

**REPRODUCTIVE SUCCESS OF GREAT BLUE HERONS
(*ARDIA HERODIAS*) NESTING IN SWANSON CREEK, MARYLAND
DURING THE CHALK POINT OIL SPILL**

**Final Report
May 16, 2001**

Introduction

On April 7, 2000, approximately 126,000 gallons of a mixture of #2 and #6 fuel oil were released from a break in a pipeline providing fuel to the Chalk Point Generating Station. The pipeline is owned by the Potomac Electric Power Company (PEPCO) and operated by Support Terminal Services Operating Partnership, LP (ST Services). The spill initially leaked into a *Spartina spp.* dominated brackish wetland located in Swanson Creek, a tidal tributary of the Patuxent River (Figure 1). The marsh covers approximately 45 acres adjacent to the PEPCO Chalk Point facility. Extensive oiling of the wetlands within Swanson Creek took place during the first two days of the spill. On April 8, high winds, rain, and tides resulted in the oil being blown over containment blooms and into the Patuxent River and its tributaries. The spill spread approximately 17 linear miles downstream in the Patuxent River and into several downstream tributaries, including Indian Creek, Trent Hall Creek, Washington Creek, and Cremona Creek, oiling approximately 40 miles of shoreline (Figure 2). In addition, water quality surveys indicated concentrations of petroleum products remained elevated above background levels in the Patuxent River for approximately 2-3 weeks following the spill (unpublished data). Shoreline clean-up activities, particularly in the most heavily impacted areas (e.g., Swanson Creek), continued through the summer and fall.

Primary habitats impacted during the spill were wetlands, sandy beaches and associated open water areas. Several avian species that are dependent on aquatic habitats were nesting in the area at the time of the spill, including osprey (*Pandion haliaetus*), federally threatened bald eagles (*Haliaeetus leucocephalus*), and great blue herons (*Ardea herodias*). The foraging strategy of these species and willingness to enter water and wetlands make them susceptible to oiling. Several oiled osprey and great blue herons were observed by wildlife survey teams during the response effort.

The Natural Resource Trustees for the Chalk Point Oil Spill were concerned about the potential effects of the oil spill on the reproductive success of these avian species. To this end, the objective of the present study was to evaluate the potential effects of the oil spill on the nesting success of great blue herons. Other reports will describe results of monitoring nesting success of bald eagles and osprey.

Study Organism and Susceptibility to Oiling

The great blue heron is the most widely distributed heron species in North America, and is also the largest wading species in Maryland (Robbins and Blom 1996). Great blue herons are

Figure 1. Location of PEPCO's Chalk Point MDI pipeline rupture, and great blue heron nesting colony monitored for hemophysal infestation during April 7, 2003 Chalk Point spill.

