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R.A. Dolbeer
U.S. Department of Agriculture,

M. Chevalier
JFK International Airport,

P.P. Woronecki
U.S. Department of Agriculture,

E.B. Butler
U.S. Department of Agriculture,

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R. A. Dolbeer[1], M. Chevalier[2], P. P. Woronecki[1], E. B. Butler[3]

Abstract. John F. Kennedy International Airport is adjacent to Jamaica Bay Wildlife Refuge administered by the National Park Service. In 1979, 15 pairs of laughing gulls (Larus atricilla) nested on the refuge, the first recolonization of Long Island by this species since the gulls' disappearance from New York around 1900. The colony, with nests as close as 0.4 km to 1 runway, has subsequently increased to about 3,000 pairs. From 1970 to 1978, only 1 laughing gull strike by an aircraft was recorded at JFK. From 1979 through August 1989, 800 strikes were recorded, including 179 in 1989, in spite of increased bird management programs on the airport. We believe public safety considerations outweigh any benefits of maintaining the colony in this proximity to JFK, especially since the colony represents but a small fraction of the expanding east coast population of laughing gulls. Oiling of eggs to eliminate hatching of young may be the best initial approach to remove the colony. Over 63% of the strikes occur in late June and early July when adults frequently fly across the airport on feeding trips for chicks.

[1]U.S. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870.
[2]JFK International Airport, Aeronautical Services Division, Jamaica, NY 11430.
[3]U.S. Department of Agriculture, APHIS/ADC, Pleasant Plains Road, Basking Ridge, NJ 07920.

INTRODUCTION

John F. Kennedy International Airport is situated between metropolitan New York City to the north and west and Jamaica Bay Wildlife Refuge to the southwest. JFK is one of the 10 busiest airports in the world with over 300,000 aircraft movements servicing 30,000,000 passengers annually (Anon. 1988). The adjacent 3,700-ha wildlife refuge, consisting primarily of open bays and salt marsh islands, is a part of Gateway National Recreation Area administered by the U.S. National Park Service (NPS).

JFK flight safety personnel have been particularly concerned about bird strikes with aircraft since 1975 when a DC-10 lost an engine on take-off after hitting several herring (Larus argentatus) and great black-backed (Larus marinus) gulls. The take-off was aborted and the 139 people aboard, all airline employees, were able to evacuate the aircraft before it was destroyed by fire (Solman 1981). At that time, a bird control unit was established in the Aeronautical Services Division to provide bird-scaring patrols on runways during daylight hours.

In 1979 a new bird problem arose when 15 pairs of laughing gulls nested on the adjacent wildlife refuge, the first recolonization of Long Island by this species since the gulls' disappearance from New York state about 1900. The nesting of this indigenous species in close proximity to the airport has created a controversy between JFK airport and the NPS regarding the management of the colony. The objective of this report is to summarize data from 1979 to 1989 regarding the laughing gull colony and bird strikes to aircraft.

These data form the basis for management recommendations to reduce the safety hazards caused by laughing gulls.

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CHARACTERISTICS OF LAUGHING GULL COLONY

Geographically, Long Island is a transitional area for nesting colonies of laughing gulls along the Atlantic coast. Laughing gulls are abundant from New Jersey southward. However, only 7 small colonies, in Maine and Massachusetts, presently are found north of Long Island (Table 1). Laughing gull nesting colonies along the Atlantic coast appear to be thriving, with average annual increases in nesting pairs of 10% or more not uncommon over the past decade. The New Jersey population has doubled in the past decade to about 60,000 pairs (Table 1).

The laughing gull colony in Jamaica Bay increased dramatically from 15 pairs in 1979 to 2,741 pairs in 1985, the last year a thorough count was made from the ground (Buckley and Gurien 1986). The growth of this colony (Table 1) was much higher than could have occurred from reproduction in the colony, suggesting that many of the gulls immigrated from expanding colonies in New Jersey. From 1985 to 1988, counts made from a helicopter and the ground indicated the colony had stabilized at between 2,500 and 3,000 pairs (Table 2). However, subjective surveys from the ground and a helicopter by us in 1989 suggested the colony was a minimum of 3,000 pairs. A complete ground survey is recommended for 1990 to determine the actual population size of the colony.

