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Birds and The Potential for Bird Strikes at John F. Kennedy International Airport

Final Report

Curtice R. Griffin
Edwin Mark Hoopes

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July, 1992

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Table of Contents

List of Figures

List of Tables

Acknowledgements

This Final Report forms part of a long-term, on-going study by the National Park Service of the relationships between waterbirds using the Jamaica Bay Wildlife Refuge portion of Gateway National Recreation Area, and operations at contiguous John F. Kennedy International Airport, a unit of the Port Authority of New York and New Jersey. Work done during this phase was supported by Cooperative Agreement CA-1600-4-0005 #40 between the National Park Service (Gateway NRA) and the University of Massachusetts at Amherst, with funds from the Port Authority. The original conception and design of the study were determined by Dr. P.A. Buckley of the National Park Service's Coastal Research Center at the University of Rhode Island, and Dr. John T. Tanacredi at Gateway NRA. Their guidance and technical direction in numerous meetings and conferences, as well as review of protocols, progress reports and an earlier draft of this report have been essential to the success of this phase of the study. Further logistic and direct field assistance were provided by the following NPS personnel: D. Riepe, Jamaica Bay Wildlife Refuge, and A. Scaglione and R. Cook, Gateway Division of Natural Resources and Compliance. We would especially like to thank R. Cook for tollerating thousands of plaster of Paris eggs in the wet room and for providing helpful discussions on Jamaica Bay and its wildlife.

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PROJECT TITLE: BIRDS AND THE POTENTIAL FOR BIRD STRIKES AT JOHN F. KENNEDY INTERNATIONAL AIRPORT

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STATEMENT OF WORK

The goal of this project was to provide information on numbers, distribution, and ecology of birds at John F. Kennedy International Airport and to assess the potential for bird strikes. In addition, movement patterns of Laughing Gulls from the Jamaica Bay gull colony, administered by the National Park Service and immediately adjacent to the airport, were determined. This information can provide managers with improved understanding of the potential for bird strikes at the airport and tools for achieving airport and National Park Service objectives.

INTRODUCTION

The potential for collisions between birds and aircraft is increasingly a major concern at John F. Kennedy International Airport (JFKIA). Much of this concern is focused at the bird populations at Jamaica Bay National Wildlife Refuge (JBWR), a unit of Gateway NRA that is adjacent to JFKIA. The diverse habitats of the Refuge

attract thousands of water, land, and shorebirds and support a major Laughing Gull breeding colony (7,600 + pairs) on Joco Marsh (Fig. 1). It is the occurrence of this gull colony immediately adjacent to the airport, the relatively high incidence of Laughing Gulls on the airport, and other bird species within JBWR and their potential hazard to aircraft that provided the impetus for this study.

In response to this concern, the National Park Service, in cooperation with the Port Authority of New York and New Jersey convened an expert panel in 1989 to review the bird hazard to aircraft at the airport (Buurma et al. 1989). While the panel recognized the extreme nature of the bird strike hazard caused by the proximity of the colony to the airport, they concluded that the Laughing Gull colony could not be considered in isolation from hazards posed by other birds. Further, the panel found the airport to be an "attractive nuisance." This is because many landscape features on, and in the vicinity of, the airport also provide habitats that attract a variety of bird species. These include the runways and grass infield areas of the airport, the grassy areas along the Van Wyck Expressway, a major landfill (Edgemere), and extensive grass-covered areas of a golf course and race track (Aqueduct). Further, the use of these habitats by birds is probably increased substantially because, considering the highly urbanized nature of western Long Island, there is little natural remaining habitat.

Recognizing these various factors affecting the potential for bird strikes at the airport, the panel made

several recommendations for information and management needs, including:

1. Collection of data on bird strikes at the airport.
2. Baseline information on all birds utilizing the airport and bird movements over the airport.
3. Initiation of an experimental gull control program in the Jamaica Bay Laughing Gull colony.

The goal of this project was to meet these information and management needs. Given these recommendations, our specific objectives were:

1. To obtain baseline information on birds utilizing John F. Kennedy International Airport.
   a. Determine species, age, sex, and numbers of all bird species utilizing the airport.
   b. Monitor daily activity patterns of birds at the airport.
   c. Evaluate bird distribution at the airport in relation to available habitats, environmental factors, and proximity to gull colonies.
   d. Collect and examine all bird carcasses found at the airport according to species, age, sex, breeding status, and stomach contents.
2. To obtain baseline information on the ecology of Laughing Gulls nesting in Jamaica Bay adjacent to JFK Airport.
   a. Determine size and distribution of gull colonies.

b. Determine movements of nesting Laughing Gulls by color-marking nesting gulls and radio-tagging nesting and non-nesting gulls.

c. Monitor daily activity patterns of gulls in relation to nesting chronology and status.

3. Initiate an experimental management action in the Jamaica Bay Laughing Gull colony.

a. Reduce reproductive output by egg-oiling.

b. Evaluate efficacy of egg-oiling to reduce egg hatching.

c. Determine if this action reduces the frequency of gull flyovers at the airport.

4. Develop a management plan for reducing the potential for bird strikes at JFKIA and evaluate the need for additional gull management actions.

METHODS

Bird numbers and Distribution

We conducted avian use surveys at a variety of sites on and around JFKIA from 7 June to 15 September. Surveys were conducted at: 1) the airport, in areas on and adjacent to runways, taxiways, and infield areas, 2) street-side (JFK Airport), separated into three sections-- terminal, cargo, and Van Wyck areas (Fig. 2), 3) Aqueduct Race Track, 4) Edgemere Landfill, and 5) Floyd Bennett Field. Further, we separated the airport into two areas: 1) operational, areas supporting aircraft operations which included runways, taxiways, and infield areas, and 2) non-operational, areas

which did not support aircraft operations but were still on JFKIA, such as the grass areas along the Van Wyck Expressway, street-side terminal and cargo areas, and associated parking lots and roadways (Fig. 3).

Airport surveys were conducted every other day from 7 June through 15 September 1990. We established 60 survey stations, spaced at approximately 0.4 km (0.2 mi) intervals, around the airport runway and taxiway system. We stopped at each station for 1 min and recorded the species, number, age, sex, and behavior of all birds within approximately 200 m. Each survey was approximately 23 km (15 mi) in length and took approximately 2 hours to complete. Surveys were conducted every other day between 0600 h and 1300 h or 1300 h and 2000 h. Over 100 surveys were conducted.

Street-side airport surveys were conducted daily throughout the study period covering all daylight hours. All gull species, numbers, ages, and locations were recorded. Each survey was 11 km (6.8 mi) in length and took approximately 25-30 min to complete. Over 300 surveys were completed. We could only conduct surveys at Aqueduct Race Track during their regular business hours (Monday through Friday, 0800-1700 h). All gull species, numbers, and ages were recorded during 30 min observation periods. All observations were conducted from the press box atop the grandstand. Nearly 150 surveys were conducted.

Edgemere Landfill surveys were conducted every other day. Because the areas of active dumping within the landfill

changed daily, we recorded all gull species, numbers, and ages from three permanent stations within the landfill. All three stations provided full coverage of the landfill. Over 150 surveys were completed at this site.

Floyd Bennett Field (FBF) surveys were conducted daily. We drove a standardized 8 km (4.5 mi) route around FBF and recorded species, number, age, and habitat of all gulls utilizing FBF. Surveys were conducted from 0600 h to 2100 h and over 300 surveys were made.

We periodically recorded numbers of Laughing Gulls flying over JFKIA in the three hours before sunset. Ten surveys were conducted once per week in June (n = 2), July (n = 4), and August (n = 4); and were conducted from the General Aviation Terminal parking lot.

Activities of birds on JFKIA

We recorded activities of birds on the airport as part of our airport surveys (non-operational and operational areas). We recognized four behavioral categories: 1) feeding, 2) locomotion, 3) maintenance, and 4) other. Activities were recorded for both individual birds and flocks and by habitat.

Birds found dead at JFKIA

All birds found dead on runways and taxiways on the airport were collected and location recorded by S. Chevalier. Carcasses were transferred to us and we recorded species, age, sex, and breeding status. We took external measurements on all birds (when possible) including 1) total length, 2) bill length, 3) wing chord, 4) tarsal length, and 5) total

weight. We also recorded breeding status based on plumage and internal examination of gonads (Welty 1984).

Food Habits

We removed the digestive tracts of all birds recovered on the airport regardless of cause of death. Digestive tracts, from crop to cloaca, were removed, fixed in formalin, and stored for later analyses. In cases where a complete digestive tract was not present, whatever portion was available was removed but not included in the analysis. Digestive tracts were later examined and food items were identified to species, when possible, and stored in a 70% isopropyl solution. We calculated frequency of occurrence (DeBlase and Martin 1981) for all food items found in Laughing Gull stomachs.

Numbers and distribution of Laughing Gull Nests

We censused all marsh islands adjacent to JFKIA in the eastern end of Jamaica Bay. We conducted direct ground censuses using transects across each marsh island. Six to 15 people walked transects, and each nest was marked with an individually numbered flag and number of eggs recorded.

Seven 15 m^2 sample plots were established to determine hatching success and productivty of nests. Plots were constructed of 1 m high, 2.5 cm mesh wire. All nests within plots were marked and monitored once every 7-10 days. Numbers of chicks dead and alive were recorded every visit.

Movements and Flyovers

We radio-tagged 22 Laughing Gulls (19 adults, 3 fledlings) to obtain information on Laughing Gull movements and activity patterns. We used bownets placed on Laughing gull nests to capture breeding adults. If a gull was not trapped within one hour, the trap was removed and set at another nest. Average trapping time was 22 min. All birds were fitted with back-mounted transmitters, ($\bar{x}$ = 9.8 g.), and released within 15 min ($\bar{x}$ = 12.5 min). Seventeen adult Laughing Gulls were trapped on the nest. We used rocket nets set on the edge of a large pooled water area in a construction company's parking lot (across from Building 17) to capture an additional 2 adults and 3 fledglings. During airport surveys, we recorded species, numbers, age, sex, direction, and height of all birds flying over the station within 200 m.

Egg-oiling

An experimental egg-oiling/management program was initiated in an attempt to decrease Laughing Gull hatching success. Daedol 50, a pure, white mineral oil, was applied to eggs of 3,675 (47.7% of the colony) nests on Joco and Silver Hole Marshes over a three-week period (8 June to 29 June). The oil is a homogeneous mixture of completely saturated aliphatic and alicyclic hydrocarbons and has the same purity as baby oil (G. Franklin, Daminco, Inc., Mississauga, Ontario, Canada, pers. comm.) Approximately

50-75 ml of mineral oil was applied to each nest using a garden sprayer held approximately 10-15 cm above eggs.

Color-marking

We differentially color-marked adults at oiled and non-oiled nests to determine whether or not oiling affected numbers of birds occurring at the airport. Over 7,000 adults at all treated nests were color-marked with Rhodamine-B, a red dye. Dye was delivered by placing a mixture of dye, water, and petroleum jelly onto a dummy egg that was placed in each nest (Cavanagh and Griffin 1988). Subsequent preening by the gulls spread the dye on the breast area. When birds came in contact with water, the dye was released and stained the breast and abdomen. Malachite green, delivered in the same manner as Rhodamine B, was used to mark nearly 800 adults at 397 additional nests (5% of colony) resulting in a 9.3:1 ratio of red-marked birds to green-marked birds. Birds marked with green dye represented untreated nests (i.e.- no oil applied). Unlike Rhodamine-B, Malachite green is not water soluble. As a result, green dyed gulls were not as visible as red-dyed gulls because the dye did not cover as large an area.

Numbers of color-marked birds were recorded at all survey sites. Further, birders reported color-marked birds from various sites throughout the Northeast.

Areas on and around JFKIA attractive to Gulls

During all times throughout the study period (i.e., during surveys and other field travel periods), we recorded

areas on and around JFKIA that attracted birds. Typically, these areas regularly provided a feeding, resting, or roosting site for gulls. These attractants were monitored daily or every other day for presence or absence of birds.

RESULTS

Bird numbers and Distribution

Gulls and a variety of other birds used many sites on and around JFKIA (Table 1), and numbers of birds utilizing these sites were highly variable. Average numbers of Laughing Gulls, other gulls, and other bird species on the airport varied between months and generally were highest during June (Table 2). Numbers of gulls declined throughout the summer, then increased slightly in September. Average numbers of all birds utilizing the non-operational areas of the airport were highest on grass-covered areas along the Van Wyck Expressway (Table 3). Laughing Gull numbers were generally highest in June at these non-operational areas (Table 3) and at the Aqueduct Race Track (Table 4) and declined through the summer. Mean numbers of Laughing Gulls were signifcantly higher along the Van Wyck Expressway than mean numbers of Laughing Gulls for both Terminal ($t = 143.7$, $df = 1$, $P < 0.05$) and Cargo Areas ($t = 183$, $df = 1$, $P < 0.05$) in June, but were not significantly higher during July, August, and September (Table 3). Surveys of sites south of Joco Marsh (Edgemere Landfill and Floyd Bennett Field, FBF) showed an increase in average numbers of gulls in July at FBF and in August at Edgemere, with numbers decreasing in September

(Tables 5 and 6). Laughing and Herring Gulls, increased dramatically at Edgemere in August (Table 6).

Activities of birds on JFKIA

Overall, the behavior of gulls utilizing the airport during summer consisted largely of maintenance activities such as loafing, resting, and preening (Table 7). Feeding occurred at a much lower frequency, ranging from 0% for both Great Black-backed (L. marinus) and Ring-billed (L. delawarensis) gulls in June and August to as high as 50% for Laughing Gulls in August. Most gull maintenance activities occurred in a large (50 m x 20 m) area of standing water located between Taxiways H and J. Ring-billed and Herring Gulls spent a large portion of their time in loafing activities on the concrete apron around the approach end to Runway 4L. Laughing and Herring Gulls exhibited an increase in time spent feeding in August (Table 7).