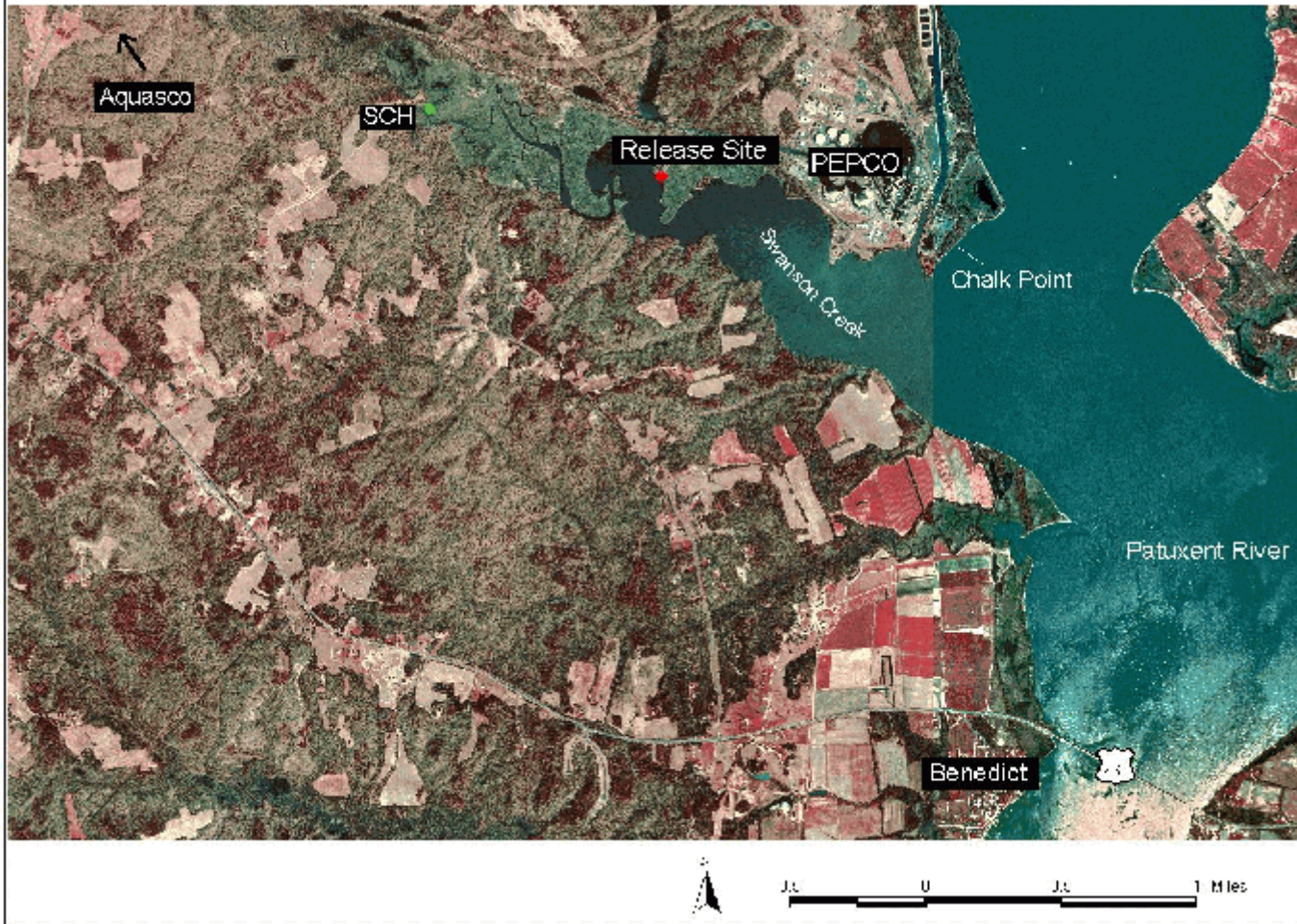


Figure 2. Extent of shoreline oiling resulting from the Chalk Point Oil spill.



identified as a colonial nesting species, a feature commonly associated with members of the heron family Ardeidae (Robbins and Blom 1996). An active great blue heron heronry was located within Swanson Creek, approximately 0.75 miles upstream of the spill release. Great blue herons and similar species spend much of their foraging activity wading in shallow waters often associated with wetlands (Willard 1997, Robbins and Blom 1996, Kushlan and Hafner 2000), making them highly susceptible to oiling.

Adults that become oiled may transfer the oil from their plumage to their eggs during incubation. Refined oil may be highly toxic to avian embryos depending on the species; stage of embryonic development; and type, weathering, and dose of oil. Small quantities of oil on eggs can lead to embryo mortality, or cause deformities, especially during the early incubation phase (Albers 1991, 1995, Hoopes *et al.* 1994). Studies have shown that as little as 1-20 uL of some types of oil can have lethal effects on developing embryos (Parnell *et al.* 1984, Hoffman 1990). Louisiana heron (*Hydranassa tricolor*) eggs treated with 10 uL of weathered crude oil had a reduced hatchability of 17% (Macko and King 1980). In addition, the oil spill may have reduced or contaminated prey species, such as crustaceans, fish, amphibians, snakes, and small mammals (Butler 1992). Several studies have reported reproductive effects on avian species due to dietary exposure to petroleum-derived products (Coon and Dieter 1981, Ainley, *et al.* 1981).

Study Area

Two great blue heron colonies, an exposed heronry and a reference heronry, were selected for monitoring reproductive success. The exposed heronry was located in Swanson Creek (SCH) and the reference heronry was located in Black Swamp Creek (BCH).

