

4 AERODROME PAPERS
Chairman Mr Olavi Stenman, Finland

**EVALUATION OF SHOOTING AND FALCONRY TO REDUCE BIRD STRIKES
WITH AIRCRAFT AT JOHN F. KENNEDY INTERNATIONAL AIRPORT**

Richard A. Dolbeer
U.S. Department of Agriculture
Wildlife Services
National Wildlife Research Center
6100 Columbus Avenue
Sandusky, Ohio 44870 USA

Summary

The collision of birds with aircraft is a serious problem at John F. Kennedy International Airport (JFKIA), New York. Gulls (*Larus* spp.), primarily laughing gulls (*L. articularis*), accounted for 84% of bird strikes (an aircraft striking >1 bird) from 1988-1990, averaging 260 strikes/year. Laughing gulls are present from May-September in association with a nesting colony (7,629 nests, 1990; 3,381 nests, 1997) in Jamaica Bay adjacent to JFKIA. A program to reduce gull strikes was undertaken from May-August 1991-1997 in which 2-5 people stationed on airport boundaries shot gulls flying over the airport. In 6,369 person-hours of shooting, 52,235 gulls were killed, comprised of 47,601 laughing gulls and 4,634 other gulls. In 1996 and 1997, experimental falconry programs were implemented to complement the shooting program. In 1996, the falconry and shooting programs were conducted simultaneously from 21 June-9 August, after which shooting stopped but falconry continued until 20 October. In 1997, falconry began 25 July (1 week before shooting program ended) and ended 25 November. A statistical comparison of mean strike rates for all birds and for gulls only during 1988-1990 (no shooting or falconry), 1991-1995 (shooting but no falconry) and 1996-1997 (shooting and falconry) indicated shooting reduced ($P < 0.01$) strikes but that falconry did not ($P \geq 0.24$). On a positive note, fewer gulls were shot and struck in 1996-1997 compared to 1994-1995 although the reductions were not statistically significant ($P > 0.05$). Falconry, which provides positive publicity and other unique attributes, can have a role in the integrated bird management program at JFKIA. However, additional years of data are needed to obtain a more definitive assessment of the role that falconry can play in reducing strikes. The falconry program will continue at JFKIA in 1998-2000, which should provide sufficient data for this more complete assessment.

Key Words: Airport, Bird Strike, Falconry, Gull, JFK, Shooting

1. INTRODUCTION

The collision of birds with aircraft is a serious problem at John F. Kennedy International Airport (JFKIA), New York. Port Authority of New York and New Jersey (PANYNJ) personnel reported 80-315 aircraft struck by birds/year at JFKIA from 1979-1997 (Dolbeer and Bucknall 1998). These strikes have caused millions of dollars in damage to aircraft as well as a significant threat to human safety. From 1988-1990, laughing gulls were the species most frequently struck by aircraft at JFKIA, averaging 157 aircraft incidents (52%) involving 170 birds (47%)/year. Other gulls (herring [*L. argentatus*], great black-backed [*L. marinus*] and ring-billed [*L. delawarensis*]), which are present year-round, comprised 34% of the aircraft strikes and, another 52 species of birds comprised the remaining 14%. There is a nesting colony of laughing gulls adjacent to JFKIA in Jamaica Bay Wildlife Refuge, a protected area administered by the U.S. National Park Service. This colony increased from 15 nesting pairs in 1979 to 7,629 pairs in 1990. Almost all laughing gull strikes have occurred from May-September with most in June and July during chick rearing (Dolbeer et al. 1989). Many laughing gulls fly from the colony over the airport to off-airport feeding areas throughout metropolitan New York City (Griffin and Hoopes 1991). Strikes with other gull species occur throughout the year. As one approach to solving the problem, U.S. Department of Agriculture (USDA) biologists, under a cooperative agreement with the PANYNJ, initiated an experimental management program at JFKIA in 1991 to reduce strikes by gulls, primarily laughing gulls. From 20 May-8 August 1991, biologists shot gulls attempting to fly over the airport. Hypotheses tested were that shooting would not only directly reduce the population of gulls flying over the runways but also enhance ongoing bird-frightening programs at JFKIA by conditioning gulls to avoid the airport. Because strikes by gulls were significantly reduced at JFKIA in 1991 (Dolbeer et al 1993), the shooting program was continued during late May-early August in 1992-1997. In 1994, an Environmental Impact Statement (EIS) was finalized that addressed the management of gulls to reduce bird strikes at JFKIA (U. S. Department of Agriculture 1994). The EIS recommended that the shooting program be continued as part of an integrated management program until other actions are taken that would result in relocation of the gull colony.

