1,250
Mute Swan	*Cygnus olor*	10,735
Canada Goose	*Branta canadensis*	3,564
Great Blue Heron	*Ardea herodias*	2,390
Great Egret	*Ardea alba*	874
Snowy Egret	*Egretta thula*	371
Tri-colored Heron	*Egretta tricolor*	375
Little Blue Heron	*Egretta caerulea*	340
Yellow-crowned Night-Heron	*Nyctanassa violacea*	682
Black-crowned Night-Heron	*Nycticorax nycticorax*	883
Glossy Ibis	*Plegadis falcinellus*	506
Green Heron	*Butorides virescens*	212
Short-billed Dowitcher	*Limnodromus griseus*	136
Willet	*Catoptrophorus semipalmatus*	215
American Oystercatcher	*Haematopus palliatus*	632
Northern Harrier	*Circus cyaneus*	440
Sharp-shinned Hawk	*Accipiter striatus*	138
Peregrine Falcon	*Falco peregrinus*	782
Merlin	*Falco columbarius*	185
Osprey	*Pandion haliaetus*	1,485
Fish Crow	*Corvus ossifragus*	285
Boat-tailed Grackle	*Quiscalus major*	166

APPENDIX IIa. Summary of field conditions during low-tide periods. Information represents an average or range over the 3-hr observation period.

Breeding Cycle	Date mo/dy/yr	Time Period	Temperature Range (ºC)	Wind Direction (º)	Wind Speed Range (mph)	Cloud Cover Range (%)	Peak Boat Number (N)
Incubation	6/5/00	8:15-11:15	19-28	76-111	2.8-14.7	100	13
	6/8/00	12:00-15:00	33-38	180-216	4.5-13.00	0-5	2
	6/9/00	12:30-15:30	33-38	210-220	6.5-13.0	7.4-13.1	8
	6/14/00	16:15-19:15	22-30	94-122	3.5-12.7	100	2
Brooding	7/11/00	15:15-18:15	25-32	56-68	2.5-11.7	75-100	1
	7/12/00	15:30-18:30	27-32	316-340	5.8-10.3	10-20	0
	7/19/00	8:45-11:45	28-34	196-222	0-6.2	95-100	1
	8/8/00	12:45-15:45	33-36	290-320	2.0-5.1	0	2
	8/9/00	14:00-17:00	33-35	202-218	6.0-12.8	10-40	1
	8/10/00	14:15-17:15	32-35	280-330	4.0-7.6	0-40	1
P-fledging	8/23/00	12:30-15:30	24-26	195-200	15.3-18.1	15-80	2
	8/24/00	13:15-16:15	26-30	214-220	2.0-8.3	30-80	0
	9/7/00	13:45-16:45	24	275-306	3.4-8.1	0-10	1
	9/8/00	14:30-17:30	24-26	152-228	2.5-8.3	50-70	0
	9/9/00	14:45-17:45	27-28	200-222	3.6-7.4	5-15	0
	9/10/00	15:00-18:00	26-29	220-222	2.5-7.8	5-10	1
	9/15/00	8:30-11:30	21-24	320-348	13.2-20.4	75-100	5
	9/16/00	8:45-11:45	14-23	328-360	4.6-14.8	50-65	5

APPENDIX IIb. Summary of field conditions during high-tide periods. Information represents an average or range over the 3-hr observation period.

Breeding Cycle	Date mo/dy/yr	Time Period	Temperature Range (ºC)	Wind Direction (º)	Wind Speed Range (mph)	Cloud Cover Range (%)	Peak Boat Number (N)
Incubation	6/7/00	16:45-19:45	20-33	215-268	0.9-10.5	0-40	3
	6/8/00	17:45-20:15	21-30	182-200	12.0-16.8	5-50	0
	6/9/00	7:30-10:30	20-28	240-246	6.0-16.2	0	10
	6/14/00	11:45-14:45	25-39	48-78	0-5.8	100	9
Brooding	7/11/00	8:30-11:30	28-40	64-94	3.2-10.7	60-100	0
	7/12/00	9:30-12:30	30-35	42-86	3.5-11.2	10-40	0
	7/13/00	9:45-12:45	25-33	172-206	4.5-9.2	15-50	1
	7/18/00	13:45-16:45	32-34	188-220	1.8-13.5	0-10	1
	7/19/00	14:15-17:15	27-28	26-43	8.5-14.6	100	2
	8/9/00	8:15-11:15	29-34	250-312	8.8-15.5	10-80	6
P-fledging	8/23/00	7:30-10:30	19-24	214-233	8.1-18.3	0-5	5
	8/24/00	8:00-11:00	24-26	226-244	5.2-12.5	40-60	5
	9/8/00	8:45-11:45	23-26	115-220	2.0-7.6	10-20	4
	9/9/00	9:15-12:15	20-26	212-224	4.3-12.1	60-85	4
	9/10/00	9:45-12:45	22-29	222-224	2.0-6.4	0	0
	9/14/00	12:30-15:30	27-29	210-220	3.2-7.0	0-60	3
	9/15/00	13:00-16:00	23-25	290-316	8.8-21.0	10-50	1
	9/16/00	13:00-16:00	22-24	304-334	6.2-12.7	30-40	1

APPENDIX III. Distribution of species perched on electrical structures. Numbered columns refer to segments of the transmission line moving south to north.

Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Herring Gull	35	61	77	68	96	79	122	128	141	141	162	76	91	74	71
Great Bl-backed Gull	64	85	88	72	111	113	100	65	59	54	59	43	42	46	65
D-crested Cormorant	0	0	1	0	2	45	83	68	54	29	81	45	62	101	22
Osprey	49	93	52	99	37	25	10	46	25	8	20	4	9	1	3
Fish Crow	10	4	1	3	4	2	0	2	3	4	3	6	4	3	2
Peregrine Falcon	1	0	0	0	0	0	0	0	3	0	0	0	0	1	0
Laughing Gull	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Royal Tern	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Sharp-shinned Hawk	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Total	159	245	219	242	251	264	315	310	285	236	325	174	209	226	163

APPENDIX IV: Summary of activities for species observed during movement observations (see methods).

Species	Crossed Above (beyond 2m)	Crossed Above (within 2m)	Crossed Below (beyond 2m)	Crossed Below (within 2m)	Landed on Substrate
Great Black-backed Gull	235	39	64	3	149
Herring Gull	987	122	302	24	163
Laughing Gull	71	4	25	-----	-----
Royal Tern	119	17	1	-----	1
Forrester's Tern	3	-----	3	-----	-----
Common Tern	51	2	12	-----	4
Brown Pelican	207	64	336	26	2
Double-crested Cormorant	172	21	152	2	27
Mallard	-----	-----	1	-----	-----
American Black Duck	31	2	19	-----	-----
Canada Goose	-----	8	-----	-----	-----
Mute Swan	-----	-----	22	-----	-----
Glossy Ibis	4	-----	-----	-----	-----
Great Blue Heron	12	-----	15	-----	4
Great Egret	45	1	60	-----	-----
Snowy Egret	18	1	16	-----	-----
Tricolored Heron	6	-----	17	-----	-----
Little Blue Heron	16	-----	34	-----	-----
Y-crowned Night-heron	3	-----	1	-----	-----
Short-billed Dowitcher	2	-----	-----	-----	-----
Willet	6	-----	-----	-----	-----
American Oystercatcher	3	-----	6	-----	-----
Northern Harrier	2	-----	-----	-----	-----
Sharp-shinned Hawk	-----	-----	2	-----	-----
Peregrine Falcon	-----	-----	-----	-----	-----
Merlin	1	-----	-----	-----	-----
Osprey	112	9	18	1	70
Fish Crow	55	6	58	7	52
Boat-tailed Grackle	2	-----	2	-----	-----

APPENDIX V: Summary of distribution patterns for species observed during movement observations (see methods). Numbered columns refer to power line segments moving south to north.

Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Great Black-backed Gull	88	59	72	54	72	68	45	8	6	7	3	4	1	1	2
Herring Gull	298	217	179	141	262	205	124	54	46	29	22	9	7	6	1
Laughing Gull	13	18	18	18	13	4	4	6	2	2	2				
Royal Tern	65	22	16	12	4	6	5	2	1	2	2	1			
Forrester's Tern	1		1	1			1				2				
Common Tern	32	8	8	3	8	2	2	2	2		2				
Brown Pelican	221	86	92	80	46	16	19	22	13	8	5	21	2	4	
Double-crested Cormorant	121	61	20	26	30	30	21	23	11	10	15	1	3	4	
Mallard						1									
American Black Duck	7	13	6	7	7	5	1	2	2	2					
Canada Goose				8											
Mute Swan		7	15												
Glossy Ibis				1				2	1						
Great Blue Heron	5	2	5	5	2	2	7			1	2				
Great Egret	7	9	16	14	12	13	12	7	5	3	3	2	3		
Snowy Egret	1	4	6		3	3	3	3	6		2	2	1	1	
Tricolored Heron	1	1	3	2	3	2	4	2	3			1	1		
Little Blue Heron		5	10	2	7	7	7	5	1	2	4				
Y-crowned Night-heron									1	2		1			
Short-billed Dowitcher						2									
Willet	1				6										
American Oystercatcher			4	3						2					
Northern Harrier	1							1							
Sharp-shinned Hawk										2					
Peregrine Falcon									1						1
Merlin									1						
Osprey	54	31	32	31	15	12	9	8	2	5	4	1	4	2	
Fish Crow	27	16	16	19	18	17	10	9	8	11	10	9	4	3	
Boat-tailed Grackle						1		1	1					1	