FOREAGING ECOLOGY OF BLACK-CROWNED NIGHT HERONS *Nycticorax nycticorax* IN THE NEW YORK CITY AREA

A Final Report of the Tibor T. Polgar Fellowship Program

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ABSTRACT

Over 1,700 pairs of colonial wading birds (e.g., herons, egrets, and ibis) breed and forage in the industrialized ecosystem of metropolitan New York City. Wading bird colonies are located on seven islands that lie between western Staten Island and Long Island Sound. The Black-crowned Night Heron (BCNH), a mainly nocturnal forager, is the numerically dominant breeding wader in these colonies, and has been undergoing population declines both locally and region-wide since the mid-1990s. My objective was to determine how Black-crowned Night Herons use marine, freshwater, and terrestrial environments in this highly urbanized setting. From March to September 2004, I conducted weekly surveys on Staten Island, NY to describe: (1) BCNH night-time abundance and foraging success in four habitat types (shoreline, salt marsh, fresh water, terrestrial); and (2) BCNH foraging flight patterns from an active breeding colony. In 2004, I observed a mean of 54 Black-crowned Night Herons per week foraging at 35 sites on Staten Island. I found that: (1) a tradeoff existed between foraging success and habitat type (i.e., freshwater foragers experienced low capture success but captured larger prey, while salt marsh foragers had higher capture success on smaller prey); (2) individuals used different foraging techniques in different habitats; (3) activity level remained constant over the entire night cycle; and (4) the most abundant prey items available at foraging sites also made up the largest proportion of food provisioned to nestlings. By describing habitat use and foraging success for BCNH, and developing techniques to establish a direct link between individuals and their shifting use of foraging habitats, comprehensive conservation and management plans for local wader populations can be developed.

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INTRODUCTION

New York City is a highly manipulated urban environment, and also the location of numerous wading bird (i.e., heron, egret, and ibis) colonies (Bull 1974, Blanchard et al. 2001). These colonies are located on islands throughout New York Harbor and surrounding waterways, from the Arthur Kill in western Staten Island to Jamaica Bay in Queens and Pelham Bay in the Bronx. The most abundant nesting species in these colonies are Great egret *Ardea alba*, Snowy egret *Egretta thula*, Glossy ibis *Plegadis falcinellus*, Little blue heron *Egretta caerulea*, and Black-crowned Night Heron *Nycticorax nycticorax*. Over the past thirty years, wading bird population dynamics, reproductive biology, diurnal foraging ecology, and environmental contaminant loads in eggs and nestlings have been documented (Brzorad et al. 2004, Kerlinger 2004, Maccarone and Brzorad 1998, Maccarone and Parsons 1994, Parsons 1994, Matz and Parsons 2004). Nocturnal studies of those species that are active at night, however, have not previously been conducted in this region.

Black-crowned Night Herons (BCNH) are ubiquitous as breeders and foragers in urban areas. They have been shown to: (1) forage diurnally during the breeding season (Endo and Sawara 2000, Fasola 1984); (2) function as largely crepuscular foragers; and (3) forage throughout the night and more often at low tides (Fasola 1984, Watmough 1978). However, many of these studies have been conducted in non-urban habitats (e.g., agricultural fields, preserves, etc.).

In New York City (NYC), BCNH is the most abundant colonially nesting wading bird. In May 2004, surveys of nine NYC breeding colonies located 841 active BCNH nests (Kerlinger 2004), comprising approximately 50% of the total wading bird breeding population in NYC. One of the largest colonies, Hoffman Island, is located east of Staten Island (Figure 1), and is the last active colony in an area that once supported four colonies, and the majority of wading birds nesting in the NY/NJ region.

Historical records confirm the presence of active BCNH colonies on Staten Island at Greenridge, New Dorp, Old Place, Richmond, and Huguenot from the 1850s through the 1940s (Davis 1897, Flamm 1986). During this period, colonies were subject to pressure from hunting, egg poaching, and habitat destruction. From 1950 through 1970, however, there were no active BCNH colonies located on Staten Island or its offshore islands (Seibenheller 1981).

In the 1970s, BCNHs were reconfirmed as breeders in the waterways surrounding Staten Island: first on Shooters Island, an uninhabited island in the Kill Van Kull, in 1974 (Buckley and Buckley 1980), and subsequently in the Arthur Kill on Prall's Island and Isle of Meadows in 1978 and 1981 (Blanchard et al. 2001), respectively. In the mid 1990s, breeding began to expand at Hoffman Island while declining at the three Arthur Kill/Kill Van Kull colonies. These declines occurred after a series of oil spills in tidal marshes off western Staten Island in 1990 (Burger 1994). Following these spills, wader species specializing in tidal habitats (i.e., Snowy egret, Glossy ibis) experienced reduced reproductive success, while opportunistic species (i.e., BCNHs) showed little negative response (Parsons 1994). Breeding activity for all wader species in the Arthur Kill/Kill Van Kull colonies, however, ceased by 2001.