Birds found dead on JFKIA

Numbers of birds found dead at JFKIA have steadily increased since 1980 and varied much within the summer period from 1980-1990 (Table 8). On average, more bird deaths occur in June ($\bar{x}$ = 56.72), and there has been a notable fluctuation in numbers of bird deaths in September between years. Further, there were significant differences in the number of bird deaths between months in 1990 ($F = 15.17$, $df=3,4$, $P < 0.05$). Total numbers of Laughing Gulls found dead on JFKIA did not differ significantly between 1989 and 1990 ($F = 3.7$, $df=4,5$, $P > 0.05$) (Table 9).

We examined whether increased numbers of birds found dead on JFKIA were correlated with increased numbers of airport operations. Between 1980 and 1990, total numbers of birds, total Laughing Gulls, and other gulls found dead on JFKIA were not significantly correlated with total number of operations (Table 9). Similarly, no significant correlations were detected by month ($P > 0.05$) between numbers of Laughing Gulls found dead on JFKIA and numbers of operations between May and September 1980-1989 (Table 10). However, numbers of Laughing Gulls found dead on JFKIA were correlated with numbers of nesting Laughing Gulls in JBWR, and was highly significant ($r = 0.935$, $df = 6$, $P < 0.001$, Table 11).

In 1990, total numbers of Laughing Gulls found dead on JFKIA varied between runways (Fig. 4). Laughing Gulls accounted for the majority of birds found dead on all runways except 4R/22L, where other gulls and other birds accounted equally for birds found dead (Fig. 4). Seventy percent of all birds found dead on JFKIA in 1990 occurred on runway 13R/31L (Fig. 4). Laughing Gulls accounted for 72% (n= 113) of all birds found between June and September 1990 (Table 12). Of these Laughing Gulls, 73% were adults and 17% were fledglings or after hatching year birds (Table 12).

Only 40% of the carcasses collected could be identified to sex because of physical damage. The sex ratio of birds found dead on JFKIA varied according to species, yet the ratio of males to females for all species combined was roughly 1:1 (Table 12). In contrast, nearly twice as many male Laughing Gulls were found dead than females.

The occurrence of enlarged ovaries in females or enlarged testes in males indicated the breeding status of collected birds. Although we could not determine breeding status of all bird carcasses recovered, breeding Laughing Gulls accounted for 75% and 60%, respectively of known status carcasses collected in June and July, when peak breeding activity occurred in the JBWR colony (Table 13).

Food Habits

We examined the stomachs of all Laughing Gulls found dead on the airport to determine types of food items eaten, therby providing additional information on foraging behavior. Overall, adult Laughing Gulls had a relatively natural diet. Insects comprised the majority of their diet, and 7.9% by occurrence was refuse (Table 14). However, we did observe Laughing Gulls eating other food items that were not found in stomachs. For example, we observed gulls foraging in the sewage tanks at the Jamaica Sewage Treatment Plant but did not find anything in stomachs that would suggest the sewage plant was a food source. Immature Laughing Gulls' diets were similar to adults. Approximately 9% by occurrence of diet of young gulls was refuse (Table 15). Although the remaining portion of their diet was natural, it was less varied than for adults.

Numbers and distribution of Laughing Gull Nests

In 1990, we counted a total of 7,629 nests on 6 marsh islands adjacent to JFKIA (Table 16). Nearly 90% of all nests were found on Joco and Silver Hole marshes. We estimated

that less than 50 pairs nested on Broad Creek and Duck Creek marshes. Main concentrations of nesting Laughing Gulls were located directly in line with Runway 4L (Fig. 5).

In 1990, Laughing Gulls were first observed in Jamaica Bay in the second week of April. Earliest nesting attempts (i.e., a nest with at least one egg) were observed on 19 May on Joco Marsh, when we estimated approximately 750 pairs present. We found the first nests on Silver Hole Marsh and East High Meadow in the last week of May and first week of June, respectively. During the third week in May, spring high tides, over several evenings, covered most of the marsh islands and, we believe, washed at least half the nests away. Nests on Broad Creek and Duck Creek Marshes were established in early July and believed to have been young, inexperienced nesters because there was still available nesting habitat on Joco and Silver Hole marshes. Average clutch size for all nesting islands combined was 2.3 eggs/clutch (n = 6,703 clutches). Chicks were first observed on 8 June and peak hatching occurred on 20 June. By the first week in August, 85-90% of chicks had fledged.

Laughing Gull productivity in the seven productivity plots ranged from 0.00 to 1.36 fledged chicks per pair (Table 17). Feral dog predation was the cause of zero productivity in three of our plots. In the remaining four plots, productivity ranged between 0.55 to 1.36 chicks/pair. Overall, productivity for the four non-depredated plots was 1.08 chicks/pair (Table 17).

Movements and Flyovers

We radio-tagged adult and fledgling Laughing Gulls in an attempt to understand movement patterns in and around the colony and the areas around JFKIA. However, the range of radio transmitters was limited (often < 0.5 km) and heavy traffic on roadways within the vicinity of the airport greatly limited our ability to obtain fixes on birds via triangulation. Thus, our radio telemetry data are few and biased towards birds that were stationary at a site. Whenever possible a visual confirmation of tagged birds was made.

We found tagged birds at Edgemere Landfill, Aqueduct Race Track, FBF, Jamaica Sewage Treatment Plant, and on JFKIA during all daylight hours. Radio-tagged birds were most often found at Edgemere or in a large wet area in a JFKIA construction lot across from Building 17 (Pan Am). Four radio-tagged birds abandoned the study area within a week of being tagged.

Laughing Gulls were observed flying over the airport during all daylight hours and the numbers of flyovers at JFKIA were fairly constant throughout summer 1990. Laughing Gulls comprised 54% of all flyovers, while other species (including songbirds) and other gulls comprised 39% and 7% of all flyovers on JFKIA, respectively (Table 18). Greatest number of flyovers at JFKIA occurred along runway 13R/31L with Laughing Gulls comprising 65% of the total flyovers on this runway (Table 18). Nearly 30% of all flyovers on JFKIA were comprised by Laughing Gulls on runway 13R/31L (Table 18)

of the day except late morning and late afternoon (Table 20). Other gulls were fairly consistent (in terms of percent occurrence on any one runway) along runways 13R/31L, 4L extention, and 13L/31R (Table 20). Along runway 4L/22R other gull flyovers were significantly lower except for 0900 h to 1159 h and 1500 h to 1759 h (Table 20). Likewise on the same runway, significantly fewer other bird flyovers occurred in the last 6 hours of the day (Table 20).

Within individual runway systems, there were no differences in altitude of flyovers for Laughing Gulls (Table 21). However, there were significant differences ($F = 19.3$, $df = 1, 2$, $P < 0.05$) in altitude of flyovers for other birds on runway 13L/31R where other birds accounted for 65% of all flyovers below 7.6 m on this runway (Table 21). Further, other birds were observed flying over runway 4R/22L at altitudes > 15 m significantly more often than any other altitudes ($F = 27.9$, $df = 1,2$, $P < 0.05$). Similarly, other gulls were observed flying below 7.6 m significantly more often than at other altitudes for runway 4R/22L ($F = 21.1$, $df = 1,2$, $P < 0.05$) (Table 21). Significantly more other gulls on runway 4L/22R flew at altitudes above 7.5 m ($P < 0.05$, Table 21). There also were significant differences ($P < 0.05$) in altitude of flight of other birds below 7.5 m and above 15 m on runway 4L/22R (Table 21). Likewise, there were significant differences in flyovers of other birds on the extension of runway 4L below 7.6 m and above 15 m (Table 21).

Egg-oiling

A total of 3,675 nests (47.7% of the total colony) were oiled, and we monitored 516 nests (14% of all oiled nests) to determine efficacy of oiling eggs. Of these 516 nests, 333 nests hatched no eggs, a 64.5% efficacy with one application of oil. Eggs sprayed within the first two weeks of incubation hatched successfully (n = 23) with no signs of malformed chicks. Similarly, eggs sprayed after they were starred (i.e., when an egg is cracked but not yet pipped) or pipped also hatched. Thus, spraying eggs was most effective for reducing hatchability in the latter half of the incubation period before starring or pipping occurred.

Color-marking

The observed ratio of red (oiled) to green-marked (non-oiled) birds varied between sites (Table 22). Numbers of red and green-marked birds on FBF, Street-side Airport surveys, and sightings by the public more closely reflected the actual ratio of marked birds (9.3:1), although effort (number of observations of marked birds/number of hours of observation) varied greatly (Table 22). Almost all color-marked birds were seen within 10 km of the nesting colony (red = 94%, green = 98%; Table 23). All green-marked birds were observed within 20 km of the nesting colony, while red-marked birds were observed as far away as New Haven, CT (n=1) Eastham, MA (n=4), and Truro, MA (n=2); 108 km, 350 km, and 355 km, respectively.

These included two water holes; one approximately 50m x 20 m located NNE of the VORTAC between taxiways H and J and another, smaller (25 m x 25 m) wetland area SSW of the VORTAC (Fig. 7). During June and July we observed an average of 47.2 Laughing Gulls, 2.1 other gulls, and 2.4 other waterbirds per survey using these areas for loafing, bathing, and preening. By late July, both areas had completely dried up. Another group of three water holes, encompassing approximately a 70 m x 70 m area in the vicinity of the middle-marker for runway 31R, also attracted gulls and other waterbirds, in fewer numbers than the water holes between taxiways H and J. Herring and Great Black-backed Gulls were the predominant species observed at this latter site and used it primarily for loafing and bathing (Fig. 7). Thurston Basin was used as a foraging site by all species of gulls (Fig. 7).

Within the Terminal Area (non-operational) and areas immediately surrounding the airport, we observed a number of areas that attracted gulls. Many gulls (mostly Laughing and Ring-billed) were attracted to taxi stands. On at least 25 different occasions, we observed Laughing and Ring-billed Gulls and Rock Doves being fed by taxi drivers or feeding on refuse left behind by taxi drivers. Numbers of feeding gulls ranged from 1 to 30. Dumpsters at the rental car parking lot also attracted gulls (Fig. 7). These dumpsters were continuously open every day during the study period and we observed gulls feeding in them on 17 different occasions (Fig. 7).

The grassy areas along the Van Wyck Expressway appeared to attract foraging Laughing and Herring Gulls, but especially Laughing Gulls (Fig. 7). Laughing Gulls were observed in these areas during all daylight hours; however, mean numbers generally were greatest toward sunset (Table 24). Mean numbers of Laughing Gulls observed at these areas after 1800 h was nearly twice that observed before 1800 h; however, this difference was not significant ($t = 7.48$, $P > 0.05$) (Table 24). Laughing Gulls ($\bar{x} = 24.9$) were also observed drinking, loafing, and preening in a large (20 m x 15 m) water hole in the DeMatteis Contruction Company's parking lot (Fig. 7). This area also was used by other species of gulls, Rock Doves, and several species of shorebirds; however, Laughing Gulls accounted for the majority of birds using this area. The Jamaica Sewage Treatment Plant was also used extensively by Laughing Gulls (Fig. 7). Laughing Gulls were observed feeding at this site during all hours of the day ($\bar{x} = 19$, range 3-201), with greatest numbers usually occurring before 1000 h and after 1800 h (Fig. 7, Table 25).

Throughout the summer we observed Laughing, Herring, and Great Black-backed Gulls feeding, loafing, and resting in the grass infield areas of Aqueduct Race Track. Additionally, reflecting pools in the infield area of the race track were used by Laughing, Herring, and Great Black-backed Gulls on a daily basis for drinking and bathing.

On 24 and 25 August, three feeding flocks each consisting of approximately 2000 birds (95% Laughing Gulls

and 5% other gull species) were observed over three separate areas of JFKIA. On the first occasion, a flock was feeding between runways 4L/22R and 4R/22L over a 75 min period between 1645 h and 1800 h. This flock was first observed in the vicinity of taxiway G and moved between the parallel 4/22 runways, moving slowly NE toward the approach end of runway 22L, where the flock dispersed (Fig. 8). At the time this flock was observed, runway 4R was being used for arriving aircraft and runway 4L was being used for departing aircraft. During this time, there were 3 pilot-reported bird strikes involving 8 birds (6 fledgling Laughing Gulls, 1 adult Great Black-backed Gull, and 1 immature Herring Gull). One additional fledlging Laughing Gull was also struck, but not reported by pilots (S. Chevalier, pers. comm.). The next day, at approximately 1715 h, we observed a similar flock feeding at the approach end of runway 13R (Fig. 8). This flock was feeding on swarms of flying ants that either emerged on the airport or flew onto the airport from some other location. The third flock was observed at 1800 h on 25 August (Fig. 9). It was concentrated over the NW end of runway 13R between taxiways PC and N (Flock A), and moved slowly along runway 13R until it met with a smaller flock (approximately 500 gulls, Flock B), also feeding on flying ants, located between taxiways LA and KB (Fig. 9). This combined flock moved between the parallel 4/22 runways toward taxiway F, where it dispersed at 1930 h (Fig. 9).

However, whether bird deaths at JFKIA are caused by actual contact with aircraft or by jet-blast; birds flying over the airport pose a serious threat to aircraft operations and public safety. Future work should focus specifically on observing behaviors of gulls and other birds near moving aircraft.

The reason for the decline in birds found dead on JFKIA between 1989 and 1990 for the months June through September may be due, in part, to the egg-oiling conducted in the JBWR Laughing Gull colony. While we believe this may be part of the reason for the observed monthly decline between years, we can not rule out the possibility that other factors such as nest flooding, reduced food availability, or other environmental factors may have affected the number of birds found dead at JFKIA.