In 1996-1997, the PANYNJ implemented experimental falconry programs to complement the shooting program. In 1996, the falconry program (Bird Control International, Inc., Georgetown, Ontario, Canada) and USDA shooting program were conducted simultaneously from 21 June-9 August, after which the shooting program was discontinued but falconry was continued until 20 October (Table 1). In 1997, the falconry program (T.C. Management, Inc., Goshen, New York, USA) began 25 July (a week before the shooting program ended) and continued to 25 November.

Operations personnel at JFKIA have maintained detailed, consistent records of bird strikes at the airport since the 1970s (Burger 1985, Dolbeer and Bucknall 1994). The database includes both strikes reported by pilots and unreported strikes (bird carcasses found on active runways in a condition indicating an interaction with aircraft). This database allows evaluation of a bird-strike reduction program by comparing strike rates for within-year time intervals when the program was in place with strike rates for the same time intervals in years without the program. Having shooting and falconry programs conducted during overlapping and nonoverlapping times in a 2-year period, combined with a long-term database on bird strikes, provided a unique opportunity to compare the effectiveness of these 2 programs.

2. METHODS

2.1 Shooting

Shooting was with 12-gauge shotguns using #4 steel shot on 31-62 days annually from 15 May-17 August 1991-1997. Two to 5 shooters were stationed along the southern airport boundaries where gulls often crossed the airport. Shooting typically was conducted from 0530-1400 or from 1200-2030. Shooters stood or sat in the open and wore blaze-orange vests. Shooting was directed away from the airport at flying gulls that came within range (about 40 m).

All shooters operated under *federal* and New York state permits issued to the USDA or PANYNJ. In 6,369 person-hours of shooting in 1991-1997, 52,285 gulls were killed, comprised of 47,601 laughing, 3,403 herring, 670 great black-backed, and 561 ring-billed gulls (Table 1). The laughing gull colony declined from 7,629 nests in 1990 to 3,381 nests in 1997. Dolbeer et al. (1993, 1997) and Dolbeer and Bucknall (1994, 1998) provide additional details about the shooting program and nesting colony.

2.2 Falconry

In both 1996 (21 June-20 October) and 1997 (25 July-25 November), falconers generally flew their birds (primarily peregrine falcons [*Falco peregrinus*], peregrine-gyrfalcon [*F rusticolus*] hybrid, and Harris' hawks [*Parabuteo unicinctus*]) daily on the airport. Typically, the falconers used "lure flights" in which the falcon did not attack and kill target birds but simulated hunting by chasing a lure swung from a leash by the falconer. In addition, the falconers used pyrotechnics, amplified distress calls and occasional shotgun shooting with live ammunition to disperse birds. Watermann (1997) and T. C. Management (1998) provide additional details about the 1996 and 1997 falconry programs, respectively.

2.3 Evaluation of shooting and falconry

To evaluate the shooting and falconry programs, I made 3 comparisons of strike rates among years using chi-square statistics for proportional data (Fleiss 1973:14-22). First, I compared strike rates for 21 June-20 October 1988-1996. In 1988-1990 (baseline years), there was no shooting or falconry. In 1991-1995, there was shooting from 21 June to 4-17 August but no falconry. In 1996, there was shooting from 19 June-9 August and falconry from 21 June-20 October. Second, I compared strike rates from 16 August-20 October 1988-1997 when there was no shooting in any year but there was falconry in 1996-1997. Third, I compared strike rates from 21 October-30 November 1988-1997 when there was no shooting in any year but there was falconry in 1997. In making comparisons among years, I used number of strikes instead of number of strikes/10,000 aircraft movements because aircraft movements at JFK (355,000 in 1996) have increased by only about 3% per year, 1988-1996 (U. S. Department of Agriculture 1994; Lamp 1998).