BCNHs had a stable breeding population size in the NYC area in comparison to other locally nesting wader species (e.g., Cattle egret, Glossy ibis) from 1974 to 1990. Since 1995, however, this species has been declining as a nester in NYC (Kerlinger 2004). Additionally, regional declines for this and many other wading birds have also been identified in the northeastern US (Parsons et al. 2001). Potential factors involved in these declines include exposure to environmental contaminants (Matz and Parsons 2004, Parsons et al. 2000, Rattner et al. 2000), persistent toxic events, mammalian and avian predation, and nesting habitat degradation. For these reasons, investigation of nocturnal activity for urban BCNHs is critical to the design and implementation of both local and regional conservation policies.

The purpose of this study was to examine the following four questions relating to BCNH nocturnal foraging ecology:

1. *When leaving an active breeding colony in the evening, where do BCNHs direct their foraging flights?*

Rationale: Flight line observations provide important information on foraging locations, shifts in foraging trends over the season, and interspecific differences in foraging habitat use (Erwin et al. 1991, Wong et al. 1999).

2. *What time of night are BCNHs most active during the breeding season?*

Rationale: Breeding BCNH adults have increased energetic demands when provisioning food to nestlings, and are therefore flexible in their foraging habits. Urban foraging habitats offer both artificial habitat enhancement (e.g., ambient light at foraging sites, increased nutrient loads, abandoned islands available for breeding/roosting sites, etc.) and potential disadvantages (e.g., exposure to toxins, increased mammalian predation, etc.) and, therefore, merit investigation.

3. *What is the prey capture/strike success of BCNHs in different habitat types/locations?*

Rationale: Several studies have quantified strike or capture success for diurnally foraging species in the Staten Island area, and have shown differences in wader foraging success in marine and freshwater habitats (Maccarone and Brzorad 1998, Maccarone and Brzorad 2000, Maccarone and Parsons 1994). Observations of nocturnally active species (e.g., BCNHs) also need to be conducted.

4. *What prey items are most abundant at foraging sites frequented by BCNHs?*

Rationale: BCNHs are opportunistic foragers with highly variable diets (Davis 1993). Comparison of the seasonal abundance of available prey species in different habitat types to actual prey choice and provisioning by individuals is important in understanding patterns of prey selection.

METHODS

I collected data from unmarked birds from 21 March to 16 September 2004 at 59 sites throughout Staten Island (Table 1, Figure 1). During each survey, observations were made by the author and one assistant using a light intensifying night scope (ITT 190 Night Quest w/ 100-300mm lens), 8x32 binoculars, and 30x spotting scope. We recorded observations using a database program (abcDB, PocketSOFT.ca) on an HP Ipaq Pocket PC. Research protocol was as follows:

Foraging flight ('flight line') observations: From South Beach (Staten Island), I recorded foraging flights to and from Hoffman Island once per week. Surveys were conducted two hours before and one hour after sunset, at both high and low tides, and were randomized among tides over the season. I recorded weather conditions, number of birds (singular or groups), age, and flight direction (degrees). Since the purpose of this study was to describe nocturnal foraging behavior, only evening flights were conducted. From the observation point at South Beach, flights could only be reliably viewed towards and returning from areas in Monmouth County, NJ, Staten Island, and portions of Brooklyn. Birds flying to the east and south (e.g., towards Jamaica Bay and Sandy Hook, respectively) were obscured by the island, and only observable by boat.

Site surveys: At each of the 59 survey sites, I recorded species present, number of individuals in area, their age, and their behavior. Each site was surveyed weekly between the hours of 8pm and 5am EST, and surveys were randomized according to tidal cycle, time interval (8pm-11pm, 11pm-2am, 2am-5am), and patch size (e.g., small (1-3 hectares), medium (3-20 ha), and large (>20 ha)). For analysis, each site was grouped into one of four broad habitat types: (1) salt marsh (i.e., the surface of *Spartina* marshes with adjacent creeks and ditches), (2) shoreline (i.e., natural or man-made beaches, jetties, piers, etc), (3) fresh water (i.e., natural or man-made ponds, lakes, streams, and reservoirs), and (4) terrestrial (i.e., grassland, meadow, and sporting fields).

Individual foraging observations: While at a site, I located actively foraging BCNHs and, whenever possible, observed focal animals for 20-minute bouts following protocols described in Martin and Bateson (1993). For each individual, I collected data on behavior (number of strikes, number of captures, prey species and size (when possible), movement, etc.), age, tide, and inter/intraspecific interactions.

Prey species monitoring: From May to August 2004, I measured prey species presence/absence biweekly at foraging sites in fresh water (i.e., Clove Lakes, Willowbrook Pond), salt marsh (i.e., Great Kills, Arlington Marsh, Main Creek), and shoreline (i.e., Arthur Kill at Androvette Ave., Great Kills harbor) habitats. Between the hours of 9pm and 6am EST, I set two stationary killifish traps, and conducted three 5-minute seine net hauls at known locations at each site. Only areas realistically reached by foraging BCNHs were sampled (e.g., areas no deeper than 60cm). For each sample, I identified prey species to the lowest taxonomic level, recorded length and weight, and