Bird carcasses were encountered on all runways on JFKIA during 1990, with the majority being Laughing Gulls and occurring on runway 13R/31L. The reason for this high occurrence of birds found dead along this runway is two-fold. Runway 13R/31L is the longest runway on JFKIA (4,442 m, 14,572 ft.) and covers a major section of JFKIA from SE to NW and lies between the JBWR Laughing Gull colony and several areas attractive to gulls. As a result, Laughing Gulls flying to these areas fly in a direct line over this runway. Further, Laughing Gulls flying toward the JBWR Laughing Gull colony in the evening fly well over 60 m (200 ft) in altitude, but as they approach the airport they drop to between 0 and 10 m in altitude (S. Chevalier, pers. comm., E.

Hoopes, pers. obs). Further, Laughing Gulls tend to flock in the evening as they fly low over the airport (E. Hoopes, pers. obs.). Although Laughing Gulls accounted for the majority of bird deaths on the remaining 3 runway systems, numbers of birds found dead were much lower. This is most probably a result of the movement patterns of birds flying over JFKIA; the majority of which move in more northerly or southerly directions and were not frequenting the south and east sections of JFKIA.

There are few data on breeding status of birds involved in bird strikes at airports. Buckley and Gurien (1987) reported that Laughing Gulls found dead or collected on JFKIA in 1985 (n=37) were not breeding birds based on the absence of a brood patch and that gonads of these birds were not enlarged. However, in 1990, we found that 70% of the adult Laughing Gulls found dead on JFKIA's runways were breeding birds from the JBWR Laughing Gull colony. Had we not had a color-marked population to work with, we would have misidentified breeding status of at least 40% of the adult Laughing Gulls involved in bird-aircraft interactions or found dead on the runways. This is because red-marked birds, known to be nesting and attending eggs in the JBWR Laughing Gull colony, did not have brood patches. Similar to Buckley and Gurien (1987), our data also suggest there is a non-breeding contingent of Laughing Gulls in the JFKIA area. During June, when breeding was at a peak, one in every three Laughing Gulls found dead were non-breeders (Table 13).

A variety of factors contribute to the bird strike problem at JFKIA. Unfortunately, previous years' data, while extensive, do not allow for direct comparisons to be made between years. With the exception of 1985 and 1986, there were no direct censuses of the Laughing Gull colony. Hence, we do not know if changes in numbers of birds found dead on the airport reflect true changes or are a result of fluctuating numbers of nesting gulls. Further, collection of bird strike data at JFKIA has been continually refined as interpretation of what constitutes a bird strike continues to be better defined. However, some general conclusions can be made: 1) the general trend has been an increase in total numbers of birds found dead at JFKIA, 2) numbers of Laughing Gulls and other gulls found dead have increased over the past 10 years, 3) Laughing Gulls account for approximately 50% of all birds found dead each year between 1980 and 1990, and 4) number of non-gull species found dead is generally less each year and accounts for approximately 10-15% of all carcasses found. Environmental factors, population size, and number of operations may all play a part in actual number of birds found dead at JFKIA from year to year.

We believe the general trend of increasing numbers of birds found dead at JFKIA is attributable to several factors including: 1) the dramatic increase in numbers of nesting Laughing Gulls in JBWR, 2) the probable increase in the number of non-breeding adults and sub-adults associated with the JBWR gull colony, 3) the remaining attractants on and adjacent to JFKIA (e.g., Edgemere Landfill, grassy areas

along the Van Wyck Expressway, Jamaica Sewage Treatment Plant, and Aqueduct Race Track), and 4) to a lesser extent, increased aircraft operations, especially over the summer months, at JFKIA between 1980 and 1990.

There is no doubt that JFKIA has a serious bird-aircraft interaction hazard involving not only Laughing Gulls but also other species of birds as well, which is consistent with the conclusions of Buurma et al. (1989). However, gulls account for the majority of bird-aircraft interactions at JFKIA. Further, Laughing Gulls are only present in the JFKIA area for approximately 6 months, yet account for nearly half of all gulls involved in bird-aircraft interactions and, 40% to 52% of all bird-aircraft interactions recorded since 1986 (R. Dolbeer, pers. comm.). In discussions we had with managers at the 20 busiest airports (in terms of aircraft operations) in the United States (FAA, pers. comm.), we found that in 1990 JFKIA ranked twentieth in operations but was first (by nearly 10 times) both in total numbers of strikes and numbers of strikes per 10,000 operations, for those airports reporting a bird strike problem. Solman (1981) found 17 of 28 (60%) of the more serious bird strike incidents involving civilian aircraft at airports around the world since 1912 were caused by gulls. Further, most studies indicate that gulls pose the greatest threat to aircraft (Blokpoel 1976, Frings 1984), compared to all other threats (e.g., mechanical failure, pilot error, foul weather).

Food Habits

Laughing Gulls have been reported to feed in a variety of habitats ranging from mudflats, beaches, shallow coastal waters, behind fishing vessels (Bent 1921), recently mown or short grass and newly plowed agricultural fields (Buckley and Gurien 1987, Blokpoel 1976, Mayr 1948, and Wolk 1959), and sanitary landfills (Schreiber et al. 1979). We observed Laughing Gulls from the JBWR Laughing Gull colony feeding in all of these habitats (except newly plowed agricultural fields) and also recorded extensive feeding in a sewage treatment plant, which has not previously been reported in the literature.

The diet of adult Laughing Gulls found on JFKIA was quite varied and mostly natural. Other studies have reported shrimp, small fish, crabs, insects including beetles, grasshoppers, ants, and moths were the main prey items consumed by Laughing Gulls (Bent 1921, Buckley and Gurien 1987, Howell 1932, Nisbet 1976, Tolonen 1970, and White et al. 1979) which is consistent with our findings. Buckley and Gurien (1987) found beetles comprised a majority (84% and 74%, by weight, 1985, 1986, respectively) of the diet of Laughing Gulls collected on JFKIA. Unfortunately, it is not possible to make direct comparisons between our results and those of Buckley and Gurien (1987) because we examined diet via frequency of occurrence. However, beetles did not account for much of the diet of Laughing Gulls in 1990, perhaps because grassy infield areas (where beetles are found) were allowed to grow tall and, as a result, gulls did not forage

in these areas because of their aversion to foraging in tall grass (Blokpoel 1976, Boulter et al. 1973, Brough and Bridgman 1980, Buckley and Gurien 1987, Canada Transport 1973, Compton et al. 1973, Mead and Carter 1973). The diet of fledgling Laughing Gulls found dead on the airport, although less varied, was still mostly natural and did not differ from that of adults. While refuse did occur in adult and fledgling Laughing Gull diets, it did not occur in the frequency reported for Herring and Great Black-backed Gulls in Massachusetts (56.9% and 42.0% by occurrence, respectively; Cavanagh and Griffin 1990).

We do not consider vegetation found ingested by adult and fledgling Laughing Gulls to be of any nutritive value. It is likely the vegetation found in Laughing Gull stomachs was the result of accidental ingestion, as Cavanagh and Griffin (1990) reported for Herring Gulls.

We believe that the items we found in Laughing Gull stomachs represent a minimum of food items exploited by Laughing Gulls because we observed Laughing Gulls feeding on other food items not found in our analyses. For example, we observed Laughing Gulls feeding at the Jamaica Sewage Treatment Plant, but only found evidence for this in one fledglings stomach (latex), however this could have come from a source other than the sewage treatment plant. Further, we observed an adult Laughing Gull flying in the direction of the JBWR Laughing Gull colony with a snake in its bill. Several nests in the colony had snake skins and partially eaten snakes near them. However, we never found snake as

part of the diet of birds we examined. Further, for those birds found dead on the airport, we found relatively small amounts of fish and mostly insects making up the bulk of the diet. We believe these birds may not be attending young and can spend more time exploiting predictable insect resources around JFKIA while adults attending young spend time foraging for high quality, but patchily distributed food sources such as fish and crusteceans in the marsh and Jamaica Bay. Annett (1985) reported that Herring and Western Gull L. occidentalis adults exploited predictable food sources during pre-laying and incubation, but once chicks hatched, switched to unpredictable, but high quality food sources, such as fish.

Numbers and distribution of Laughing Gull Nests

Since 1979, nesting Laughing Gulls in Jamaica Bay have expanded from only a few pairs, to nearly 3,000 pairs in 1984 (Buckley and Gurien 1987). Prior to our study, the last year a direct count was made was 1986 when approximately 2,800 pairs nested on Joco Marsh and adjacent areas (Buckley and Gurien 1987). Since 1986, colony size was only estimated from partial belt-transects and helicopter surveys.

Numbers of nesting Lauging Gulls are expanding throughout the Northeast including Massachusetts (D. Houghton, pers. comm.), New York (Post and Riepe 1980, Buckley and Buckley 1984, this study), and New Jersey (D. Pharo, pers. comm.). The dramatic increase in numbers of nesting Laughing Gulls on Joco Marsh is probably due to several factors. Some of this increase may be due to

recruitment from within the JBWR colony. However, it is doubtful that this alone could account for these observed increases. Of 19 banded Laughing Gulls recovered on JFKIA between 1979 and 1980, 17 (89%) were banded as chicks at Barnegat Light, NJ; 95 km south of JFKIA and 2 (11%) were banded at Beach Haven, NJ; 120 km south of JFKIA (R. Dolbeer, pers. comm). During the summer of 1990, we recovered four banded Laughing Gulls (3 adults in the colony and 1 fledgling on JFKIA). All of these birds were banded as chicks in Stone Harbor, NJ. Laughing Gull colonies in southern New Jersey are expanding (J. Burger and D. Pharo, pers. comm.). Further, there probably is little available nesting habitat between southern New Jersey and Jamaica Bay, yet there appears to be much nesting habitat still available in JBWR and adjacent marshes in New York. Considering the large populations of Laughing Gulls that exist in New Jersey and the availability of suitable nesting habitat in and around Jamaica Bay, it seems likely that much of the increase in numbers of nesting Laughing Gulls on JBWR is the result of both recruitment from within the JBWR colony and immigration of birds from other colonies in New Jersey.

Laughing Gulls arrive at breeding sites from late February in Florida (Dinsmore and Schreiber 1974) to early May in Massachusetts (Bent 1921). First nesting attempts range from mid April in Florida (Dinsmore and Schreiber 1974) to early June in Massachusetts (Nisbet 1976). In New Jersey, first nesting attempts occur in mid May (Bongiorno 1970, Montevecchi et al. 1979), which is comparable to our

observations in the JBWR Laughing Gull colony. Average clutch size for the JBWR colony (2.3/nest) was comparable to those found in other studies (Bent 1921, Chaney et al. 1978, Dinsmore and Schreiber 1974, Kepler 1978, Montevecchi 1978, Schreiber et al. 1979, White et al. 1983). Peak hatching at a Laughing Gull colony in Stone Harbor, NJ occurs in late June (D. Pharo, pers. comm.) which is consistent with our findings in the JBWR colony. Schreiber and Schreiber (1980) reported fledging rates at a colony in Florida as 1.00 chick/pair for two- and three-egg clutches. Hahn (1981) found 2.13 young per pair for three-egg clutches in New Jersey. These are comparable to those found at the JBWR colony in 1990 of 1.08 chicks/pair.

Predation was believed to have caused 3-10% of losses of eggs laid at one Florida colony (Schreiber et al. 1979) and Montevecchi (1977) found 4.4% of the eggs in a New Jersey colony were lost to predators. While we have no data addressing predation in the JBWR as a whole, other than our observations of the effects of feral dogs in 3 of our productivity plots, we do not believe predation was a major factor in loss of eggs or young. Several researchers (Montevecchi 1979, Schreiber et al. 1979, Segre et al. 1968) reported a variety of avian predators of Laughing Gull eggs and young; however, we found no mention of mammalian predators (specifically feral dogs) in the literature. We believe the largest cause of nest loss in the JBWR colony was flooding. Montevecchi (1978) also regarded tidal flooding as

the greatest threat to Laugning Gull nests at Forsythe NWR, NJ.

Movements and Flyovers

Unfortunately, the limited range of transmitters combined with the difficulty of moving through traffic to obtain triangulation on a moving bird prevented us from closely following tagged gulls. However, we did monitor for the presence or absence of radio-tagged birds at all survey sites during all times of the day. Radio-tagged birds were found most often at sites that provided loafing, preening, and drinking opportunities.

We believe the large evening flights observed at the airport represent birds that staged at other sites off the airport and were returning to the colony for the evening. On Cape Cod, MA, Cavanagh and Griffin (1990) found Herring Gulls staged on fresh water ponds and other open areas and left these sites in large flocks as sunset approached. Further, breeding Herring Gulls were observed returning to their colony on Monomoy NWR, for up to one hour after sunset (P. Cavanagh, pers. comm.). We observed similar behaviors for Laughing Gulls returning to the JBWR colony. Further, these flights occurred throughout the summer and, while mean numbers of Laughing Gulls peaked during the 20-40 min prior to sunset, steady, continuous flights were observed beginning approximately 1.5 hours before sunset and continuing for an hour after sunset. This period of approximately one hour either side of sunset seems to be a particularly heavy flight

time for Laughing Gulls returning to the JBWR colony and poses a serious threat to aircraft operating during this period. A major problem associated with evening flights of gulls over JFKIA is that Laughing Gulls tend to fly over the airport at this time of day in large flocks (10-35 birds), whereas earlier in the day we rarely observed more than 2-3 birds flying together (E. Hoopes, pers. obs.).