To determine if the falconry program reduced the number of -gulls shot in 1996, when shooting and falconry were conducted simultaneously, I used 1-way analysis of variance to compare the mean number of gulls shot/person-hour of shooting, 1991-1997 and tukey tests to determine which annual means were different ($P < 0.05$) (Statistix 1994).

3. RESULTS

3.1 Bird Strikes: 21 June-20 October 1988-1996

In 1991-1995, when shooting but no falconry was done, there were mean reductions of 68% ($X^2 = 60.26$, 1 df, $P < 0.01$) and 78% ($X^2 = 74.79$, 1 df, $P < 0.01$) in strikes for all birds and gulls only, respectively, compared to annual means for 1988-1990 (Fig. 1). For 1996, when shooting and falconry were done, the numbers of strikes for all birds (71) and gulls only (25) were comparable ($X^2 = 1.82$, 1 df, $P = 0.17$ [all birds]; $X^2 = 1.43$, 1 df, $P = 0.24$ [gulls only]) to mean numbers recorded in 1991-1995 ($x = 55.8$ and 34.2 , respectively) when shooting only was done. The 25 gulls struck in 1996 was a 38% reduction compared to the 40 gulls struck in 1995, but this difference was not significant ($X^2 = 3.46$, 1 df, $P = 0.07$). When only pilot-reported strikes are considered (Fig. 2), there was also little indication that strikes in 1996 for all birds (15) or gulls (2) were lower than in the previous 5 years ($x = 9.2$ and 2.8 , respectively).

The number of gulls shot/person-hour during the shooting program differed ($P < 0.01$) among years, 1991-1997 (Table 1). The number killed/person-hour in 1996, when falconry and shooting were done simultaneously, was the lowest for the 7 years but was not different ($P > 0.05$) than means in 1993-1995 and 1997.

3.2 Bird Strikes: 16 August-20 October 1988-1997

During this 2-month period following the shooting program in 1991-1995, there were mean reductions of 48% ($X^2 = 7.75$, 1 df, $P < 0.01$) and 68% ($X^2 = 14.53$, 1 df, $P < 0.01$) in strikes for all birds and for gulls only compared to the means for 1988-1990 (Fig. 3). For 1996-1997, when falconry was carried out following the shooting program, there was a mean increase of 100% ($X^2 = 9.00$, 1 df, $P < 0.01$) in strikes for all birds ($x = 54.0$) compared to the mean for 1991-1995 ($x = 27.0$). There was no difference ($X^2 = 1.10$, 1 df, $P = 0.71$) in the mean number of strikes by gulls in 1996-1997 ($x = 8.5$) compared to the mean for 1991-1995 ($x = 13.4$). The 8-9 gulls struck in 1996-1997 was a mean 48% reduction compared to the 13-20 gulls struck in 1991-1995, but this difference was not significant ($X^2 = 2.56$, 1 df, $P = 0.13$). When only pilot reported strikes were considered (Fig. 2), there also was little indication that strikes in 1996-1997 for all birds ($x = 13.0$) or for gulls only ($x = 1.0$) were lower than in 1991-1995 ($x = 6.0$ and 1.4 , respectively).

3.3 Bird Strikes: 21 October-25 November 1997

During 1997, the only year falconry was conducted during this time period, the numbers of strikes by all birds (8) and gulls only (5) were not different ($\chi^2 = 0.91$, 1 df, $P = 0.30$; $\chi^2 = 0.00$, 1 df, $P = 0.99$) than the mean numbers of strikes by the respective groups in 1991-1996 ($\bar{x} = 12.3$ and 4.9) (Fig. 4). In 1997, pilot-reported strikes for all birds (1) and gulls only (0) were within the range of values (0-5) for 1991-1996:

4. DISCUSSION

Shooting gulls at JFKIA reduced gull strikes, based on a comparison of strikes in 1988-1990 (preshooting) and 1991-1997 (shooting) (Dolbeer et al. 1993, Dolbeer and Bucknall 1994, 1998). However, this shooting program resulted in the killing of 52,235 gulls.