Swanson Creek Heronry (SCH)

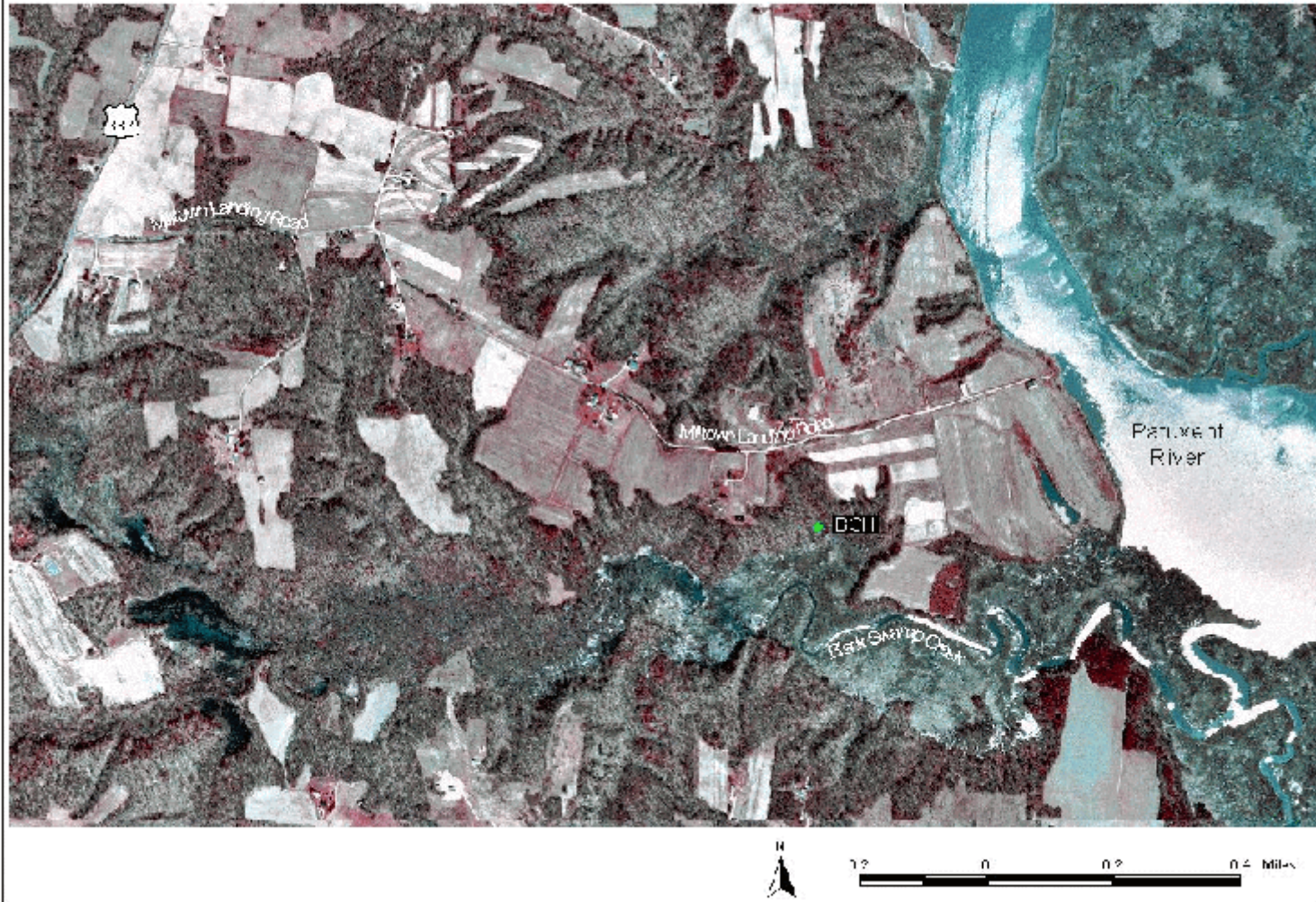
SCH was located (N: 38° 33.093' W: 76° 43.926'; USGS 7.5 min. Quadrangle, Benedict, MD) approximately 0.75 miles upstream of the release site in Swanson Creek and was composed of approximately 34 active nests (Figure 1). The nests that were selected for monitoring were all located in mature sycamore trees (*Platanus occidentalis*) approximately 75-100 feet in height. The site is considered a seasonally flooded forested wetland. Extensive emergent wetlands and shallow open water habitats within Swanson Creek provide excellent foraging habitat for great blue herons nesting within the heronry.

Black Swamp Creek Heronry (BCH)

BCH was selected as the reference heronry for comparative purposes and was located (N: 38° 37.737' W: 76° 41.909'; USGS 7.5 min. Quadrangle, Lower Marlboro, MD) on state game lands identified as Milltown Natural Resources Management Area near Milltown Road in Prince George's County, Maryland, and adjacent to Black Swamp Creek, a tidal tributary of the Patuxent River (Figure 3). BCH was located approximately 5.4 miles north of SCH and was comprised of approximately 70 pairs

of nesting great blue herons, based on a ground census during the study period and a second census in the fall of 2000. The number of breeding pairs at

Figure 3. Location of Black Swamp Creek Heronry (reference site) monitored for reproductive success during the April 7, 2000 Chalk Point spill.