The reason why other birds accounted for the majortiy of flyovers on all runways in June, but Laughing Gulls accounted for the majority of flyovers in July and August may be due in part to egg-oiling in Joco Marsh. During late June, adults at oiled nests were incubating eggs past the expected hatch date (EHD) and after peak hatching had occurred. We believe adults from treated nests may have abandoned nests in early July and dispersed throughout Jamaica Bay (including JFKIA), thereby accounting for part of this increase (discussed further in effects of egg-oiling). It is also likely that cutting the grass infield areas on JFKIA in August attracted gulls to the airport, therby increasing numbers of flyovers during August. In the future, all grass on JFKIA should be left long at least until after Laughing Gulls migrate out of the area in late September. Several species of passerines were observed nesting and roosting in and on hangers adjacent to the NW end of runway 13L/31R. The reason other bird species account for the high percentage of flyovers on this runway is due to these resident birds. The reason for the fluctuating numbers of other gulls on the parallel 4/22 runways may be due to the numbers of gulls flying in and out

of the water holes located adjacent to the VORTAC between taxiways H and J. These wet areas should be eliminated as recommended by Buckley and Gurien (1987) and Buurma et al. (1989).

Egg-oiling

We hypothesized that oiling eggs would extend the expected hatch date, thereby causing incubating adult birds to remain on eggs longer instead of moving out over the airport in search of food for newly hatched chicks.

We believe the majority of red-marked birds abandoned their nests and, not needing to return to the colony to feed young, began dispersing throughout the area, loafing and feeding at Edgemere, FBF, and on JFKIA. Conversely, green-marked birds were presumably still feeding chicks. Considering the natural diet of young gulls, we believe gulls attending young probably foraged predominantly in Jamaica Bay and other natural areas thereby reducing the potential to be seen at the airport and Edgemere. Further, parent birds would be continually returning to the colony instead of loafing on JFKIA and at Edgemere.

However, caution is advised in interpreting these data. Numbers of green-marked birds may have been too small to reflect accurate distribution information. Further, green dye was not water soluble and did not stain breast feathers as extensively as the red dye. The green dye may also have been more difficult to detect when birds were in grassy areas.

In operational spraying of Ring-billed and Herring Gull eggs in Ontario, nearly 100% efficacy was achieved when four to six sprayings were applied throughout the incubation period (H. Bloekpol, pers. comm.). While the logistical constraints of working in a marsh prevent this intensity of spraying, we believe that the spraying efficacy (64.5% in the JBWR colony) could be increased substantially by spraying at least twice in the incubation period, but before starring occurs.

Areas on and around JFKIA attractive to Gulls

There were 3 basic reasons gulls were attracted to sites on or around JFKIA: 1) a food source was available, 2) a source of fresh, clean water was available, or 3) a site provided a good loafing area. Many sites met more than one of these criteria.

Several studies have investigated optimal grass lengths for bird control at airports. At Montreal International Airport, significantly fewer birds were found in grass taller than 15 cm (Blokpoel 1976). Other studies in Canada suggest an optimal grass height of 10-20 cm (Canada Transport 1973). Boulter et al. (1973) and Compton et al. (1973) recommend grass heights of 10-15 cm or 20-30 cm, depending on grass species. Brough and Bridgman (1980) reported long grass (14-15 cm) reduced bird numbers in general by two-thirds compared to short grass and that this effect was most significant for gulls. Similarly, at JFKIA, Buckley and Gurien (1987) found taller grass significantly reduced the number of gulls in

grass infield areas, and they found significantly greater numbers of Laughing Gulls occurred in short grass than in tall grass.

Our observations of gulls at JFKIA indicated that grassy areas were primarily used for feeding and to a lesser extent loafing. Gulls generally avoid tall grass for feeding because it restricts their access to prey and obstructs visibility for detecting predators (Blokpoel 1976, Brough and Bridgman 1980). However, the major problem of feeding gulls comes from the grass areas within the non-operational areas of JFKIA such as along the Van Wyck Expressway, where grass is mowed throughout the summer. Laughing Gulls in these areas apparently were feeding on Lightningbugs (Lampyridae) and probably other invertebrates. Airport managers must establish and maintain suitable vegetative cover to discourage bird use throughout JFKIA, including both operational and non-operational areas as recommended by Buurma et al. (1989).

Street-side terminal areas also provided opportunities for foraging gulls (mostly Laughing and Ring-billed). The most serious gull management problem in this area result from refuse (i.e., food scraps) left at taxi stands by taxi drivers. Taxi drivers were frequently observed feeding gulls and Rock Doves. This problem could be corrected by not allowing taxi drivers to feed birds while waiting for fares and ensuring that taxi stands remain free of refuse. Similarly, all dumpsters should be kept closed tightly. Airport management must ensure that all edible waste is inaccessible to birds on the airport (Buurma et al. 1989).

Seasonal outbreaks of insects contributed to large feeding flocks of gulls on JFKIA in August, and Laughing Gulls on JFKIA were observed occasionally feeding on beetles in June and July. The Port Authority should seek to reduce these insect outbreaks in a sensible, environmentally sound manner.

Several authors have suggested that a major attractant to birds at airports are water puddles that form after rain (Buckley and Gurien 1987, Murton 1971, and Solman 1978). These ponded areas are used by gulls and other birds for drinking and bathing. Laughing Gulls possess glands for excreting accumulated salt, adults can survive for extended periods of time on full salt water (Harriman 1967), but prefer freshwater when it is available (Buckley and Gurien 1987, Zale and Mulholland 1985). This is very important for coastal airports like JFKIA where availability of freshwater is limited and large numbers of gulls occur. A factor further compounding this problem at JFKIA is that runways and taxiways are suitable loafing sites as well.

Several problems were observed at JFKIA that need to be corrected. The water holes and depressions that cause pooling around the VORTAC must be eliminated. These areas should also be vegetated or the sand/dirt fill will be used for loafing. This also applies to the water holes in the vicinity of the middle marker for runway 31R. Action should also be taken to eliminate the numerous small, temporary puddles that occur throughout the airport following heavy rain showers. Following the recommendations of Buurma et al.

(1989), all larger puddles (i.e., those that persist for more than 24 hours after a rain) should be channeled to storm sewers to hasten draining.

The Jamaica Sewage Treatment Plant is an unacceptable attractant, providing food, water, and loafing sites to Laughing Gulls. Future work needs to examine potential methods for significantly decreasing or eliminating Laughing Gull use of this site. For example, the use and effectiveness of monofilament grids strung over all the settling tanks may possibly eliminate gulls from the plant.

Aqueduct Race Track also provides feeding, drinking and loafing sites for all resident gull species. This site may prove a more valuable site to gulls than our data suggest based on the large numbers of gulls observed flying out of the track at sunset. We believe the main reason gulls are attracted to the track is for the freshwater and loafing sites provided on the infield and reflecting pools. Some reduction in gull numbers may occur if the reflecting pools were not allowed to fill with water, but to be fully effective, grass height would also need to be tall.

Edgemere Landfill poses an unacceptable attractant to gulls. Gulls use this area primarily for feeding and resting and, to a lesser extent, for drinking when puddles form after a rain storm. Buurma et al. (1989) observed that after the crash of a DC10 ONA flight in November 1975, the National Transportation Safety Board (NTSB) recommended closure of all neighboring landfills (NTSB 1976). While closure of two of

the three landfills operating in the JFKIA area has been completed, Edgemere continues to operate. Edgemere Landfill must be closed as soon as possible and then vegetated so it will not attract gulls as a loafing site.

Taxiways and inactive runways on JFKIA were often used by gulls for loafing. Buckley and Gurien (1987) found Laughing Gulls were loafing on taxiways and runways associated with puddles. One area we frequently observed gulls loafing was on the concrete apron around the approach end of runway 4L. Other than increased harassment, little can be done to dissuade gulls from loafing on these areas. JFKIA maintains a bird dispersal unit between 0600 h and 2200 h each day that is responsible for harassing birds that congregate on JFKIA. We believe continual harassment and an increase in number of personnel assigned to each shift of the bird dispersal unit is the most effective way of preventing gulls from congregating on runways and taxiways.

MAJOR CONCLUSIONS

1. A variety of bird species utilize JFK Airport. Laughing Gulls accounted for nearly 50% of all birds occurring on the airport from June to September, 1990. However, Laughing Gulls should not be considered the only problem species on the airport.
2. Laughing Gulls, and other gull species, spent a majority of their time on the airport involved in maintenance behaviors and only 21% in feeding behaviors.
3. Numbers of birds found dead on the airport, thus potential bird-plane interactions, have varied between months and years. Numbers of Laughing Gulls found dead on JFKIA have increased dramatically since 1980.
4. Stomach content analysis of adult and hatching year Laughing Gulls found dead on the airport reflect largely natural diets. Refuse accounted for less than 10% by occurrence of gull diets.
5. Over 7,600 pairs of Laughing Gulls nested in Jamaica Bay adjacent to the airport in 1990. Further, Jamaica Bay attracts many non-breeding Laughing Gulls and other gull species.
6. Oiling eggs resulted in a 64.5% efficacy in reducing hatchability. Best results occurred when oil was applied late in incubation (within two weeks of hatching) but before eggs were starred. We believe recruitment from within the colony could be decreased to near zero if all nests were sprayed at least twice late in incubation.

7. Observations in the colony and frequency of sightings of red-marked gulls suggest that adults of oiled nests stayed at the nest site initially. However, within 7-10 days after expected hatch date, these birds began flying over the airport and adjacent sites (e.g., Edgemere). The frequency of green-marked birds from non-oiled nests was low at these sites. We suggest that these adults were most likely foraging for natural foods in Jamaica Bay, feeding young regularly, and thereby reducing the frequency of their occurrence at JFKIA.

8. There was no evidence that oiling reduced the total number of Laughing Gull flyovers at JFKIA. However, numbers of red-marked Laughing Gulls found dead on JFKIA were reduced by 50% after peak-hatch (20 June). This reduction was probably due to nest abandonment by adults at oiled nests, thereby reducing the potential for their occurrence at JFKIA. We believe that many of these birds probably abandoned the Jamaica Bay area, as suggested by the extra-limital sightings of red-marked gulls.

9. A reduction in the size of the Jamaica Bay gull colony over time will reduce numbers of birds found dead and potential for bird-plane interactions at JFKIA, considering historical trends in colony size and numbers of birds found dead. Additionally, reductions in Laughing Gull productivity by egg-oiling in the Jamaica Bay colony and its subsequent effect on gull behavior will also reduce the number of birds found dead at JFKIA and the potential for bird-plane interactions.

10. Considering the need to reduce the numbers and probability of bird-plane interactions at JFKIA and the efficacy, logistical and permitting constraints of other gull management options, we recommend that a 100% egg-oiling program be initiated in the JBWR Laughing Gull colony.
11. There are numerous instances of standing water (i.e., water holes, puddles) in all areas (operational and non-operational) of JFKIA that are attractive to gulls and other species of birds.
12. Portions of infield areas on the operational areas of the airport are not vegetated and may potentially attract gulls.
13. Extensive areas of short grass exist in the non-operational areas of JFKIA (e.g., along the Van Wyck Expressway). These areas are a major gull attractant.
14. Both the Jamaica Sewage Treatment Plant and Edgemere Landfill are feeding and loafing sites for several gull species and serve as gull attractants.

MANAGEMENT RECOMMENDATIONS

1. Airport management should initiate a program of 100% tall grass on all operational and non-operational areas of JFKIA.
2. All water puddles on JFKIA must be eliminated. Notably, wet areas between taxiways H and J and by the 31R middle marker should have the highest priorities for immediate elimination.
3. Numbers of Laughing Gulls feeding along the Van Wyck Expressway must be reduced. Gulls are attracted to these areas and research must be conducted to determine the best way to eliminate gulls from these areas.
4. Edgemere Landfill should be closed as soon as possible. This landfill is a major attractant to gulls.
5. The potential attractions of Aqueduct Race Track should be addressed and corrected.
6. The Aqueduct may be more important to gulls as a major evening staging area. Future work should examine this closely.
7. The Jamaica Sewage Treatment Plant is an unacceptable attractant to gulls, especially Laughing Gulls, and methods such as wire strung over all settling tanks should be examined as a possible means to prevent and eliminate gull use of the Plant.
8. Information needs to be collected on numbers, distribution, and habitat requirements of island-nesting bird species nesting on JBWR in close proximity to JFKIA.

9. Current bird deterrant methods at the airport should be expanded (i.e., harassment by the bird dispersal unit). Other bird deterent methods (i.e., shooting) need to be investigated.
10. Birds loafing on JFKIA must be continually and immediately harassed to reduce their occurrence.
11. Airport management should expand the number of personnel on bird dispersal units.
12. JFKIA should accelerate the draining of large depressions that fill with rain water to reduce the availability of water on the airport.
13. All dumpsters on or around the airport should be kept closed at all times, and policed.
14. Taxi stands in the street-side terminal area should be cleaned as often as is neccessary to eliminate all sources of food scraps from these areas.
15. Feeding of any birds at taxi stands, airport construction sites, etc., should be eliminated as this may act as an attractant to gulls. Violators should be fined.
16. The potential for bird-aircraft interactions at JFKIA would be lowered if the numbers of Laughing Gulls nesting on Joco Marsh were reduced.
17. Numbers of Laughing Gulls nesting on Joco Marsh could be reduced in several ways. One feasible method would be through initiation of a multi-year oiling program. Best results would be realized by conducting 2 sprayings between days 14 and 24 in the incubation period if political and logistical constraints permit.

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Figure 1. Map of JFKIA in relation to Greater New York City.