In an effort to develop alternative, nonlethal methods to reduce strikes, the PANYNJ implemented falconry at JFKIA in 1996-1997 as part of their integrated bird management program. As noted by Blokpoel (1976), falconry on airports has attracted public interest because it uses a medieval sport to protect modern jet aircraft. Falconry, as practiced at JFKIA, is also attractive to the general public in that it is a biological control procedure in which birds are usually only dispersed and not killed. JFKIA has, indeed, received considerable positive media coverage in 1996-1997 regarding the falconry program as an environmentally friendly means of reducing bird strikes (L. Rider, PANYNJ, Personal Communication). Another benefit has been that the falconers, during their daily routines, provide additional personnel on the airfield to harass birds as a supplement to the regular bird patrol staff. JFKIA has not sacrificed other components of their bird management program to employ the falconers (L. Rider, PANYNJ, Personal Communication).

The statistical analysis of strike data, however, did not support the hypothesis that the 4 month falconry programs in 1996-1997 reduced bird strikes at JFKIA below baseline levels in the 5 years immediately prior to falconry. On a positive note, there were fewer gull strikes in 1996-1997 compared to 1994-1995 even though the reductions were not statistically significant and the strike numbers were within the range of values for 1991-1995. In addition, falconry may have resulted in fewer gulls shot in 1996 although the kill/person-hour was not statistically different than in 1993-1995 and 1997. Additional years of data are needed to determine if these trends continue.

Reviews of airport falconry programs by Blokpoel (1976), Chamorro and Clavero (1994) and Hahn (1996) indicated that falconry sometimes can reduce bird strikes but that success is contingent on many factors. Chamorro and Clavero (1994), in discussing falconry on Spanish airports, concluded that "falconry is a very cost-effective (\$460,000/year/airport) method for the control of birds in airdromes, but not all the airfields are suitable for falcons." Hahn (1996), after a study of falconry at a military airfield and waste disposal site in Germany, concluded that "we cannot recommend falconry because the success by using falconry for bird control is correlated to a *lot* of different factors and the effort is not proportional to the success."

Most evaluations of airport falconry programs have presented general observations of effectiveness without detailed, objective analyses of strike rates or bird responses (see Hahn [1996] as an exception). More objective, quantitative analyses are needed so that the effectiveness of falconry under various circumstances, in comparison to other management actions, can be determined. The PANYNJ plans to continue the falconry program in 1998-2000, as part of their integrated bird management plan. This should provide an ideal opportunity for a more detailed, 5-year evaluation of falconry as compared to this initial evaluation.

In conclusion, the shooting program at JFKIA in 1991-1997 was designed to deal with a specific problem of gulls from a large, nearby nesting colony in a protected wildlife refuge flying over the airport to dispersed feeding sites beyond the airport. Aside from this specialized shooting program, the PANYNJ should continue in their commitment to develop an innovative, integrated bird management program, including habitat management and the use of various bird-frightening techniques, to prevent gulls and other bird species from using the airport (U. S. Department of Agriculture 1994). Falconry, which provides much positive publicity and other unique attributes, can have a role in this integrated bird management program at JFKIA. However, additional years of data are needed to provide a more complete assessment of the exact role that falconry can play in reducing strikes.

5. ACKNOWLEDGMENTS

I thank S. Chevalier, J. K. Gartner, A. J. Graser, L. Rider and C. Zeilfelder of the PANYNJ for their support, assistance and willingness to try innovative approaches to reducing bird strikes at JFKIA, as well as for their commitment to maintaining a long-term database of bird strikes. I particularly acknowledge the discussions and constructive comments provided by L. Rider regarding this manuscript. I acknowledge the dedication and professionalism of the USDA employees at JFKIA, especially J. L. Bucknall, and the falconers, especially T. J. V. Cullen. III of T. C. Management, Inc and M. Givlin and U. Watermann of Bird Control International, Inc. B. F. Blackwell and R. B. Chipman reviewed drafts of the manuscript.