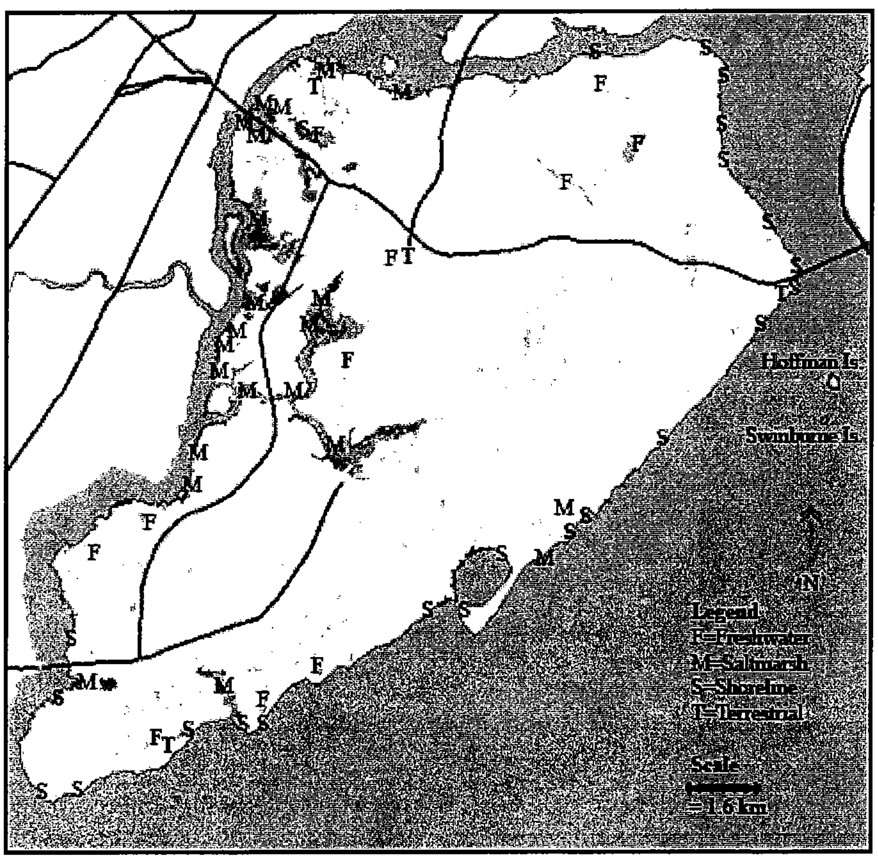
Table 1: Survey sites on Staten Island, 2004.

LOCATION	HABITAT
Johnson Ave @ Arthur Kill Rd	Freshwater
Ellis Rd/Clay Pit Culvert @ Arthur Kill Rd	Freshwater
Allison Pond Park/Goodhue Pond/Snug Harbor	Freshwater
Clove Lakes Park	Freshwater
Fresh Kills retention ponds	Freshwater
Mt Loretto ponds	Freshwater
Silver Lake Park reservoir	Freshwater
Willowbrook Park pond	Freshwater
Wolfes Pond Park—retention ponds and culverts	Freshwater
Wolfes Pond Park—pond	Freshwater
Goethals Bridge Pond—overlook	Freshwater
Blazing Star Marsh @ Arthur Kill Rd	Salt marsh
Sharrotts Ln @ Arthur Kill Rd	Salt marsh
Richmond Valley Rd @ Arthur Kill Rd	Salt marsh
Arlington marsh and shoreline	Salt marsh
Bridge Creek @ Western Av	Salt marsh
Great Kills Park beach side	Salt marsh
Gulfport Marsh @ River Rd	Salt marsh
Kill Van Kull Shore @ Van Name St	Salt marsh
Lemon Creek @ Hylan Av overpass	Salt marsh
Main Creek @ Travis Av Bridge	Salt marsh
Main Creek @ Signs Av	Salt marsh
Neck Ck Marsh-Meredith Av W of Rte 440	Salt marsh
Neck Ck Marsh-Meredith Av E of Rte 440	Salt marsh
Neck Ck Marsh at end of Victory Blvd	Salt marsh
Old Place Creek @ Gulf @ Western Avs)	Salt marsh
Old Place Creek (Gulf Av @ Keyspan Building)	Salt marsh
Old Place Creek (Gulf Av @ culvert)	Salt marsh
Saw Mill Marsh/Creek	Salt marsh
Fresh Kills Landfill	All 4 types
Androvette Av @ Arthur Kill Rd	Shoreline
Alice Austen Park shoreline	Shoreline
End of Brighton St & Billop Av	Shoreline
Conference House, shoreline	Shoreline
Crescent Park, Armstrong Av	Shoreline
Front Street @ Hannah St shoreline	Shoreline
Front Street @ Navy Yard parking lot shoreline	Shoreline
Fort Wadsworth-jetty and beach (S of Verrazano Br)	Shoreline
Fort Wadsworth-boat launch (N of Verrazano Br)	Shoreline
Goethals Bridge Pond, from trailer park	Shoreline
Great Kills Park harbor side including footbridge	Shoreline
Kill Van Kull Shore @ Snug Harbor	Shoreline
Lemon Creek Park & Marina	Shoreline

Table 1 continued: Survey sites on Staten Island, 2004.