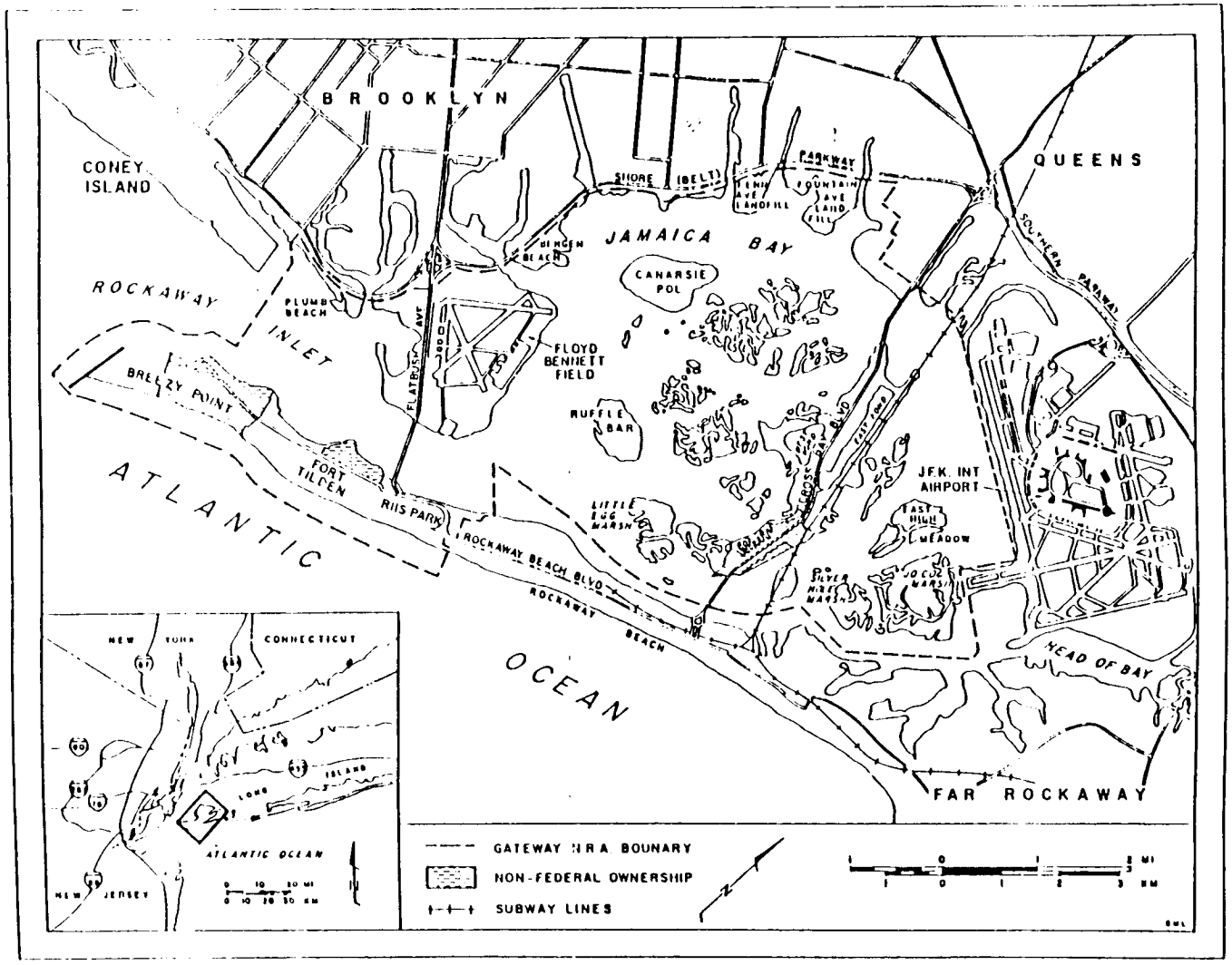
BROOKLYN
QUEENS
CONEY ISLAND
JAMAICA BAY
ROCKAWAY INLET
PLUMB BEACH
BREEZY POINT
FORT TILDEN
RIIS PARK
FLOYD BENNETT FIELD
CANARSIE POL
RUFFLE BAR
LITTLE BOG MARSH
JFK INT AIRPORT
EAST HIGH MEADOW
ROCKAWAY BEACH BLVD
ROCKAWAY BEACH
ATLANTIC OCEAN
HEAD OF BAY
FAR ROCKAWAY
SOUTHERN PARKWAY
NEW YORK
CONNECTICUT
NEW JERSEY
LONG ISLAND
GATEWAY NRA BOUNARY
NON-FEDERAL OWNERSHIP
SUBWAY LINES

Figure 2. Map of the street-side survey areas, JFK Airport, 1990. A) Terminal area, B) Cargo Area, and C) Van Wyck Area.

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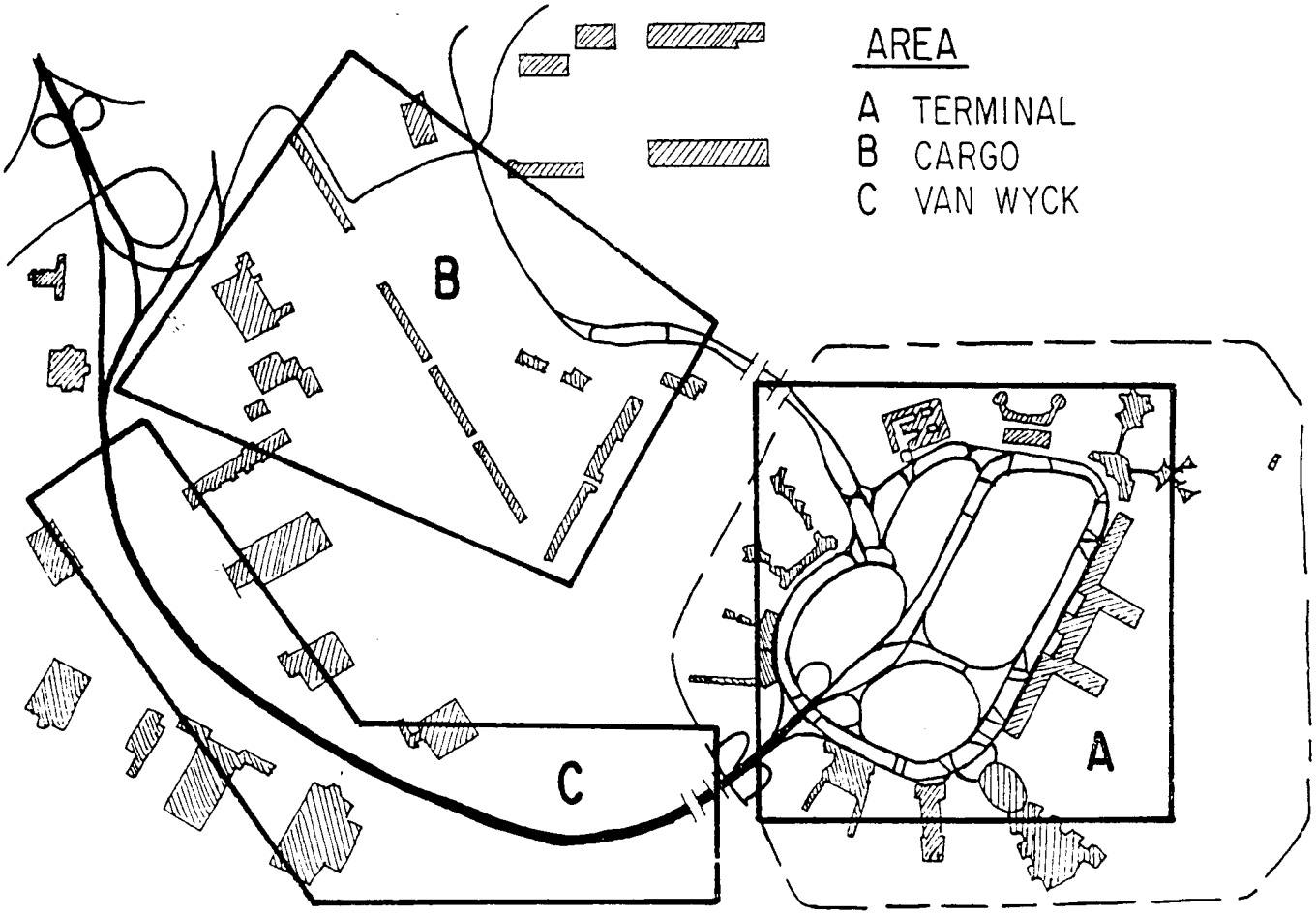
AREA
A TERMINAL
B CARGO
C VAN WYCK
B
C
A

Figure 3. Map of operational (runway and taxiway) and non-operational systems on JFKIA.

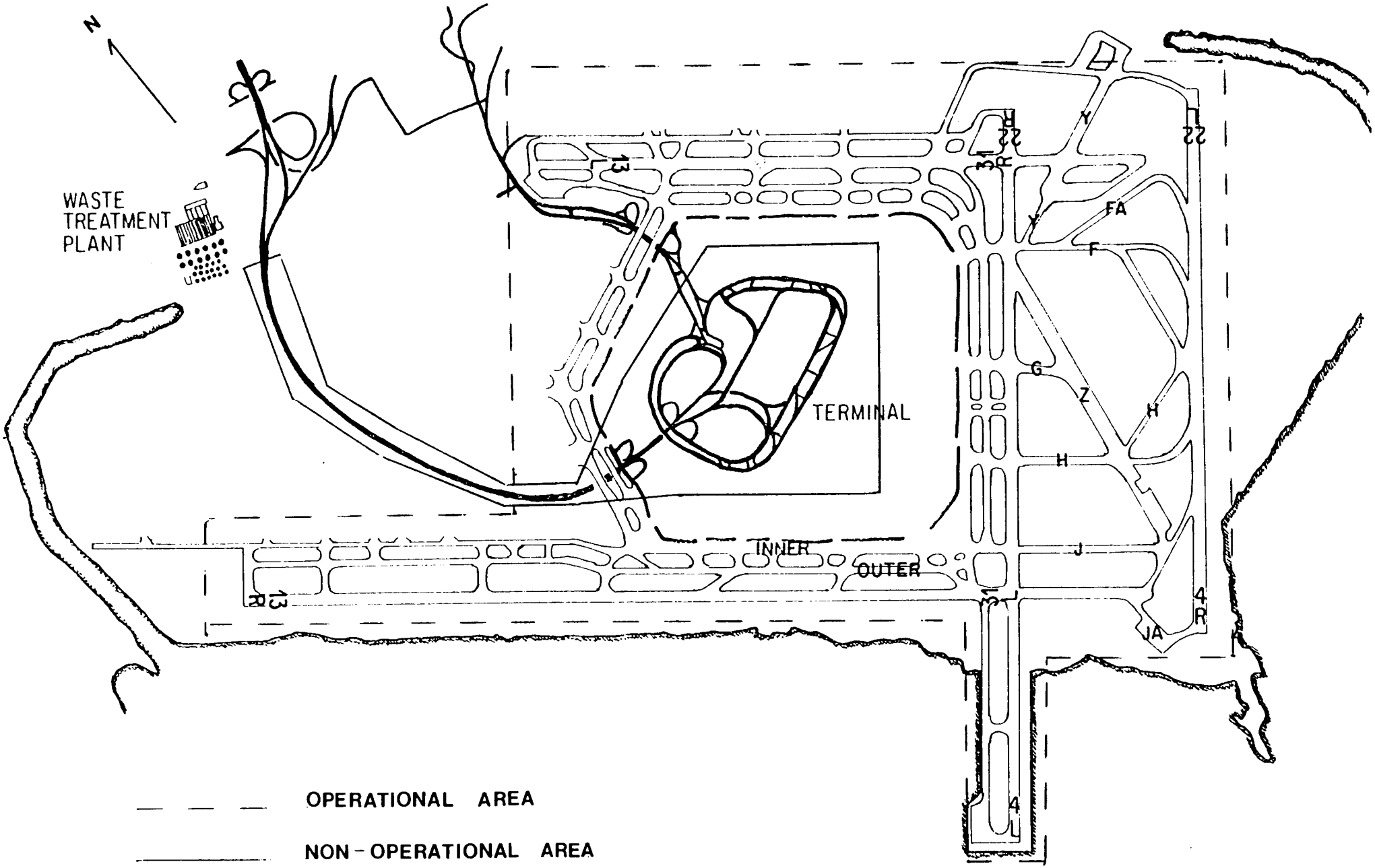
N
WASTE
TREATMENT
PLANT
TERMINAL
INNER
OUTER
13
22
31
4
FA
F
G
Z
H
J
JA
OPERATIONAL AREA
NON-OPERATIONAL AREA

Figure 4. Percent of birds found dead at JFKIA, by runway, 1990. (N = number of carcasses collected)

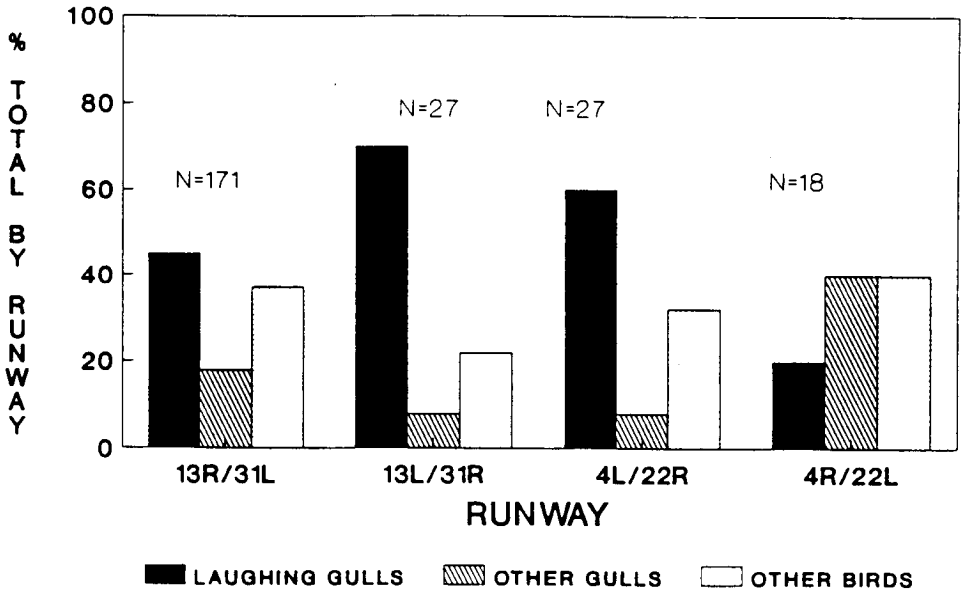
100
80
60
40
20
0
% TOTAL BY RUNWAY
N=171
N=27
N=27
N=18
13R/31L
13L/31R
4L/22R
4R/22L
RUNWAY
LAUGHING GULLS
OTHER GULLS
OTHER BIRDS