Table 1. Estimates of nesting pairs and population growth rates for laughing gulls in selected states along U.S. east coast, 1977-1988.

Area	Years of Census Year 1	Years of Census Year 2	No. yrs. between censuses	Estimated no. of nesting pairs (no. of colonies) Year 1	Estimated no. of nesting pairs (no. of colonies) Year 2	Mean annual % increase	Ref.
Maine[a]	1977	1988	11	231(6)	927(4)	13.5	[b]
Mass.[a]	1977	1988	11	200(1)	600(1)	10.5	[b]
New York	1979	1988	9	15(1)	2,665(1)	77.8	[c]
New Jersey	1977	1985	8	30,940(25)	58,550(80)	8.3	[b]
N. Carolina	1977	1983	6	12,353	22,903	10.8	[b,d]

[a] These are only known colonies presently established north of Long Island, New York.
[b] Spendelow and Patton (1988) plus unpubl. data.
[c] Buckley and Buckley (1984), Ducey-Ortiz et al. (1989).
[d] Clapp and Buckley (1984).

Table 2. Birds involved in strikes with aircraft, JFK Airport, and estimated number of nesting pairs in laughing gull colony on Jamaica Bay, 1979-89.

Year	Number of gulls (% of all gulls)			Other birds	All birds	Gulls as a % of all birds		Estimated nesting pairs of laughing gulls Jamaica Bay Wildlife Refuge[a]
	Laughing gulls	Other gulls	All gulls			All gulls	Laughing gulls	
1979	2 (2)	111 (98)	113	25	138	82	1	15
1980	19 (17)	96 (83)	115	28	143	80	13	235
1981	18 (22)	63 (78)	81	40	121	67	15	325
1982	14 (17)	70 (83)	84	61	145	57	9	715
1983	43 (29)	106 (71)	149	55	204	73	22	1,805
1984	60 (30)	139 (70)	199	90	289	69	21	2,802
1985	86 (30)	199 (70)	285	100	385	71	22	2,741
1986	62 (57)	46 (43)[b]	108	25	133	81	47	3,000
1987	137 (65)	75 (35)	212	32	244	87	56	2,875
1988	180 (55)	149 (45)	329	32	361	91	50	2,665
1989[c]	179	109	288	29	317	91	56	>3,000
Totals	800 (41)	1,163 (59)[d]	1,963	517	2,480	79	32	

[a] Data for 1979 to 1984 from Buckley and Buckley (1984), for 1985 to 1988 from Buckley and Gurien (1986) and Ducey-Ortiz et al. (1989), and for 1989 (see text).
[b] Fountain Avenue Landfill, located 3 km west of airport, closed on 31 December 1985.
[c] Through 31 August.
[d] Comprised of 631 herring gulls (54%), 170 great black-backed gulls (15%), 99 ring-billed gulls (8%), and 263 unidentified (but not laughing) gulls (23%).

Analysis of data for banded laughing gulls recovered along runways at JFK airport support the hypothesis that the expanding colonies in New Jersey have been a major source of birds colonizing Jamaica Bay. All 23 banded birds recovered since the Jamaica Bay colony's establishment in 1979 came from New Jersey (Table 3).

About 77% of the laughing gulls in Jamaica Bay nest on Joco Marsh, a 130-ha salt marsh island characterized by Spartina grasses interspersed with tidal creeks and pools (Fig. 1). Some of these nests are within 0.4 km of the end of runway 4L at JFK airport. The remaining gulls nest on nearby East High Meadow (41 ha) and Silver Hole Marsh (22 ha), both of which have habitat similar to Joco Marsh (Buckley and Gurien 1986).