LOCATION	HABITAT
Beach from Lemon Creek Park to Wolfe's Pond	Shoreline
Millers Field jetty and shoreline	Shoreline
Oakwood Beach shoreline	Shoreline
Oakwood Beach to Fox Beach/Great Kills Lane	Shoreline
South Beach	Shoreline
St George Ferry shore W to Jersey Av	Shoreline
St George Ferry shore E to Hannah St	Shoreline
Sharrotts Lane Pier at Hylan Blvd	Shoreline
Arthur Kill Road @ end of Ellis St (Tottenville Inn)	Shoreline
Mariners Marsh Preserve—ballfield	Terrestrial
Fort Wadsworth—ballfield	Terrestrial
Mount Loretto—grasslands	Terrestrial
Willowbrook Park—ballfield	Terrestrial

Figure 1. Location of survey sites on Staten Island, 2004. Map image modified from OASIS-NYC.



released individuals whenever possible. A portion of prey samples was stored in a -80°C freezer for future contaminant analysis.

Nestling diet monitoring: BCNH young readily regurgitate when approached on the nest or handled. During colony surveys on 7 June (N=8 samples) and 10 August 2004 (N=2 samples), I collected regurgitant from randomly selected 25-40 day-old nestlings at Hoffman Island in order to determine diet as provisioned by adult birds. In a lab, I sorted and weighed each bolus, identified prey items to lowest taxonomic order, and stored samples in a -80°C freezer for future contaminant analysis.

RESULTS

Flight line observations (N=21) of Hoffman Island were conducted between 14 March and 24 August 2004, with roughly equal samples taken at high (N=10) and low tides (N=11). A total of 1094 BCNHs was observed throughout the season. More individuals were noted leaving the colony (N=940) than entering it (N=240) during the evening survey period. The first breeding activity was noted on 10 April, later than the expected mid-March arrival date for NYC area colonies (Davis 1993). Cold weather and storms may have delayed the onset of breeding in 2004 (e.g., 16 March to 5 April 2004, www.nws.noaa.gov). Peak activity occurred in late June/early July (Figure 2), and by 24 August no adults were observed entering or leaving the colony. The majority of flights out of the colony occured in either southwest and northwest directions, whereas most individuals entered the colony heading southeast or east (Figure 3). There were no significant differences in flight direction of individuals entering or leaving the colony by tide (Watson's F test, F=0.31, p=0.58).

BCNH adults entering and leaving the colony were subject to intense harassment by immature and adult Greater black-backed gulls from 25 April to 9 June 2004 (N=64 individuals). Gulls pursued night herons either to the mainland or back to the colony, and seemed to be trying to force individuals into Lower NY Harbor. On 5 and 15 May, of five BCNHs forced into the harbor by gulls, three were subsequently swarmed by a group of 15+ gulls, killed, and consumed (Bernick 2004). This is potentially an important source of mortality for breeding wading birds, and warrants further study

Figure 2. Total flight activity from Hoffman Island over breeding season. Numbers represent total number of individuals entering/leaving the colony.

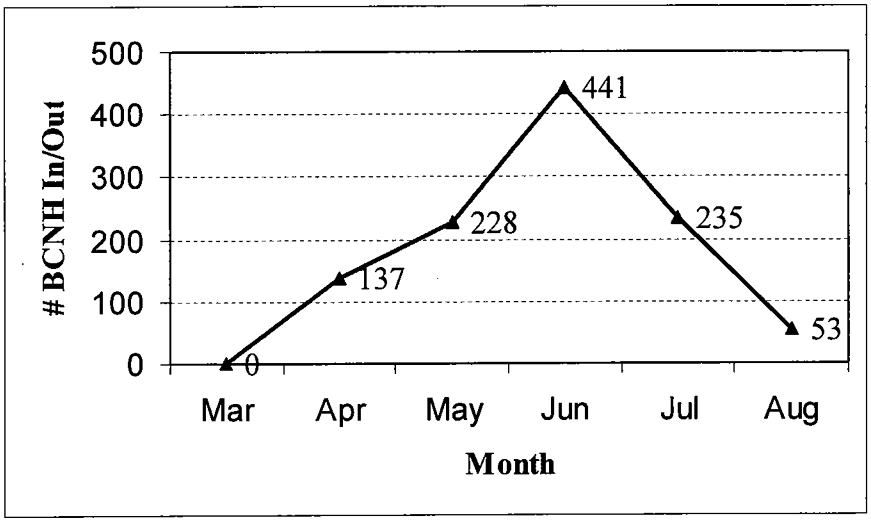
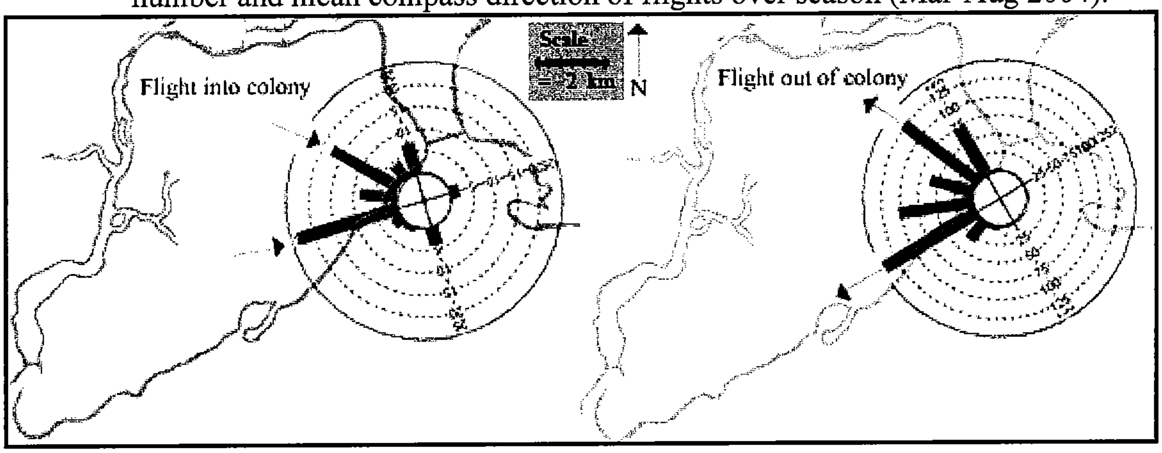