6. REFERENCES

- Blokpoel, H. (1976) Bird hazards to aircraft. Books Canada Limited. London, U.K. 236pp.
- Burger, J. (1985) Factors affecting bird strikes on aircraft at a coastal airport. *Biological Conservation* 33:1-28.
- Chamorro, M., & Clavero, J. (1994) Falconry for bird control on airdromes. *Bird Strike Committee Europe* 22:397-407.
- Dolbeer, R. A., Belant, J. L., & Sillings, J. L. (1993) Shooting gulls reduces strikes with aircraft at John F. Kennedy International Airport. *Wildlife Society Bulletin* 21:442-450.
- Dolbeer, R. A., Belant, J. L., & Bernhardt, G. E. (1997) Aerial photography techniques to estimate populations of laughing gull nests in Jamaica Bay, New York, 1992-1995. *Colonial Waterbirds* 20:8-13.
- Dolbeer, R. A., & Bucknall, J. L. (1994) Shooting gulls reduces strikes with aircraft at John F. Kennedy International Airport, 1991-1993. *Bird Strike Committee Europe* 22:375-396.
- Dolbeer, R. A., & Bucknall, J. L. (1998) Shooting gulls to reduce strikes with aircraft at John F. Kennedy International Airport, 1991-1997. Special Report for the Port Authority of New York and New Jersey by U.S. Department of Agriculture, National Wildlife Research Center Sandusky, Ohio, USA. 31 pp.
- Fleiss, J. L. (1973) *Statistical methods for rates and proportions*, Second edition. John Wiley and Sons, New York, New York, USA. 321 pp.
- Griffin, C. R., & Hoopes, E. M. (1991) Birds and the potential for bird-strikes at John F. Kennedy International Airport. Final Report submitted to U.S. National Park Service Cooperative Research Unit, Natural Resources Science Department, University of Rhode Island Kingston, Rhode Island, USA, 102pp.
- Hahn, E. (1996) Falconry and bird control of a military airfield and a waste disposal site. *Bird Strike Committee Europe* 23: 347-352.
- Lampl, R. (Editor). (1998) *The aviation and aerospace almanac 1998*. Aviation Week Group Newsletters, McGraw-Hill. Washington, DC. USA, 1,022pp.
- Statistix. (1994) User's manual, version 4.1. Analytical software, Tallahassee, Florida, USA.
- T. C. Management. (1998) Summary report JFK falconry program 1997. Report prepared for Port Authority of New York and New Jersey by T. C. Management, Inc., Goshen, New York, USA.
- U.S. Department of Agriculture. (1994) Gull hazard reduction program at John F. Kennedy International Airport. Final Environmental Impact Statement. U.S. Department of Agriculture, Animal Damage Control Program, Pittstown, New Jersey, USA.
- Watermann, U. (1997) Experimental falconry program to reduce the gull strike hazard to aircraft at John F. Kennedy International Airport, New York, New York. Report prepared for Port Authority of New York and New Jersey by Bird Control International Inc., Georgetown, Ontario, Canada.

Table 1. Dates of shooting and falconry, person-hours expended in shooting, and gulls killed by shooting at John F.Kennedy International Airport, 1991-1997

Year	Dates of shooting	Dates of falconry	Person-hours shooting	No. of gulls killed by shooting			Gulls killed/person-hour ^b
				Laughing	Other ^a	Total	
1991	20 May-8 Aug		896	14,191	695	14,886	17.6A
1992	15 May-4 Aug		1,310	11,847	1,619	13,466	10.0B
1993	25 May-9 Aug		1,195	6,496	844	7,340	6.1C
1994	21 Jun-5 Aug		717	3,688	293	3,981	5.4C
1995	20 Jun-17 Aug		861	6,167	592	6,759	7.3BC
1996	19 Jun-9 Aug	21 Jun-20 Oct	657	1,970	293	2,263	3.5C
1997	12 Jun-1 Aug	25 Jul-25 Nov	733	3,242	298	3,540	5.3C
Total			6,369	47,601	4,634	52,235	8.2

a Herring, great black-backed, and ring-billed gulls.

b Mean number of gulls killed/person-hour is different among years ($F=47.2$; 6, 1192 df; $P < 0.01$); yearly means with different letters are different ($P < 0.05$).