Laughing gulls arrive in Jamaica Bay in April and peak egg laying occurs in the second half of May. Incubation requires 21-23 days (Segre 1968) and peak hatching occurs in mid-June. Buckley and Gurien (1986) reported 10 June to be the earliest hatching date in both 1985 and 1986. Fledging occurs in late July and August. Migration south is generally in October (Burger and Galli 1986).

STRIKES BY LAUGHING GULLS AND OTHER SPECIES

Annual Trends

Bird strikes with aircraft at JFK are reported from 2 sources. First, all pilot-reported strikes are investigated by searching the designated runway and adjacent areas for struck birds and, when warranted and possible, inspecting the aircraft for bird remains. Second, bird control personnel continually inspect runways and adjacent areas on their patrols and collect all dead birds. These birds are all assumed to be unreported bird strikes. Data recorded for

Table 3. Band recoveries from dead laughing gulls collected along runways at JFK Airport since 1979 when the nearby nesting colony was established in Jamaica Bay. All birds were banded in July.

No.	Banding location	Age at banding	Recovery date	Age (yrs) at recovery
1	Barnegat Light, NJ[a]	Chick	June 1981	1
2	Barnegat Light, NJ	Chick	June 1981	3
3	Barnegat Light, NJ	Chick	June 1982	1
4	Barnegat Light, NJ	Chick	July 1982	4
5	Barnegat Light, NJ	Chick	June 1983	3
6	Barnegat Light, NJ	Chick	July 1983	3
7	Beach Haven, NJ[b]	Chick	Aug. 1983	2
8	Barnegat Light, NJ	Chick	May 1984	2
9	Barnegat Light, NJ	Chick	June 1984	4
10	Barnegat Light, NJ	Chick	June 1985	4
11	Barnegat Light, NJ	Chick	June 1985	1
12	Barnegat Light, NJ	Chick	Aug. 1985	5
13	Barnegat Light, NJ	Chick	June 1986	2
14	Beach Haven, NJ	AHY	June 1986	≥2
15	Barnegat Light, NJ	Chick	June 1987	3
16	Barnegat Light, NJ	Chick	June 1987	2
17	Barnegat Light, NJ	Chick	June 1987	3
18	Barnegat Light, NJ	Chick	July 1987	6
19	Barnegat Light, NJ	Chick	Sept 1988	0
20	Barnegat Light, NJ	Chick	June 1989	4
21	Barnegat Light, NJ	Chick	June 1989	5
22	Barnegat Light, NJ	Chick	June 1989	3
23	Barnegat Light, NJ	Chick	May 1989	2

[a] 95 km south of JFK airport.
[b] 120 km south of JFK airport.