Figure 3. Summary of flights to/from breeding colony at Hoffman Island. Bars represent number and mean compass direction of flights over season (Mar-Aug 2004).



From 21 March to 16 September 2004, I surveyed a total of 59 potential BCNH foraging sites (i.e., 12 fresh water, 19 salt marsh, 23 shoreline, and 5 terrestrial) once a week (N= 98 nights). During these surveys, a total of 1403 BCNHs were observed throughout the period of the study (mean number/week = 54 individuals, density per site = 1-18 individuals). Individuals were observed at least once from March to September at 35 sites (i.e., 59% of total sites surveyed). There was a significant difference in the mean number of BCNHs per survey by habitat type ($F=96.029$, $p<0.001$; Figure 4), with more individuals per survey found at terrestrial foraging sites than all other sites, and more

shoreline foragers per survey than either saltmarsh or freshwater foragers ($p<0.001$). Additionally, there was no significant difference in the mean number of BCNHs per site by time of night ($F=0.085$, $p=0.918$; Figure 5).

From 24 March to 16 September 2004, focal animal foraging observations were conducted on 229 individuals (49 freshwater, 79 salt marsh, 76 shoreline, and 25 terrestrial) at 35 survey sites. Focal observations were not possible each time a BCNH was located, as often individuals were either too far from a reasonable observation point or flushed before an observation could be started or completed. Observations less than twenty minutes in length were excluded from the analysis. There was a significant difference in strike rate ($F=21.640$, $p<0.001$; Figure 6) and capture success ($F=11.918$, $p<0.001$; Figure 7) by habitat type. Terrestrial foragers had both the highest mean strike rate and capture success. Shoreline foragers, while not differing from saltmarsh foragers in strike rate, had a significantly higher capture success (via Bonferroni multiple comparisons test). Freshwater foragers had the lowest strike rate and capture success of all habitat types. Terrestrial foragers were excluded from the analysis of prey capture size, as it was difficult to accurately assess the length of earthworm prey. When pulled from the substrate, these prey items had a tendency to either stretch or break.

Of the three remaining habitat types, freshwater foragers captured significantly larger prey items (mainly fish species) than either shoreline or freshwater foragers ($F=4.451$, $p=0.014$; Figure 8).

Prey sampling was conducted from 5 May to 29 August 2004 ($N=8$ samples). A total of 6189 individuals of 24 species was captured (Figure 9). Of these potential prey species, the majority were fish species ($N=19$, 6 freshwater & 13 marine), with two species of marine shrimp and three species of marine crab. No discernable differences were noted in the number or size of prey among sites over the season. The most prevalent species at shoreline and saltmarsh sites were mummichog *Fundulus heteroclitus*, grass shrimp *Palaemonetes pugio*, striped killifish *Fundulus majalis*, Atlantic silverside *Menidia menidia*, sand shrimp *Crangon septemspinosa,* and juvenile white mullet *Mugil curema*.

Figure 4. BCNH presence at survey sites by habitat type. Numbers over bars represent number of individuals observed (top) and mean number of individuals present per site per sampling period (bottom).

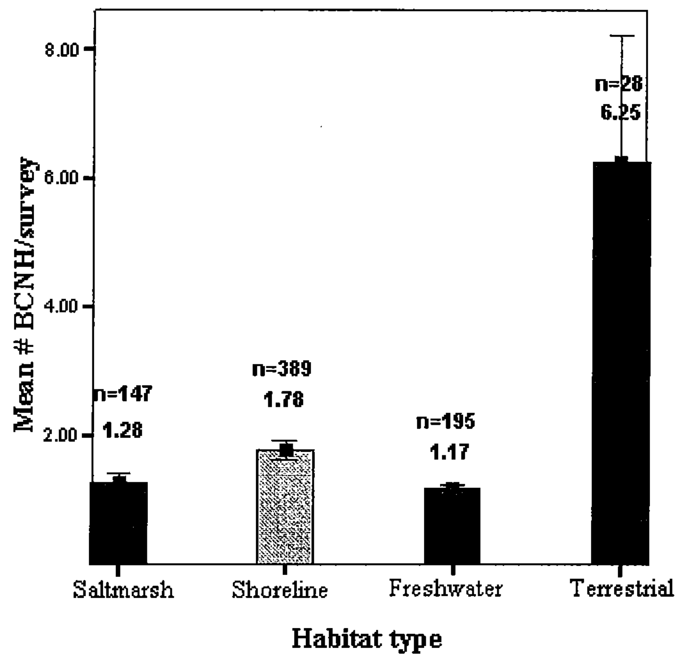


Figure 5. Black-crowned Night Heron (BCNH) activity by time interval. Number over bars represents number of individuals observed in each interval over the season.