BCH in 1995 was reported as 90 increasing to 122 pairs in 1999 (Dave Brinker, MDNR; personal communication). The nesting area encompasses approximately 3 acres of deciduous forested bottomland/upland. All great blue heron nests were located in sycamore trees (*Platanus occidentalis*), approximately the same height as trees located at SCH. The heronry is located adjacent to an extensive emergent wetland and is associated with shallow open water habitats similar to those found in Swanson Creek and provides ideal foraging habitat.

Methods

The methodology for this assessment was developed cooperatively by the Wildlife Injury Workgroup for the Chalk Point Oil Spill Natural Resource Damage Assessment consisting of personnel from PEPCO, U.S. Fish and Wildlife Service (USFWS), the Maryland Department of Natural Resources, and the U.S. Geological Survey's Patuxent Wildlife Research Center and is described in the *Wildlife Injury Assessment Workplan for the Chalk Point Oil Spill* (October 2000). The National Oceanic and Atmospheric Administration and the Maryland Department of the Environment also provided input to the assessment plan. In general, the approach was to monitor nests on a regular basis until fledging occurred. Nest inspections consisted of counting and recording live young and eggs by climbing trees and observing the nests from nearby branches.

Each great blue heron nest was selected for monitoring based on two criteria established by the monitoring team, two professional tree climbers experienced with conducting avian nest surveys, during a pre-monitoring survey. The two criteria used for nest selection were: 1) safety, and 2) accessibility to nests. Each selected nest was identified by a unique identification number and charted on a pictogram for future reference (Werschkul *et al.* 1977, Pratt and Winkler 1985). The nests were initially visited April 19-20 to determine ease of monitoring, and then visited five times in a period ranging from May 12 to June 14, 2000. During each visit to the heronry, the number of eggs and/or young per nest were noted and recorded. In addition to the reproductive parameters that were recorded during each site visit, nests, adults and nestlings were also inspected for oiling.

Ideally, in a reproductive study, the investigator(s) would monitor a nest from the day the first egg was laid, follow the fate of each successive egg until hatching and then follow each nestling until fledging, approximately 54-60 days post hatch (Robbins and Blom 1996, Kushlan and Hafner 2000). In this study, nesting activity had already been initiated at each heronry, with eggs already laid in a number of nests at both sites. Therefore, in this study only the young could be reliably monitored. The number of eggs laid initially could not be positively determined, a result of the time delay between the day of egg laying and the initiation of monitoring.

Data Analysis

The total number of live young per nest (the sum of live young in each nest plus live young on branches nearby) was used for analyses of nest success and productivity. Nest success, defined in this study as at least one nestling successfully fledging per nest, was analyzed using the Mayfield method (Mayfield

1961, 1975, Bart and Robson 1982), the results of which were used to compare SCH to BCH, the reference site. This analysis estimates a daily survival rate for nests at each colony and controls the bias which may exist due to nests which failed before the collection of data began. Overall survival rate of young great blue herons from hatching to fledging was calculated by raising the calculated daily survival rate to the 54th power, the approximate number of days required for great blue heron nestlings to fledge. The Program Mayfield, written by J.E. Hines (available at: <http://www.mbr-pwrc.usgs.gov:80/software.html>), was used to calculate the daily nest survival rates as described by Bart and Robson (1982). Program Contrast was used to compare the daily nest survival rates between the two colonies (Hines and Sauer 1989).

Productivity of each nest or the number of young per successful nest (nests with at least one chick) was analyzed using Fisher's exact test to compare the productivity of SCH to BCH (Lehmann 1975). Each visit was analyzed separately in this analysis because of the unknown fate of chicks once they were no longer associated with a nest.

The average pre-fledging brood size (i.e., brood size based on 20-40 day old nestlings) as well as the average number of young observed (per nest) at the age when they are capable of sustained flight, a surrogate measure for the average number of young fledged, were also calculated as measures of reproductive success. These statistics can be used to compare the productivity of the heronries to each other as well as to values reported in the literature (Parsons and McColpin 1995, Kelly *et al.* 1993). Pre-fledging brood size was calculated as the overall average brood size of successful nests at each site from the beginning of monitoring on May 12 through May 26, 2000. Nestling data for June 7 were used to estimate the average number of young observed (per nest) at the age when they are capable of sustained flight. This date was chosen as the best estimate of fledging age based on the reproductive biology of great blue herons and literature for Maryland. Robbins and Blom (1996) stated that the earliest hatch date records for Maryland is April 13. Based on this assumption, young in nests monitored on June 7 would be approximately 53 days old, very close to the age at which birds would begin to leave the nest.