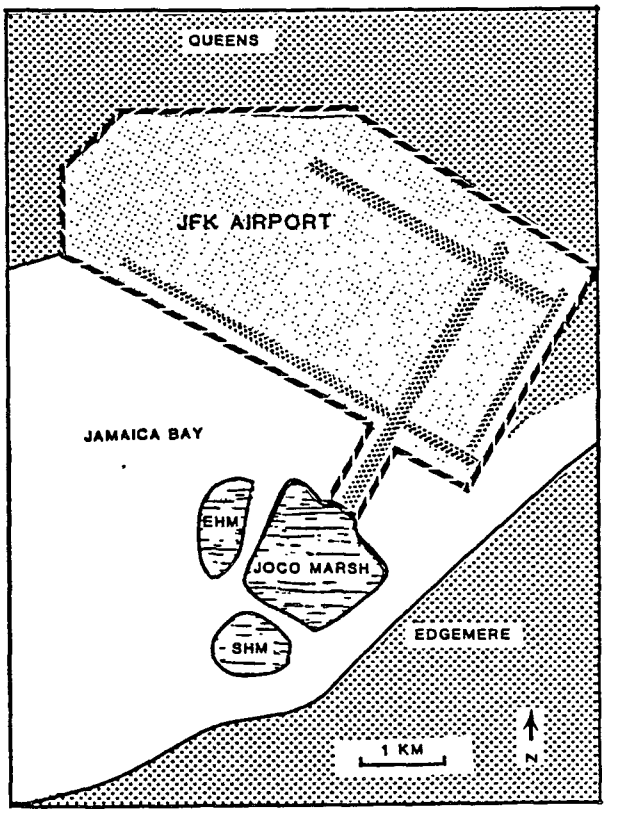

Fig. 1. Map of JFK airport and portion of Jamaica Bay Wildlife Refuge containing the laughing gull nesting colony on Joco Marsh, Silver Hole Marsh (SHM) and East High Meadow (EHM).

each bird include, when possible, species and age class, location and time of strike, and, if a pilot-reported strike, the type of aircraft and the reported damage. Only about 18% of the birds found are reported as strikes by pilots (Table 4).

From 1970 to 1978, only 1 laughing gull strike by an aircraft was recorded at JFK. Since the colony was established in 1979, there has been a steady increase in strikes closely paralleling the growth of the colony (Table 2). There were 180 strikes recorded in 1988 and 179 in 1989 through 31 August. In 1987 and 1988 laughing gulls comprised over 50% of the total bird strikes recorded at the airport compared to only 10% in 1979 through 1982. A total of 800 laughing gull strikes has been recorded from 1979 through 31 August 1989.

The annual number of strikes by other gull species has shown no consistent trend of increase or decrease from 1979 to 1988, ranging from 46 to 199 (Table 2). The only notable change occurred in 1986 when there was a sharp drop in strikes corresponding to the closure of the Fountain Avenue Landfill 3 km west of JFK. However, these gulls apparently have shifted to feeding at the

Edgemere Landfill 2 km southeast of JFK, and the number of strikes by these larger gulls is increasing again (Table 2). Non-gull species have comprised 23% of the strikes from 1979 to 1989, the number ranging from 25 to 100 annually.

Seasonal Trends

Laughing gulls have shown a pronounced seasonal trend in strikes closely related to their nesting activities. Although laughing gulls are active in the Jamaica Bay area from April through September, 40% of the strikes have occurred during the 15-day period from 16 to 30 June (Fig. 2). An additional 23% of the strikes have occurred during the first half of July for a combined 63% of the total strikes occurring during the 30-day period, 16 June - 15 July.

This pronounced peak in strikes beginning in mid-June corresponds precisely with the hatching of eggs in the colony. Apparently, the increased number of strikes results from adults making repeated flights across JFK airport in search of food for nestlings. This hypothesis is supported by the fact that over 92% of the strikes in June and July are by adult (at least 2-year old) gulls in breeding plumage (Table 5). Hatching-year birds, which first appear in strikes in late July (Fig. 2), comprise 14% of the total laughing gull strikes for the year. Band recovery data at the airport also indicate most strikes are by adult birds; 19 of the 23 banded birds were at least 2-years old when recovered (Table 3).

We frequently have observed adult laughing gulls flying over the airport during late June and July to foraging areas at least several kilometers from the colony. Apparently the airport itself provides little food for the chicks. An analysis of regurgitated boluses from chicks in the Jamaica Bay colony in 1985 and 1986 revealed over 80% fish and marine invertebrates (Buckley and Gurien 1986).

In contrast to laughing gulls, the seasonal pattern of strikes by the larger gull species has not been so pronounced (Fig. 3). May has been the peak month with about 20% of the annual strikes. January and February, each with about 4% of the annual strikes, have been the lowest months.