Figure 5. Distribution of Laughing Gull sub-colonies, Jamaica Bay, 1990. (Shaded areas indicate largest concentrations of gull nests)

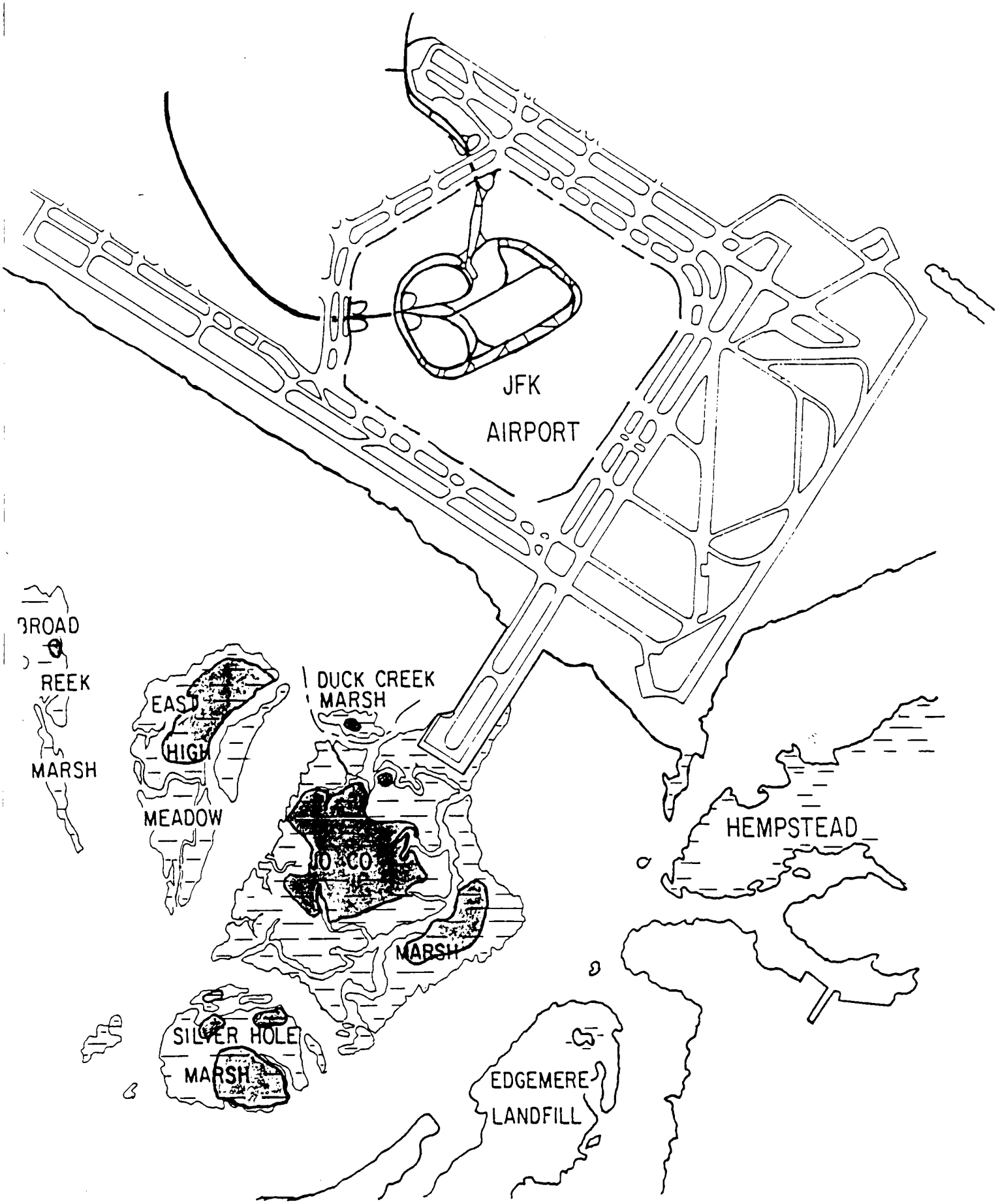
JFK
AIRPORT
BROAD
REEK
MARSH
EAST
HIGH
MEADOW
DUCK CREEK
MARSH
JO CO
MARSH
HEMPSTEAD
SILVER HOLE
MARSH
EDGEMERE
LANDFILL

Figure 6. Mean number of Laughing Gulls observed flying over JFKIA in the three hours before sunset, Summer 1990 (June N = 2, July N = 4, August N = 4).

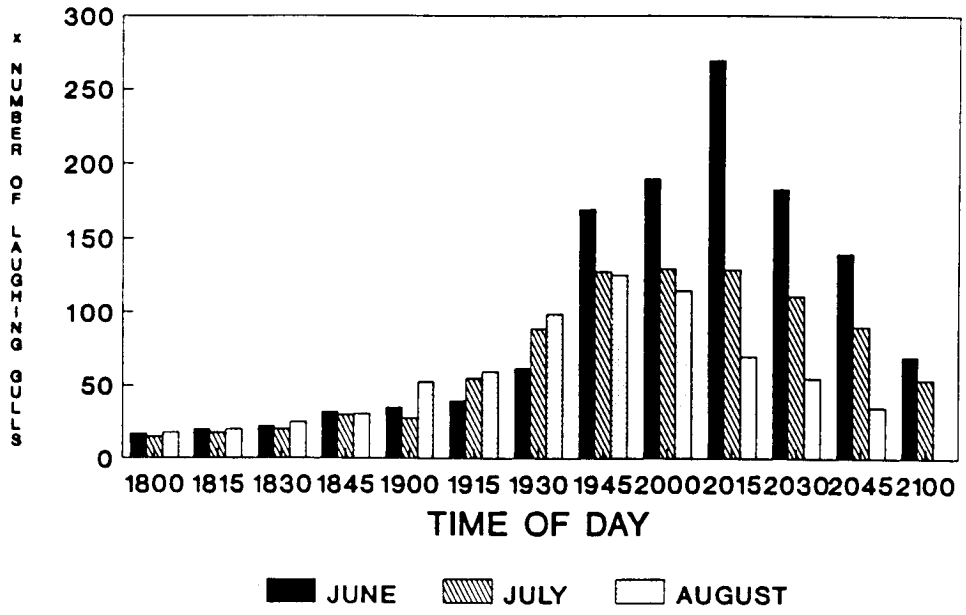
x NUMBER OF LAUGHING GULLS
300
250
200
150
100
50
0
1800 1815 1830 1845 1900 1915 1930 1945 2000 2015 2030 2045 2100
TIME OF DAY
JUNE
JULY
AUGUST

Figure 7. Map of bird attractants (shaded) observed on JFKIA, summer 1990.

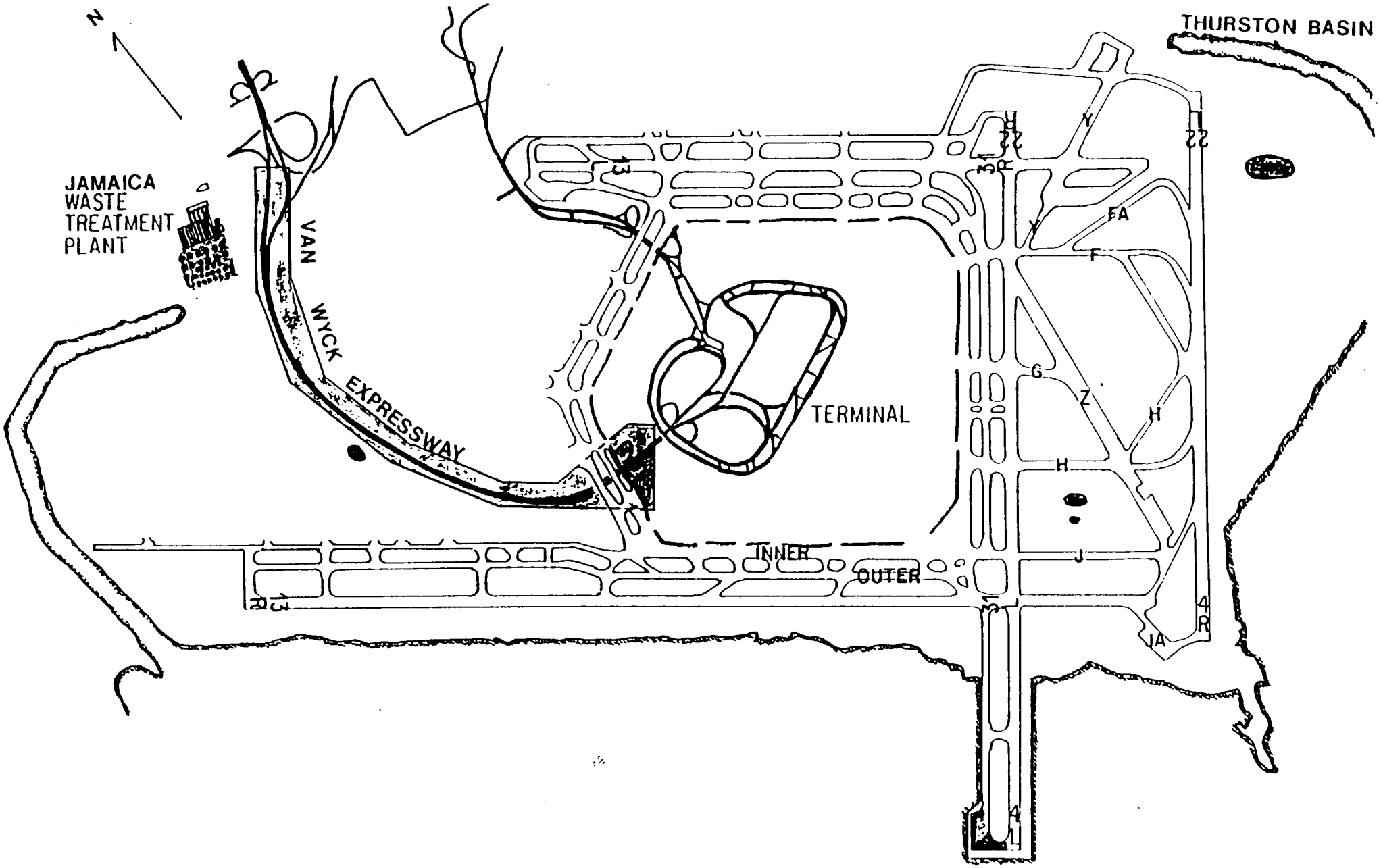
N
THURSTON BASIN
JAMAICA
WASTE
TREATMENT
PLANT
VAN
WYCK
EXPRESSWAY
TERMINAL
INNER
OUTER
22
13
31
4R
4L
JA
FA
F
G
Z
H
J

Figure 8. Map showing location of feeding flocks of Laughing Gulls observed on 24 and 25 August 1990.