Results

The colonies were visited on May 12, 2000 (Swanson Creek only), May 15, 2000 (Black Swamp Creek only), May 19, 2000, May 26, 2000, June 7, 2000, and June 14, 2000. During the monitoring period, a number of dead nestlings were observed in nests and on the ground. Table 1 provides a summary of the dead nestlings found at each heronry.

Nest Success

The daily survival rates, 0.9934 and 0.9947 for the estimates of nest success at SCH and BCH, respectively, were not statistically different ($c_1^2 = 0.0475$, $P = 0.8275$). Overall survival rates (daily survival rate raised to the 54th power, based on fledging age of 54 days) for nestlings from hatching to fledging were 70% and 75% for SCH and BCH, respectively.

Table 1. Summary of dead nestlings observed at each heronry during the great blue heron reproductive monitoring period of May 12 through June 14, 2000.

Heronry	SCH		BCH	
	Nest	Ground	Nest	Ground
12 May 2000	1	1		
19 May 2000			2	
7 June 2000	3		4	
14 June 2000	1	2	2*	
Sub-Total	5	3	6	
Total	8		6	

* Nestlings observed were from the same group of 4 observed dead the previous week.

Table 2. Summary statistics (mean, number of nests (N), and standard deviation (SD)) and p-values from Fisher's exact test comparing the number of chicks per nest (nest productivity) of successful nests (nests with at least one chick) at Swanson and Black Swamp Creeks.

Date of visit	Black Swamp Creek (BCH)			Swanson Creek (SCH)			P-value
	Mean	N	SD	Mean	N	SD	
12-15 May 2000	2.47	17	0.87	2.08	12	0.51	0.378
19 May 2000	2.18	17	0.95	1.92	12	0.51	0.544
26 May 2000	2.07	15	0.88	1.83	12	0.58	0.556
07 June 2000* 1.50	12	0.67	1.88	8	0.64		0.370
14 June 2000	1.00	5	0	1.25	4	0.50	0.444

* Estimated fledging date

Nest Productivity

The results of the analysis of nest productivity found no significant differences ($P > 0.05$) between the two colonies during any of the visits to the nests (Table 2). Prefledging brood size based on 20-40 day old nestlings was calculated as 1.94 and 2.24 at SCH and BCH, respectively. The average number of young observed (per nest) at the age when they are capable of sustained flight were 1.88 at SCH and 1.50 at BCH (Table 2).

Discussion

Nest Success

Although extensive oiling of foraging habitats utilized by great blue herons occurred during the Chalk Point oil spill, the reproductive data showed that there was no statistical difference in daily survival rates of nestlings to fledging between SCH and BCH. In addition, overall survival rates of SCH nestlings (70%) were similar or higher than those reported in the literature. For example, Butler (1992) reported an average survival of 63% for studies of populations ranging from Florida to Alberta.

Nest Productivity

There were no statistical differences between the number of nestlings produced per nest at each sampling day. However, the average number of young fledged (i.e., mean number of chicks on June 7) in SCH and BCH, 1.88 and 1.50, respectively, were both lower than the 2.3 fledged per nest average (S.D. = 0.30, $n = 16$ studies) reported by Butler (1992). In an extensive reproductive study involving 19 great blue heron colonies in Ohio and Pennsylvania, values for the number of nestlings fledged per nest ranged from 1.23 - 2.60 (Carlson and McClean 1996). Parsons and McColpin (1995) reported a value of 1.6 for great blue herons nesting in Delaware Bay; however, they suggest this value may be low because of difficulties in determining nestling ages. Although the number of fledged young per nest at BCH and SCH are lower than many literature values reported for the east coast, the numbers compare favorably with values (1.5 - 1.7) needed to maintain a stable population at approximately 38° north latitude, the same latitude as the Chalk Point spill area (Henny 1972). However, Henny's (1972) fledging values are calculated for west coast populations (California) and should be interpreted with caution, as they may not be applicable to Mid-Atlantic great blue heron populations. Values similar to Henny's have not been calculated for the Chesapeake Bay region (Kathy Parsons, Manomet Observatory for Conservation Sciences, and Brian Watts, College of William and Mary, personal communication).