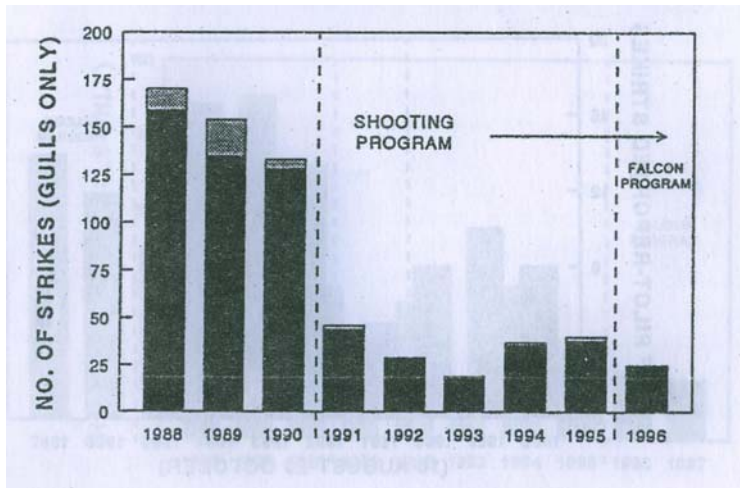
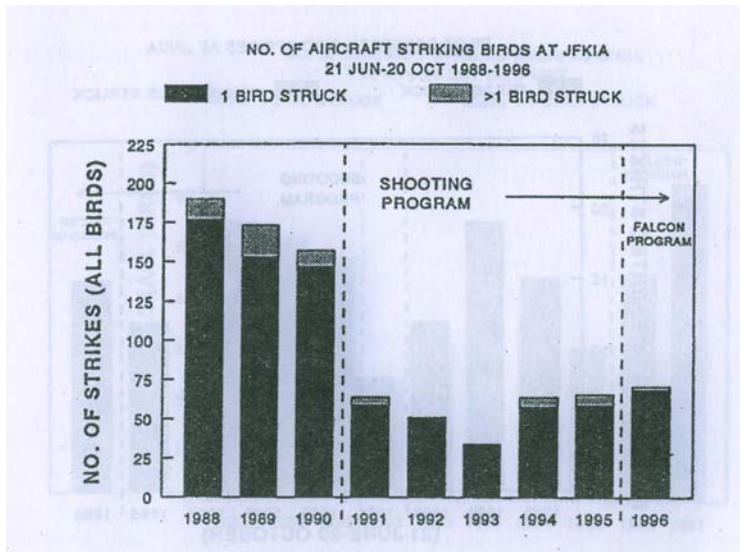


Figure 1. Number of aircraft striking birds (top graph) and gulls only (bottom graph) at John F. Kennedy International Airport, 21 June-20 October 1988-1996. During 1988-1990, there was no shooting or falconry; during 1991-1996, there was shooting from late May-early August; during 1996, there was a falconry program from 21 June-20 October.