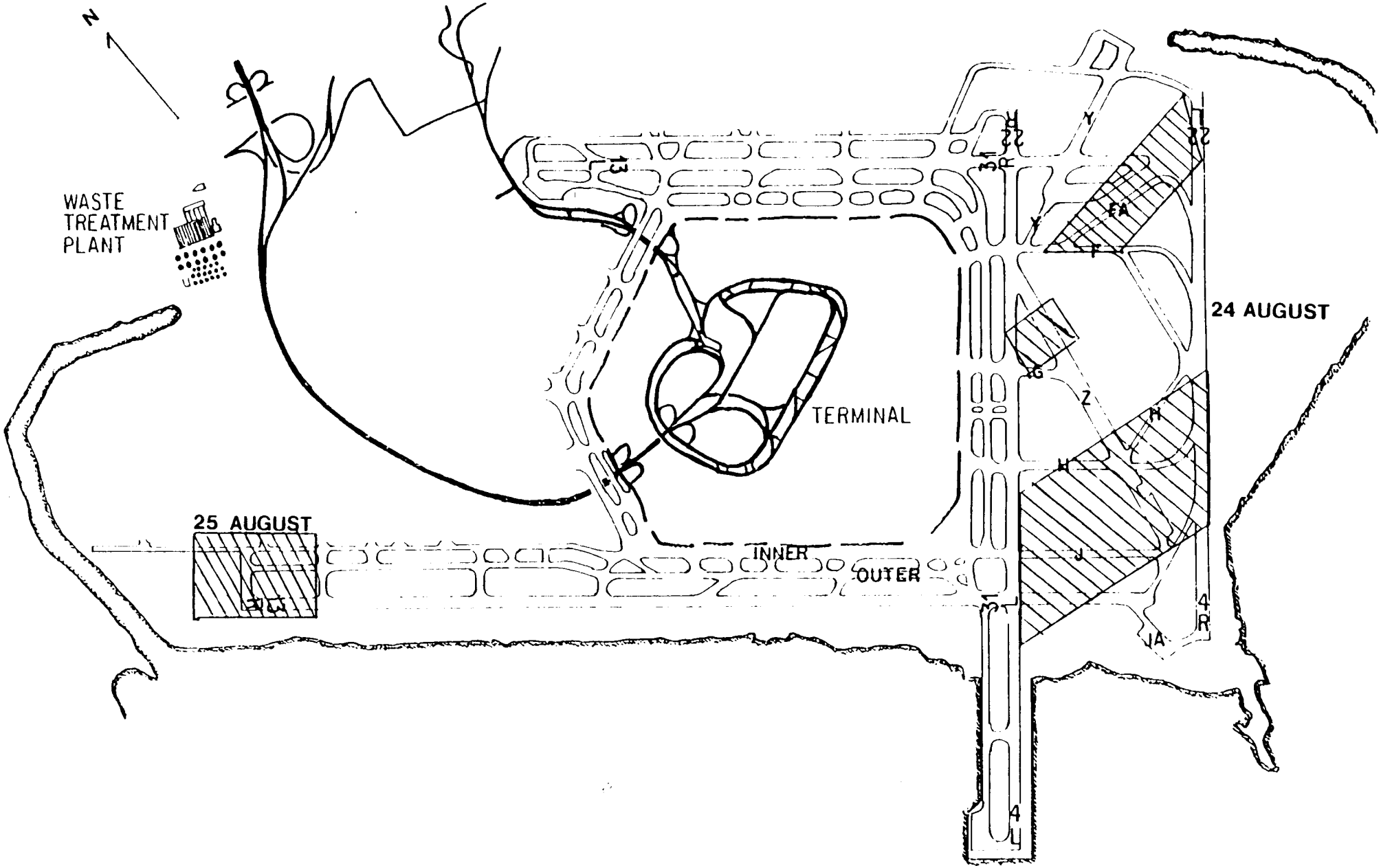
N
WASTE
TREATMENT
PLANT
13
TERMINAL
24 AUGUST
25 AUGUST
INNER
OUTER
EA
G
Z
H
J
JA
4R
4L

Figure 9. Map showing location and movement of a feeding flock of Laughing Gulls observed at 1800 h on 25 August 1990, at JFKIA.

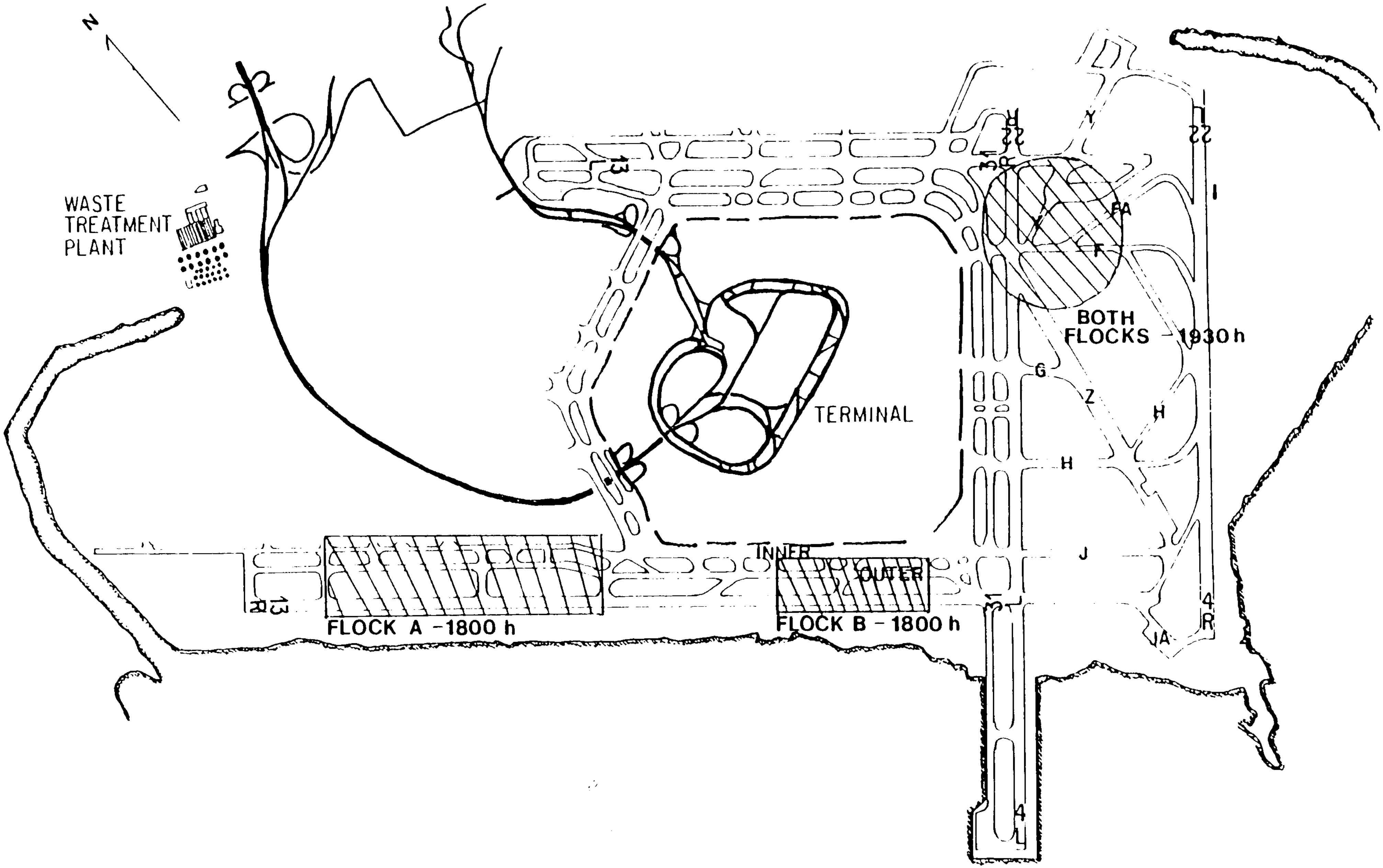
N
WASTE
TREATMENT
PLANT
BOTH
FLOCKS - 1930 h
TERMINAL
INNER
OUTER
FLOCK A -1800 h
FLOCK B - 1800 h
13
13R
22
22R
4R
4L
FA
F
G
Z
H
J
JA
Y
I

Table 1. Categories of species observed on or flying over JFKIA, summer 1990.

Category	Common Name	Latin Name
Laughing Gull		
	Laughing Gull	*Larus atricilla*
Other Gulls		
	Herring Gull	*L. argentatus*
	Great Black-backed Gull	*L. marinus*
	Ring-billed Gull	*L. delawarensis*
Other Birds		
	Snowy Egret	*Egretta thula*
	Great Egret	*Casmerodius albus*
	Cattle Egret	*Bubulcus ibis*
	Glossy Ibis	*Plegadis falcinellus*
	Dbl.-crested Cormorant	*Phalacrocorax auritus*
	Mallard	*Anas platyrynchos*
	Black Duck	*A. rubripes*
	Wood Duck	*Aix sponsa*
	Canada Goose	*Branta canadensis*
	Am. Oystercatcher	*Haematopus palliatus*
	American Golden-Plover	*Pluvialis dominica*
	Killdeer	*Charadrius vociferus*
	Am. Woodcock	*Scolopax minor*
	Upland Sandpiper	*Bartramia longicauda*
	Common Tern	*Sterna hirundo*
	American Kestral	*Falco sparverius*
	Northern Harrier	*Circus cyaneus*
	Osprey	*Pandion haliaetus*
	Ring-necked Pheasant	*Phasianus colchicus*
	Rock Dove	*Columba livia*
	Mourning Dove	*Zenaida macroura*
	Common Barn-Owl	*Tyto alba*
	Horned Lark	*Eromophila alpestris*
	Barn Swallow	*Hirundo rustica*
	American Crow	*Corvus brachyrhyncos*
	N. Mockingbird	*Mimus polyglottos*
	European Starling	*Sturnus vulgaris*
	Grasshopper Sparrow	*Ammodramus savannarum*
	Field Sparrow	*Spizella pusilla*
	House Sparrow	*Passer domesticus*
	Eastern Meadowlark	*Sturnella magna*
	Red-winged Blackbird	*Aegelaius phoeniceus*
	Common Grackle	*Quiscalus quiscula*

Table 2. Mean numbers of gulls and other birds per survey using JFK Airport, June through September, 1990.

Month	Laughing Gulls $\bar{x}$ (Range)	Other Gulls $\bar{x}$ (Range)	Other birds $\bar{x}$ (Range)
June	56.0 (1-273)	9.8 (1-33)	55.2 (21-151)
July	6.9 (0-87)	11.7 (1-37)	39.0 (14-116)
August	1.3 (0-92)	2.7 (1-49)	50.0 (19-234)
September	4.5 (1-101)	8.3 (0-56)	36.3 (19-271)

Table 3. Mean numbers of Laughing Gulls and other gulls per survey using non-operational areas, June through September, 1990.

Month	Terminal Area LAGU[1] $\bar{x}$ (Range)	Terminal Area Other[2] $\bar{x}$ (Range)	Cargo Area LAGU $\bar{x}$ (Range)	Cargo Area Other $\bar{x}$ (Range)	Van Wyck LAGU[3] $\bar{x}$ (Range)	Van Wyck Other $\bar{x}$ (Range)
June	17 (1-37)	14 (0-39)	6 (0-15)	6 (0-17)	64 (5-320)	49 (7-103
July	10 (1-21)	11 (1-30)	10 (1-22)	12 (1-31)	40 (1-290)	47 (0-164
August	10 (1-21)	15 (1-47)	12 (1-37)	12 (1-52)	40 (1-95)	51 (1-109
September	8 (1-16)	13 (0-31)	10 (1-39)	12 (1-57)	30 (1-107)	44 (1-98)

1 LAGU = Laughing Gull
2 Other = all gulls, other than LAGU, observed.
3 means are significantly different at $P < 0.05$

Table 4. Mean numbers of Laughing and Herring Gulls and total gulls per survey using Aqueduct Race Track, June through September, 1990.

Month	[1] LAGU $\bar{x}$ (Range)	[2] HEGU $\bar{x}$ (Range)	[3] Total $\bar{x}$ (Range)
June	185.2 (1-317)	66.4 (1-279)	221 (1-513)
July	153.5 (1-323)	86.2 (1-417)	248 (1-473)
August	45.2 (1-256)	71.4 (1-203)	142 (1-267)
September	40.1 (0-117)	80.1 (1-215)	123 (1-257)

1 LAGU = Laughing Gull
2 HEGU = Herring Gull
3 Total = all gulls observed

Table 5. Mean numbers of Laughing and Herring Gulls and total gulls per survey using Floyd Bennett Field, June through September, 1990.

Month	[1] LAGU $\bar{x}$ (Range)	[2] HEGU $\bar{x}$ (Range)	[3] Total $\bar{x}$ (Range)
June	50.9 (1-154)	74.0 (1-263)	123.7 (1-291)
July	83.9 (1-221)	147.3 (1-378)	154.7 (1-416)
August	28.1 (1-163)	153.1 (1-322)	159.4 (1-457)
September	19.0 (1-800)	87.4 (1-600)	137.4 (1-901)

1 LAGU = Laughing Gull
2 HEGU = Herring Gull
3 Total = all gulls observed

Table 6. Mean numbers of Laughing and Herring Gulls and total gulls per survey using Edgemere Landfil, June through September, 1990.

Month	1 LAGU $\bar{x}$ (Range)	2 HEGU $\bar{x}$ (Range)	3 Total $\bar{x}$ (Range)
June	154.6 (27-303)	681.2 (101-916)	1269 (127-2000)
July	206.7 (68-431)	686.7 (200-1,016)	929 (314-3047)
August	742.2 (192-1,329)	1379.8 (246-2,397)	2115 (521-3561)
September	681.7 (207-921)	1231.3 (292-1,893)	1912 (322-2967)

1 LAGU = Laughing Gull
2 HEGU = Herring Gull
3 Total = all gulls observed

Table 7. Percent time spent in various activities[1] of four species of gulls on JFK Airport runways, taxiways, and infield areas, by month, 1990.

Species/Month	Feed	Walk	Maint.	Other[2]
Laughing				
June	28	1	66	5
July	31	0	65	4
August	50	0	50	0
Herring				
June	15	1	77	7
July	16	0	83	1
August	29	0	67	4
Ring-billed				
June	0	22	78	0
July	10	0	90	0
August	0	0	100	0
Grt. Black-backed				
June	0	0	0	0
July	6	0	94	0
August	0	0	100	0

1 Does not include gulls flying over airport
2 Inter- and intra-specific defense and other agonistic behaviors

Table 8. Birds found dead at JFK Airport, June through September, 1980-1990.*

Year	June	July	August	September
1980	24	8	16	11
1981	25	9	7	14
1982	21	5	18	13
1983	52	26	22	16
1984	43	34	47	44
1985	65	47	44	62
1986	48	12	18	3
1987	50	78	24	16
1988	101	64	47	44
1989	113	61	62	23
1990	82	55	59	12
Total	624	399	364	258

* Data provided by Richard Dolbeer and Sammy Chevalier

Table 9. Pearson correlations between numbers of birds found dead and total aircraft operations at JFKIA, 1980-1990.

Year	Total Bird Deaths	Total Laughing Gull Deaths	Total Other Gull Deaths	Total Aircraft Operations
1980	161	16	111	268,653
1981	123	20	61	251,672
1982	150	13	73	252,371
1983	211	51	97	262,696
1984	289	59	139	273,787
1985	387	85	200	254,736
1986	151	60	44	249,647
1987	248	129	83	259,523
1988	375	175	160	279,908
1989	371	164	168	280,356
1990	243	118	40	283,748
r	0.546	0.636	0.290	

Table 10. Pearson correlations between number of Laughing Gulls found dead on JFKIA and number of operations (ops.) at JFKIA, May through September, 1980-1989.