The mean number of 20 to 40 day old pre-fledged young produced at both SCH and the reference heronry, 1.94 and 2.24 respectively, were lower than the 2.4 value observed by Parsons and McColpin (1995) at a great blue heron colony located in Delaware Bay. However, pre-fledging brood size for SCH was comparable to the 1.93 average reported by Kelly *et al.* (1993) in a study conducted in the San Francisco Bay area.

The reason that productivity values (i.e., number of pre-fledged and fledged young) for the BCH and

SCH populations in 2000 are on the low end of the range reported in the literature may be due to climatic factors. The spring of 2000 was one of the wettest in past years, particularly April in which the amount of precipitation was the highest recorded in 30 years (National Weather Service, <http://www.nws.noaa.gov>). April is a particularly vulnerable period for great blue heron in the region as it is the period in which a majority of great blue heron eggs begin to hatch (Robbins and Blom 1996), making the nestlings vulnerable to the elements. Young nestlings are unable to thermoregulate efficiently until they are probably at least 18 days old or more (Butler 1992).

Nestling Mortality

The dead nestlings found during the monitoring period, eight at SCH and six at BCH, likely died of natural causes. Siblicidal aggression is a common occurrence in great blue herons (Mock 1986). Great blue heron hatching events are asynchronous, with 4-8 days between hatching of the first and last egg; therefore, the first nestling born is often the largest in the nest and often outcompetes its sibling rivals for food resources, resulting in younger nestlings dying of starvation (Butler 1992). At the time of discovery, the dead nestlings were in various stages decay and/or partially scavenged, making determination of cause of death impossible.

Uncertainty

One of the drawbacks of the present study is that regular monitoring of the nests did not occur until mid-May, more than a month after the oil spill occurred. An initial survey was conducted on the Swanson Creek heronry on April 19 and April 20, 2000. A total of 34 nests were counted. Of the 34 nests, 17 were accessible to climbers. Thirteen out of 17 nests contained chicks and/or eggs for a total of 18 chicks and 15 eggs. Three adult birds were observed to be oiled and all eggs appeared to be un-oiled. However, since nest locations and contents were not accurately recorded, these data could not be incorporated into the nesting success study. On May 12, 2000, nesting success monitoring was initiated. Of the 17 nests initially surveyed, 10 contained a total of 20 living chicks and 7 were empty. No eggs were found. The decline in the number of young from April to May (33 to 20 chicks and eggs) is substantial, but may be natural. For example, in a number of great blue heron reproductive studies, nestling mortality was found to be the greatest within the first four weeks of life (Pratt 1970). Reproductive studies conducted by Quinney (1982) found that 73% of great blue heron nestlings died within the first 10 days of life, and that mortality rates decreased after 4-5 weeks of age. Pratt and Winkler (1985) reported that the second through fourth week of life were the most hazardous for great blue heron nestlings, with a 76% nestling mortality rate reported for this period.

Another area of uncertainty is the appropriateness of BCH as a reference site. Before the 2000 breeding season, the number of breeding pairs had increased annually at BCH; however, a ground census conducted during the study period and again in the fall of 2000, indicated a decrease in the number of breeding pairs from 1999 to 2000, from 122 to approximately 70. During the nesting season, the mean distance flown from the colony to principal feeding sites is reported to be 1.4 to 4.0 miles (Butler 1992), ranging as high as 9.4 miles (Gibbs 1991), which could put the Swanson Creek spill zone within the foraging area of the great blue herons nesting at BCH. Together, these

observations raise the issue of whether this population may have been affected by the spill.

As a follow-up to this study, the Trustees will be conducting a nesting pair survey at both colonies in the Spring 2001.

Summary

Overall survival rates of SCH nestlings were not statistically different from survival rates at BCH. In addition, both populations exhibited survival rates that were similar to or higher than values reported in the literature. Productivity of both SCH and BCH appear to be on the low end of the range of literature values from other areas along the east coast; however, the cause cannot be linked to the oil spill. Although several great blue herons within Swanson Creek were oiled, none of the eggs in nests that were monitored were observed to be oiled. Productivity of both great blue heron populations may have been affected by the weather, with April 2000 having the highest precipitation recorded for the month in 30 years. There is some uncertainty associated with these results due to the delay in initiating monitoring and appropriateness of BCH as a reference site. A nesting pair survey will be conducted at both colonies in the Spring 2001.

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