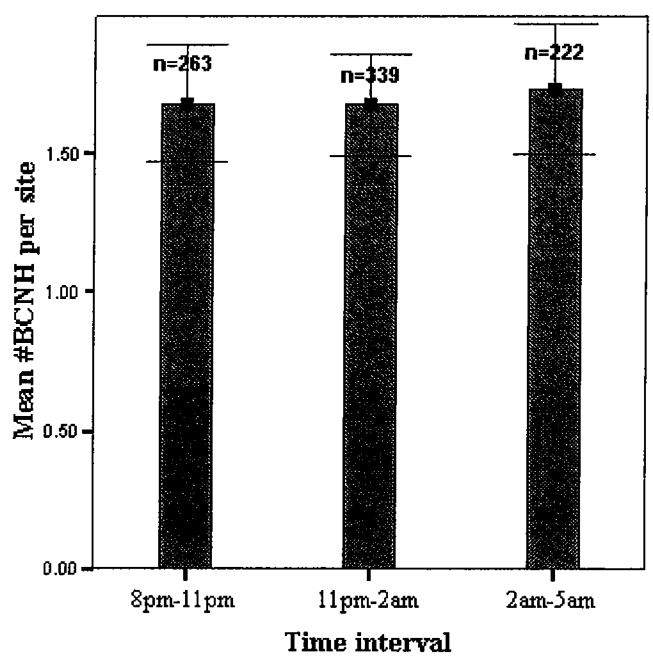


Figure 6. Mean BCNH strike rate by habitat type. Numbers over bars represent number of individuals observed (top) and mean strike rate (bottom).

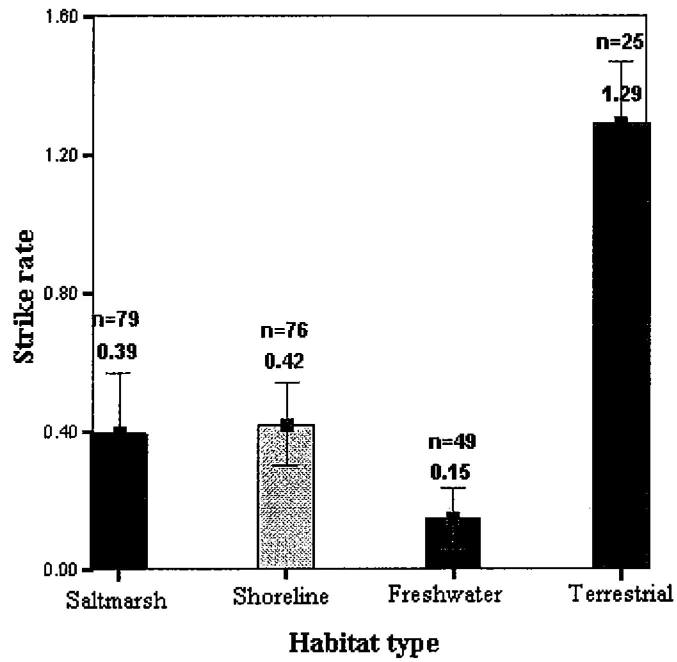
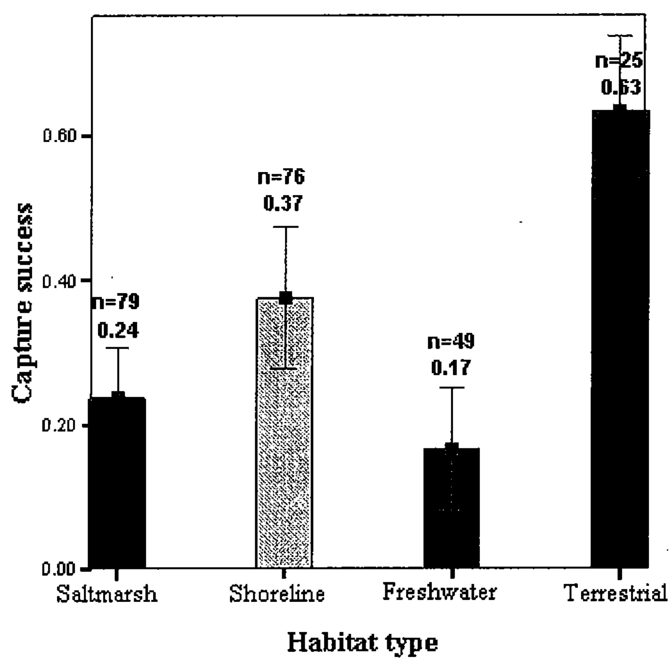


Figure 7. Mean BCNH capture success by habitat type. Numbers over bars represent number of individuals observed (top) and mean capture success (bottom).