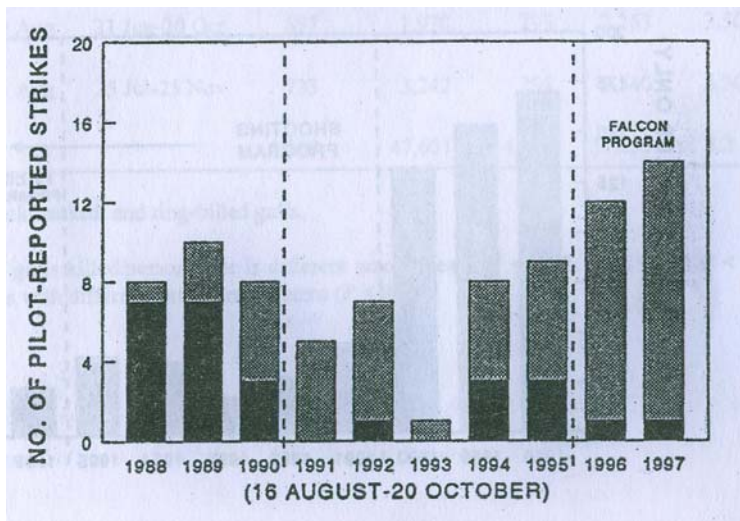
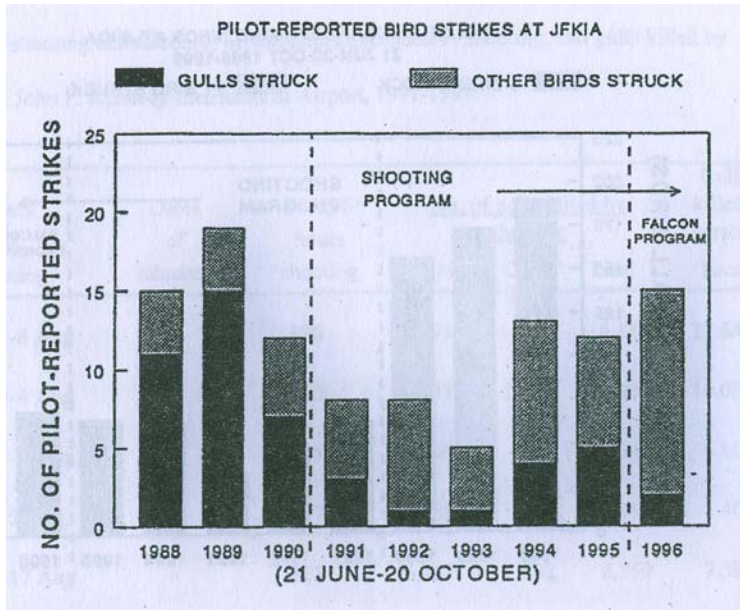


Figure 2. Number of pilot-reported strikes by gulls and other birds at John F.Kennedy International Airport, 21 June – 20 October 1988 – 1996 (top graph) and 16 August – 20 October 1988 – 1997 (bottom graph). During 1988-1990, there was no shooting or falconry; during 1991-1997, there was shooting from late May – early August; during 1996 and 1997, there were falconry programs from 21 June – 20 October and 1 August – 25 November, respectively.

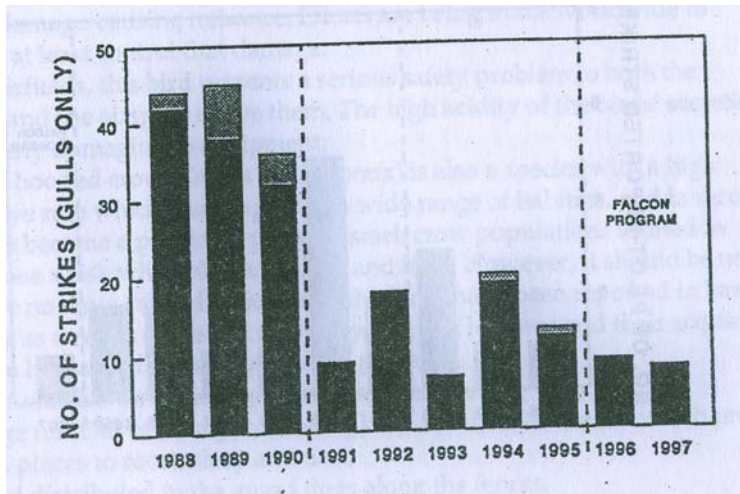
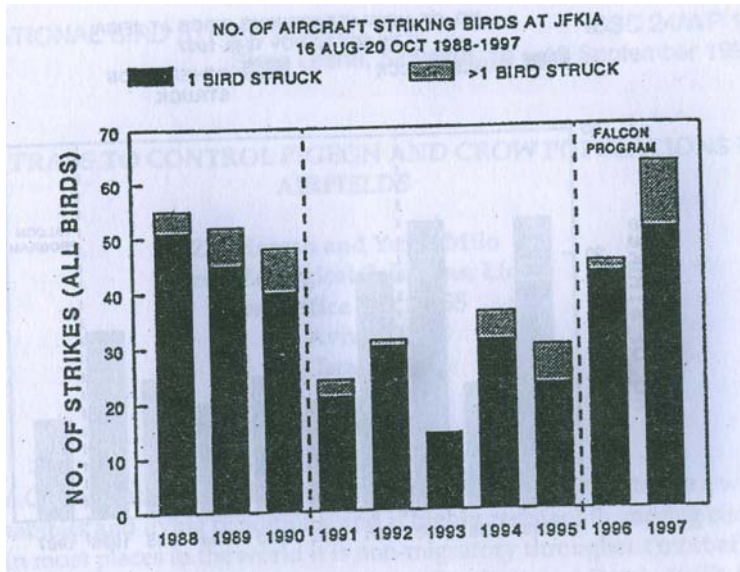