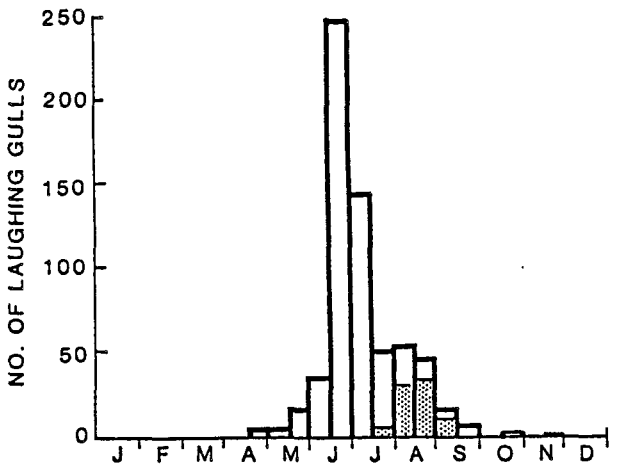

Fig. 2. Bimonthly distribution of aircraft strikes by laughing gulls at JFK airport, 1979-1988. Stipled areas represent hatching-year birds. A total of 621 strikes was recorded.

Damage to Aircraft

Fortunately, there has not been a bird strike incident at JFK airport in which human life has been put in immediate jeopardy since the DC-10 crash in 1975. However, extensive damage to engines and air frames resulting in at least several million dollars in repair and delay costs has occurred in the past decade. There have been at least 3 aborted take-offs due to laughing gull ingestions into engines, all involving DC-10 aircraft since 1986. In 1 incident an engine had to be changed and in another, 6 compressor blades had to be replaced. In addition, several incidences of engine damage have occurred in which an unknown species of gull was ingested. Some of these

Table 4. The number of aircraft for which pilots reported bird strikes and the number of birds recovered from those reported strikes for laughing gulls and all birds, JFK Airport, 1979-89.

	Laughing gulls[a]			All birds		
		Birds recovered			Birds recovered	
Year	Strikes reported by pilots	No.	% of all laughing gull recoveries[b]	Strikes reported by pilots	No.	% of all bird recoveries[b]
1979	0	0	0	21	24	17
1980	0	0	0	17	23	16
1981	0	0	0	14	13	11
1982	0	0	0	20	46	32
1983	0	0	0	25	35	17
1984	3	5	8	27	59	20
1985	4	8	9	37	130	34
1986	6	7	11	14	20	15
1987	8	9	7	22	18	7
1988	5	5	3	26	51	14
1989[c]	11	13	7	24	35	11
Totals	37	47	6	247	454	18

[a] These are minimum values because species of gull (which may have been laughing gull) was not identified for some pilot-reported strikes.
[b] Number of birds recovered from pilot-reported strikes as a percent of the total birds recovered on airport (pilot-reported and unreported strikes from Table 2).
[c] Through 31 August.

ingestions may have involved laughing gulls. Although the number of pilot-reported strikes by birds has remained relatively stable from 1979 through 1988, the number of these strikes involving laughing gulls has increased in recent years (Table 4). Also, the number of known laughing gull strikes involving 3 or more birds has increased. From 1979 to 1986 there were only 3 such incidences, each involving 3 birds. From 1987 to 31 August 1989, there were 8 incidences involving from 3 to 11 birds.

MANAGEMENT RECOMMENDATIONS

The Aeronautical Services Division of JFK airport has 2 bird-patrol shifts, each with 4 people, to maintain constant harassment of birds on the airport during daylight hours. The airport has maintained the grass in runway areas at a height of over 10 cm each summer since 1986 to discourage gulls from feeding and loafing (Brough and Bridgman 1980, Buckley and Gurien 1986). Continual efforts are being made to improve drainage to prevent standing water on the airport after rain. Similar efforts are maintained to ensure that edible garbage is secured in covered containers. While all these measures are important and should be continuously upgraded and refined to reduce hazards to aircraft from birds, they are of limited value in preventing most strikes caused by laughing gulls. As we have discussed above, most strikes apparently result from adult birds flying through critical airspace above the airport in search of food for chicks in off-airport areas. Bird management efforts on the airport, no matter how successful, can have only a limited impact on this type of activity.