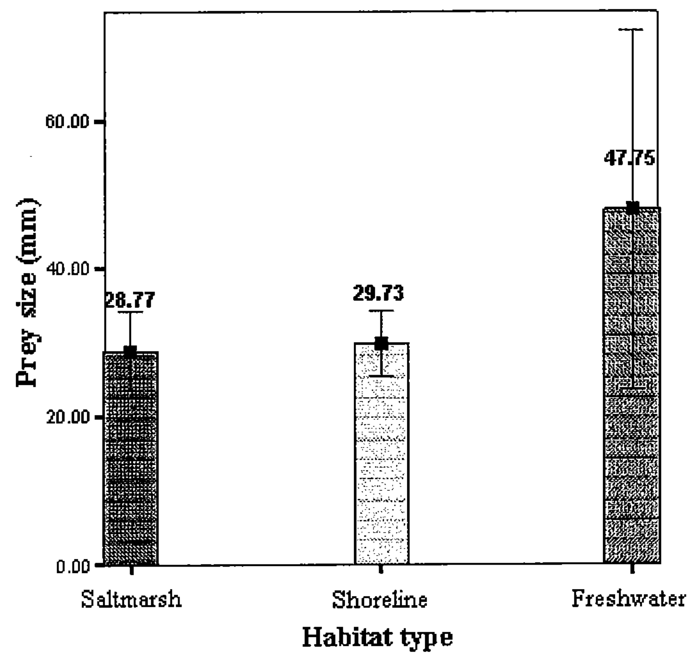
At freshwater sites, the prevalent species were bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), and largemouth bass (*Micropterus salmoides*). Although relatively small samples were captured at freshwater sites, this does not indicate that the sites were unproductive. Many fish were able to evade both the seine net and traps due to the irregular and debris-strewn pond bottoms. While terrestrial sites were not included in prey sampling, terrestrial foragers observed during focal observations consumed only earthworms (phylum Annelida).

Analysis of regurgitant collected from ten BCNH nestlings at Hoffman Island (on 7 June and 10 August 2004) supported these results, as fish species comprised the majority of the average bolus (i.e., 55% by weight). Main fish species identified in regurgitant included mummichog, Atlantic silverside, winter flounder, and unidentified sunfish. Other items present in average boluses included unidentified marine shrimp (12%), unidentified crabs (9%), unidentified rodents (8%) and unidentified arthropods (1%).

DISCUSSION

The purpose of this project was to collect information and test hypotheses on spatio-temporal shifts in BCNH abundance, individual foraging behavior, prey species abundance, and movement patterns from a breeding colony to foraging areas. This study indicated that: (1) a tradeoff exists between habitat type and foraging success/prey size (i.e., freshwater foragers striking infrequently and capturing larger prey vs. terrestrial and shoreline foragers striking frequently at smaller prey), (2) individuals use different foraging techniques in different habitats, (3) activity level remains constant over the entire night cycle, and (4) the most abundant prey items available at foraging sites also comprise the largest proportion of food provisioned to nestlings. While freshwater foragers had the lowest strike rate and capture success of all of the observed individuals, they captured larger prey. They also were more likely to use a sit-and-wait strategy, followed by plunge diving after prey items. Conversely, terrestrial foragers had high strike rates and high capture success, and concentrated on a single, plentiful food source (i.e., annelids). In fact, all of the terrestrial foragers were found at one site: a baseball field approximately 1.5 km from the Hoffman

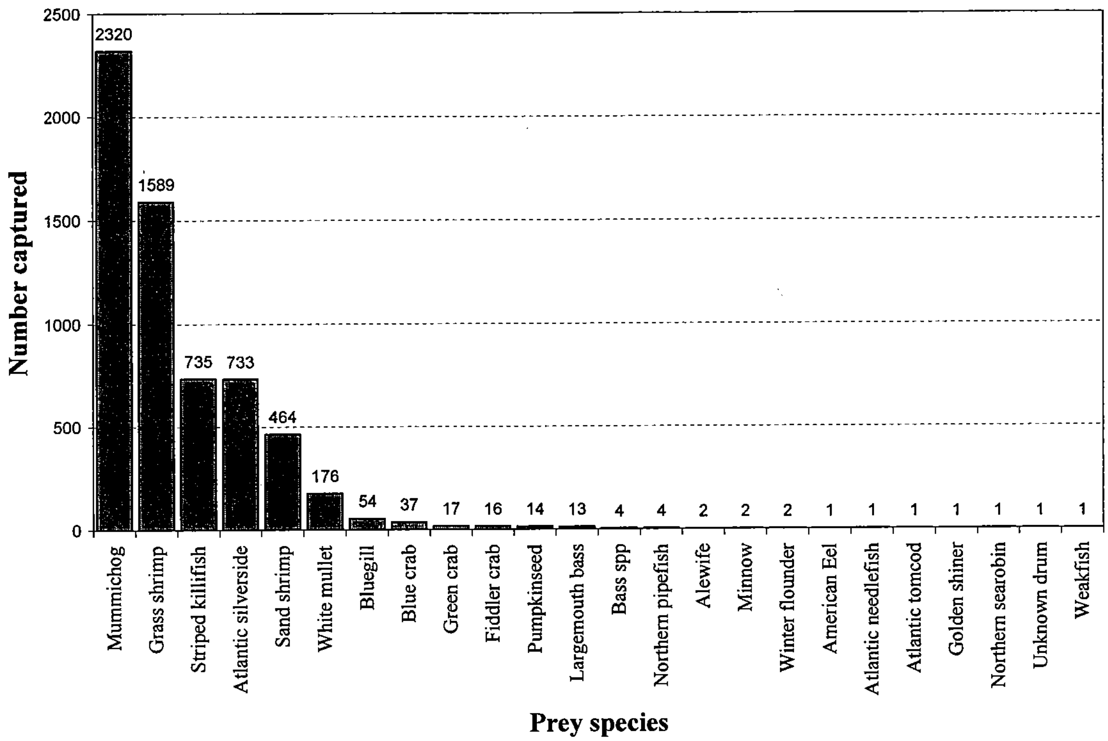
Figure 8. Mean prey size by habitat type. Number over bars represents mean size (mm) of prey successfully captured by foraging BCNH.