Figure 3. Number of aircraft striking birds (top graph) and gulls only (bottom graph) at John F. Kennedy International Airport, 16 August – 20 October 1988 – 1997. During 1988 – 1990, there was no shooting or falconry; during 1991 – 1997, there was shooting from late May-early August; during 1996 and 1997, there were falconry programs from 21 June – 20 October and 1 August – 25 November, respectively.

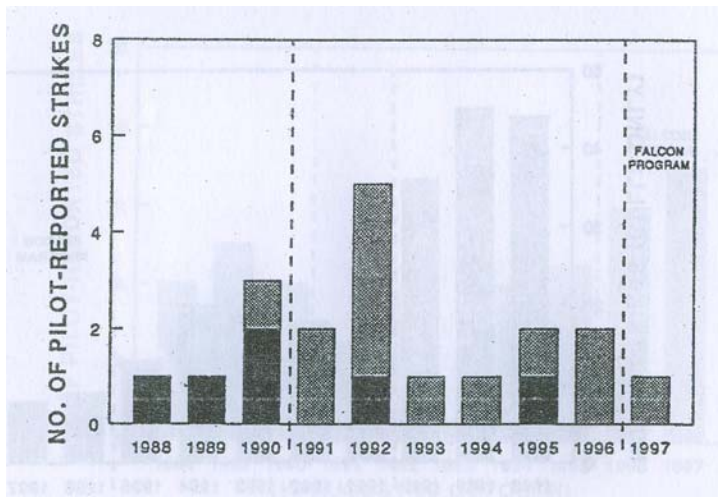
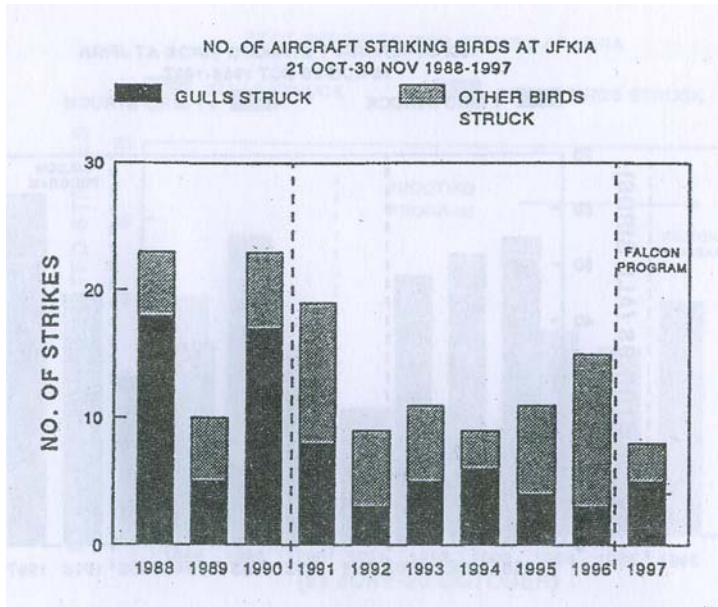


Figure 4. Number aircraft striking gulls and other birds (top graph) and number of pilot-reported strikes (bottom graph) at John F. Kennedy International Airport, 21 October – 30 November 1988 – 1997. During 1988-1990, there was no shooting or falconry; during 1991-1997, there was shooting from late May-early August; during 1996 and 1997, there were falconry programs from 21 June – 20 October and 1 August – 25 November, respectively.