We recommend that action be taken to eliminate the laughing gull colony from its present location in Jamaica Bay Wildlife Refuge. Laughing gulls

Table 5. Age classification of laughing gulls struck by aircraft on JFK Airport, 1980-88.

Year	Number of gulls (% of total) Hatching year a	Second year b	After second year c	Total
1980	8 (42)	0 (0)	11 (58)	19
1981	0 (0)	8 (44)	10 (56)	18
1982	2 (15)	2 (15)	10 (70)	14
1983	2 (7)	7 (16)	34 (78)	43
1984	11 (17)	10 (17)	39 (66)	60
1985	20 (20)	7 (16)	59 (64)	86
1986	10 (16)	4 (6)	48 (77)	62
1987	10 (7)	2 (1)	125 (92)	137
1988	23 (13)	0 (0)	157 (87)	180
Total gulls	86 (14)	40 (6)	493 (80)	619

a Brown-plumaged birds that appear from mid-July through September.
b Birds that appear beginning in April without the dark hoods and breeding plumage but also without the brown plumage of HY birds.
c Birds in full breeding plumage (dark hoods, maroon bills and legs).

now comprise over 50% of the bird strikes on the airport and must be recognized as a serious economic liability and safety hazard. Although we recognize the importance of Jamaica Bay Wildlife Refuge as critical habitat for indigenous wildlife species in the metropolitan New York City area, we believe the risks of permitting laughing gulls to nest next to the airport outweigh any benefits. We note that laughing gulls are thriving in many other localities along the east coast.

A panel of 4 international experts on bird hazards at airports met with National Park Service and JFK airport personnel in June 1989 to discuss the laughing gull problem. This panel also concluded that the colony should be eliminated, recommending the oiling of eggs (with the addition of formaldehyde as a preservative to prolong the incubation period and prevent renesting) as a first step toward accomplishing this objective (Thomas et al. 1989). We concur with their recommendation for oiling. Our analysis (Fig. 2) indicated 63% of the strikes occurred during a 30-day period in June and July when adults were feeding chicks. An additional 7% of the strikes were from adults in late July and another 14% of the strikes were from newly fledged young in late July through September. Thus, we hypothesize that the elimination of chicks from the colony will result in a major reduction in strikes. Oiling of eggs may or may not cause the colony to abandon in future years (Drury and Nisbet 1969); thus, additional management actions against the colony may have to be taken subsequently.

Finally, we note that laughing gulls comprise only 1 component of the bird hazard problem at JFK airport. For example, our data clearly demonstrate that strikes by the other, larger, gull species continue to be a serious problem. Thus, efforts need to be continued to eliminate other focal points of gull activity as an overall part the bird management program for JFK airport.

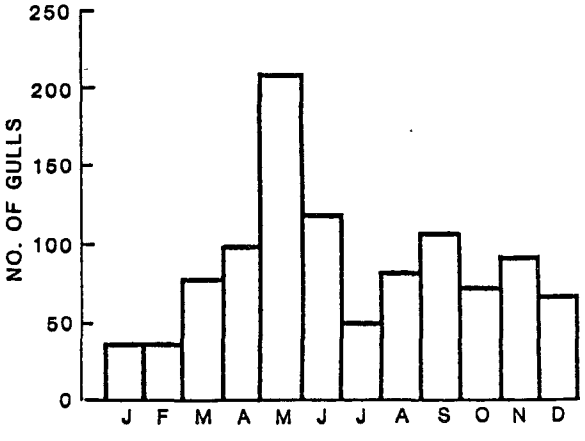

Fig. 3. Monthly distribution of aircraft strikes by large (herring, great black-backed and ring-billed) gulls at JFK airport, 1979-1988. A total of 1,054 strikes was recorded for these species (51% herring, 15% great black-backed, 9% ring-billed and 25% unidentified).

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