Island breeding colony where prey was plentiful through the entire breeding season. These foragers would constantly move over the site, scanning the ground and striking rapidly. Shoreline and saltmarsh foragers were more flexible in their behavior, using the broadest range of foraging techniques, and had more intermediate strike rates and capture success. It may be that these areas are more prone to tidal fluctuations, winds, and other conditions that influence foraging success, but these effects were not determined in this study.

One of the major limitations of this study, however, was the difficulty in capturing and marking adult BCNHs and reliance on observations of unmarked individuals. While this provided a general description of habitat use, it offered no solid evidence of short-term or seasonal changes in foraging ecology. For instance, foraging flights were fairly stereotyped regardless of time of season or tide, with the majority of birds heading in two directions in evening flights from the colony (Fig 3). It is not known, however, where these individuals headed along these flight paths, and whether or

Figure 9. Prey species seined at selected survey sites: Sampling was conducted biweekly (May-August 2004) in freshwater (CLOV, WILL), saltmarsh (GRKI1, MAIN1, ARMA), and shoreline (AKRD5, GRKI2) habitat types. See Table 1 for site code key.



not they visited single or multiple foraging sites in a given night, week, or month. It is also likely that, if site fidelity is high, the same individuals are observed in the same sites more than once over the course of the breeding season.

One of the few studies to successfully describe seasonal changes for known individuals was a radio telemetry project on BCNHs in Japan (Endo and Sawara 2000). The authors tracked eight individuals during the breeding and post-breeding season and found that: (1) some individuals would forage at single sites for days to months, eventually moving to new foraging areas, often along the same flight path as the previous site, (2) individuals would feed in different habitats during the day and at night, and (3) all individuals switched to different foraging sites as more plentiful resources became available. In July 2004, I experimented with capture techniques for adult BCNHs. One successful technique, the use of a remote-triggered drop net (to be described in Bernick and Newman 2004), enabled me to capture and apply radio transmitters to two adult female BCNHs at a shoreline foraging site (on 17 July and 6 August 2004). Both individuals showed strong fidelity to the foraging site in which they were captured. Through August, both individuals spent the night on the foraging grounds, and during daytime either in the breeding colony or roosting near to the foraging area. One individual then switched to roosting in the day and feeding at night in the foraging area, and continued this pattern through ~10 October 2004 (54 days) before moving out of range. Clearly, a large-scale tracking study would a more accurate method to address questions on foraging ecology for BCNHs and other wading bird species.

Satellite telemetry would eliminate many of the logistical problems associated with tracking in an urban setting (e.g., access to costly and highly restricted aerial surveys in an urban area, number of hours required to physically track multiple individuals, radio interference, etc.). Using this method, a study could be designed to address the question: how does foraging success relate to foraging decisions for BCNHs? A foraging decision could be defined as the probability of an individual remaining in the same location or moving to a new location within the same feeding area according to strike success (i.e., capture and consumption of prey). In a study of this type, we could test an optimality model that, within a single foraging area, individuals with low capture success are more likely move to new foraging locations than individuals with high capture success. When such single or fixed sequences of decisions exist, it is possible to get analytic results on optimal foraging behavior (Krebs and Davies 1997). Analysis of short-term decisions in foraging behavior would also provide information on how BCNHs forage in particular habitat types or locations. Studies conducted for diurnally foraging waders (Kent 1987) found differences in foraging behavior, habitat use, and prey for three *Egretta* species (i.e., Tricolored heron, snowy egret, and Little blue heron), and should be repeated for nocturnally foraging species. To explore this question, it would be necessary to combine data on individual foraging success, and overall foraging site observations. An adequate local population size estimate coupled with repeated observation of marked individuals would be the best scenario for conducting a study of this type (Turchin 1998).

In conclusion, this project: (1) described variation in foraging habitat use in an important wading bird breeding area, (2) established a repeatable protocol for nocturnal foraging research in other areas of the New York City and Hudson River ecosystems, and (3) identified alternative methods for use in a more detailed analysis of wading bird foraging ecology. From a logistical standpoint, investigating the foraging ecology of a nocturnal species in an urban environment is a complex and time-intensive endeavor. Using remote techniques such as satellite tracking would provide concrete evidence of habitat use, site fidelity, and post-breeding dispersal.

Investigating foraging behavior for all breeding wader species is imperative to heron conservation in urban ecosystems. Heron conservation in localized or fragmented areas, requires knowledge of habitat requirements on a local scale (Kushlan and Hafner 2000). We need to fully explore habitat requirements of enigmatic wader species, such as BCNHs, to succeed in designing a comprehensive management plan for wading bird populations.

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