	Year									
Month	80	81	82	83	84	85	86	87	88	89
May (r = 0.474, NS*)										
Ops. (x1000)	22.4	21.4	21.1	21.8	23.5	22.5	20.8	21.7	23.3	23.6
Deaths	0	1	0	1	1	1	3	6	5	22
June (r = 0.463, NS)										
Ops. (x1000)	22.8	21.9	21.8	22.3	24.1	22.6	21.1	22.3	24.3	23.2
Deaths	7	17	9	23	22	36	39	40	88	93
July (r = 0.446, NS)										
Ops. (x1000)	24.5	23.6	23.2	24.5	25.8	24.2	22.3	24.0	25.8	25.2
Deaths	1	2	1	16	19	18	7	72	57	37
August (r = 0.589, NS)										
Ops. (x1000)	24.4	21.2	23.6	24.7	26.1	24.3	23.2	24.5	25.8	25.2
Deaths	4	0	3	7	10	24	10	14	28	29
September (r = 0.566, NS)										
Ops. (x1000)	22.0	20.2	21.5	22.8	23.7	21.4	21.1	22.5	23.8	23.9
Deaths	4	0	0	4	7	6	1	3	2	5

* NS = Not significant, P > 0.05

Table 11. Pearson correlations between number of Laughing Gulls found dead on JFKIA and number of nesting Laughing Gulls in JBWR colony, 1979-1990.

Year	No. of Laughing Gulls Found Dead[1]	No. Laughing Gull Nests	Source
1979	1	15	Post & Riepe 1980
1980	16	235	Buckley & Gurien 1987
1981	20	325	" "
1982	13	715	" "
1983	51	1805	" "
1984	59	2802	" "
1985	85	2741	" "
1990	117	7629	this study

$r = 0.935$, $P < 0.001$

1 Data provided by R. Dolbeer

Table 12. Species, sex, and numbers of birds found dead on JFK Airport, June through September, 1990.

Age/Sex	Species				
	Laughing Gull	Herring Gull	Grt. Blk.-bkd. Gull		Other birds
Adult					
Male	20	2	0		3
Female	12	1	0		8
Unknown	51	2	1		13
Second Hatching Year					
Male	0	1	0		0
Female	0	0	0		0
Unknown	0	1	1		1
After Hatching Year					
Male	2	3	0		0
Female	1	0	1		0
Unknown	9	4	0		2
Fledglings					
Sex Unknown	18	0	0		0
Total	113	14	3		27

Table 13. Numbers and breeding status of gulls and other birds found dead on JFK Airport, June through September, 1990.

Month/ Breeding status	Species			
	Laughing Gull	Herring Gull	Grt. Blk.-bkd. Gull	Other birds
June				
Breeding	21	2	0	1
Non-breeding	7	2	1	7
Unknown	22	2	0	12
July				
Breeding	7	1	0	4
Non-breeding	5	4	0	1
Unknown	28	0	0	8
August				
Breeding	0	0	0	0
Non-breeding	17	2	2	2
Unknown	1	1	0	2
September				
Breeding	0	0	0	0
Non-breeding	5	0	0	0
Unknown	0	0	0	7
Total	113	14	3	44

Table 14. Frequency of occurrence of food items found in adult Laughing Gull stomachs, summer 1990.

Food Item	% Occurrence
Insects	
Unidentifiable parts	6.4
Green June Beetle	5.3
Grasshopper spp.	5.3
Japanese Beetle	2.7
Carpenter Ant	2.7
Black Ant	1.6
Weevil	1.6
Oriental Beetle	1.1
Leaf Beetle	1.1
Earwig	1.1
Rove Beetle	0.5
Field cricket	0.5
Unidentified Hymenoptera	0.5
Dragonfly	0.5
subtotal	30.9
Arachnids	
Horseshoe crab (eggs)	1.1
Unidentifiable spider	0.5
subtotal	1.6
Fishes	
Unidentifiable parts	2.1
Northern pipefish	1.1
Atlantic silversides	0.5
Snapper bluefish	0.5
subtotal	4.2
Crusteceans	
Hippolytid shrimp	2.1
Crab spp.	0.5
subtotal	2.6
Miscellaneous	
Unident. digested matter	19.4
Vegetation	10.9
Shell	1.1
subtotal	31.4

Table 14 (Cont'd). Frequency of occurrence of food items found in adult Laughing Gull stomachs, summer 1990.

Food Item	% Occurrence
Inorganic items	
Pebbles	15.5
Glass	5.3
Sand	0.5
subtotal	21.3
Refuse	
Chicken	5.3
Plastic	1.1
Onions	0.5
Nuts	0.5
Aluminum foil	0.5
subtotal	7.9
Total	99.9

Table 15. Frequency of occurrence of food items found in immature Laughing Gull stomachs, summer 1990.

Food Item	% Occurrence
Insects	
Unidentifiable parts	3.0
Unidentifiable Coleoptera	3.0
Carpenter Ant	3.0
subtotal	9.0
Arachnids	
Horseshoe crab (eggs)	3.0
subtotal	3.0
Miscellaneous	
Vegetation	28.2
Unident. digested matter	23.1
Shell	6.1
subtotal	58.4
Inorganics	
Pebbles	14.4
Glass	6.1
subtotal	20.5
Refuse	
Plastic	6.1
Rubber/latex	3.0
subtotal	9.1
Total	99.0

Table 16. Nest counts by location for Laughing Gulls, Jamaica Bay, 1990.

Sub-colony	No. Nests	% Total Nests
Joco Marsh	5,293	69.4
Silver Hole Marsh	1,510	19.8
East High Meadow	653	8.6
Joco East Island	123	1.6
Broad Creek Marsh Duck Creek Marsh	< 50	0.6
Total	7,629	100.0

Table 17. Laughing Gull productivity, in study plots, Jamaica Bay, 1990.

Plot No.	No. Nests	No. Hatched	No. Fledged	Productivity
1	11	0	0	0.00*
2	10	0	0	0.00*
3	10	0	0	0.00*
4	10	10	10	1.00
5	11	9	6	0.55
6	13	17	17	1.31
7	14	23	19	1.36
Total (all 7 plots)	79	59	52	0.65
Total (plots 4-7)	48	59	52	1.08

* Feral dog predation.

Table 18. Number of flyovers at JFKIA by runway, month, and group, summer 1990.

Month/Group	Runway					
	13R/31L	4L Ext.	4L/22R	4R/22L	13L/31R	Total
June						
LAGU[1]	395	86	37	82	38	708
GULL[2]	19	9	4	17	7	56
OTHER[3]	587	150	205	149	248	1,339
Subtotal	1,001	245	246	248	363	2,103
July						
LAGU	1,588	325	198	376	532	3,019
GULL	141	43	26	148	69	427
OTHER	317	143	247	133	464	1,304
Subtotal	2,046	511	471	657	1,065	4,750
August						
LAGU	788	86	166	264	270	1,574
GULL	125	38	14	29	48	254
OTHER	116	52	18	91	259	536
Subtotal	1,029	176	198	384	577	2,364
September						
LAGU	383	127	49	97	147	803
GULL	31	15	6	12	6	70
OTHER	397	172	200	191	261	1,221
Subtotal	811	314	255	300	414	2,094

1 LAGU = Laughing Gull
2 GULL = Other gull
3 OTHER = Other birds

Table 18 (Cont'd). Number of flyovers at JFKIA by runway, month, and group, summer 1990.

Month/Group	Runway 13R/31L	4L Ext.	4L/22R	4R/22L	13L/31R	Total
Subtotal LAGU	3,154	624	450	819	1,057	6,104
Subtotal GULL	316	105	50	206	130	807
Subtotal OTHER	1,417	517	670	564	1,232	4,400
TOTAL	4,887	1,246	1,170	1,589	2,419	11,311

1 LAGU = Laughing Gull
2 GULL = Other gull
3 OTHER = Other birds

Table 19. Percent total of flyovers on each runway at JFKIA, by tidal stage, summer 1990. HTF = High-tide-falling, MTF = Mid-tide-falling, LTR = Low-tide-rising, and MTR = Mid-tide-rising.

		Runway				
		13R/31L	4L Ext.	4L/22R	4R/22L	13L/31R
Group	Tide	N=4,887[1]	N=1,246	N= 1,170	N=1,589	N=2,419
LAGU[2]						
	HTF	62	58	35	45	38
	MTF	75	60	82	0	57
	LTR	65	50	38	38	45
	MTR	60	45	50	60	40
	F	6.8	6.1	39.7*	47.9*	10.6
GULL[3]						
	HTF	12	10	5	10	7
	MTF	5	10	2	40	5
	LTR	10	18	21	5	10
	MTR	10	10	5	7	5
	F	11.1	17.5	42.1*	46.6*	5.5
OTHER[4]						
	HTF	26	32	60	45	55
	MTF	20	30	16	60	38
	LTR	25	32	41	43	45
	MTR	30	45	45	33	55
	F	12.4	12.1	18.7	9.4	8.3

1 N = total number of flyovers per runway
2 LAGU = Laughing Gull
3 GULL = Other gull species
4 OTHER = Other bird species
* significantly different at ($P < 0.05$, df = 2,2)

Table 20. Percent total of flyovers on each runway at JFKIA, by time of day, summer 1990.

Group[3]	T.O.D.[1]	Runway 13R/31L N=4,887	4L Ext. N=1,246	4L/22R N= 1,170	4R/22L N=1,589	13L/31R N=2,419
LAGU						
	0600-0859	62	38	39	90	37
	0900-1159	62	60	30	95	50
	1200-1459	42	57	40	70	40
	1500-1759	80	61	45	98	60
	1800-2059	85	30	82	40	30
	F	7.1	7.7	17.6	22.3*	9.2
GULL[4]						
	0600-0859	7	10	5	10	4
	0900-1159	5	5	33	5	5
	1200-1459	5	10	5	22	10
	1500-1759	7	15	34	2	10
	1800-2059	6	20	2	16	7
	F	2.7	11.5	23.6*	18.8	6.8
OTHER[5]						
	0600-0859	31	52	56	0	59
	0900-1159	32	35	37	0	45
	1200-1459	53	33	55	8	50
	1500-1759	13	34	21	0	30
	1800-2059	9	50	16	44	63
	F	27.8*	9.1	22.2*	31.5*	10.3

1 T.O.D. = Time of day
2 N = total number of flyovers per runway
3 LAGU = Laughing Gull
4 GULL = Other gull species
5 OTHER = Other bird species
* significantly different at ($P < 0.05$, df = 2,2)

Table 21. Percent total of flyovers on each runway at JFKIA, by altitude of flights, summer 1990.

Group	Alt(m)	Runway 13R/31L N=4,887	4L Ext. N=1,246	4L/22R N= 1,170	4R/22L N=1,589	13L/31R N=2,419
LAGU[3]						
	0 - 7.5	62	57	37	82	30
	7.6 - 15.0	75	60	80	100	62
	> 15.0	80	60	40	90	75
	F	5.3	5.9	17.6	9.5	18.1
GULL[4]						
	0 - 7.5	5	10	2	18	5
	7.6 - 15.0	10	36	15	0	5
	> 15.0	7	10	20	0	12
	F	4.1	10.2	19.5*	21.1*	11.7
OTHER[5]						
	0 - 7.5	33	33	61	0	65
	7.6 - 15.0	15	4	5	0	33
	> 15.0	13	30	40	10	13
	F	12.6	19.7*	23.1*	27.9*	19.3*

1 T.O.D. = Time of day
2 N = total number of flyovers per runway
3 LAGU = Laughing Gull
4 GULL = Other gull species
5 OTHER = Other bird species
* significantly different at ($P < 0.05$, df = 2,2)

Table 22. Color-marked Laughing Gull sightings by site and source, 1990.

Source	Number of color-marked sightings Red	Green	Ratio Red:Green	Number of Surveys	Number of hours	Effort [1]
Sightings by public	80	10	8:1	Unk.	Unk.	Unk.
Airport Surveys	163	2	81:1	92	186	0.87
Street-side Surveys	205	24	8.5:1	322	118	1.95
Edgemere Surveys	427	10	43:1	114	63	6.93
Aqueduct [2] Surveys	17	0	--- [3]	105	53	0.32
FBF Surveys	66	5	13.2:1	228	81	0.88
Total	958	51	21:1	861	501	2.01

1 Number of surveys/number of hours.
2 Limited access, 0800-1700, Monday-Friday.
3 Cannot be determined.

Table 23. Number (%) color-marked Laughing Gulls observed at various distances from the breeding colony, summer 1990.

Distance (km)	Number (%) Red-marked	Number (%) Green-marked
0-10	900 (94)	49 (98)
11-20	9 (1)	2 (2)
21-30	28 (3)	
> 30	18 (2)	

Table 24. Mean Number of Laughing Gulls observed per survey inside JFKIA on the Van Wyck Expressway, by time of day, summer 1990.

Time of Day	$\bar{x}$ (Range) Laughing Gulls	No. Surveys
0600 - 1000	35.1 (2-49)	96
1001 - 1400	32.4 (0-61)	152
1401 - 1800	42.9 (0-93)	108
1801 - 2100	70.2 (38-358)	112

Table 25. Mean number of Laughing Gulls observed at Jamaica Sewage Treatment Plant, by time of day, summer 1990.

Time of Day	$\bar{x}$ (Range) Laughing Gulls	No. Surveys
0600 - 1000	17.6 (2-49)	96
1001 - 1400	11.3 (0-61)	152
1401 - 1800	11.5 (0-77)	108
1801 - 2100	40.7 (25-273)	112

As the nations's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility of the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-141