2.0 EIS METHODOLOGY - ALTERNATIVES ANALYSIS

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2.0 EIS METHODOLOGY - ALTERNATIVES ANALYSIS

This section describes the range of approaches that have been considered in determining reasonable alternatives to reduce the gull (Herring, Ring-billed, Great Black-backed, and Laughing)-aircraft strike hazard at John F. Kennedy International Airport (JFKIA). Also discussed is the selection method by which different measures were determined reasonable and were determined to warrant analysis of potential environmental impacts. The method follows a tiered approach which eliminates all measures that are determined infeasible or ineffective and thus focuses the environmental analysis on those alternatives considered feasible and effective. Subsequently, all feasible alternatives are subjected to environmental analysis. Those that have severe detrimental environmental impacts are excluded from consideration for inclusion in the preferred alternative. Finally, an alternative is selected from the remaining low-impact alternatives which provides the best balance between effectiveness and low environmental impacts.

2.1 Range of Approaches and Alternatives Considered to Reduce the Gull Hazard

The ultimate objective of the gull (4 species) hazard reduction program at JFKIA is to protect human safety by reducing the potential for gull-aircraft interactions. A schematic overview of the different approaches to the management of the gull-aircraft strike hazard at JFKIA is provided in Figure 2-1. Among the different approaches considered, those which result in an immediate and permanent reduction of the gull hazard — rather than those which result in long-term and temporary reduction of the hazard — best address the purpose and need.

The following are the two main approaches to reducing the gull strike hazard:

1) reduce the probability that such a strike would occur; and
2) reduce the hazardous effects of a strike by improving aircraft tolerance to birdstrikes.

2.1.1 Reduction of the Probability of Gull/Aircraft Interaction

The reduction of the potential for gull-aircraft strikes could be achieved through reduction of simultaneous use of parts of JFKIA airspace by both gulls and aircraft. One approach would be to reduce the presence of gulls in active airspace, while another would be for aircraft to avoid gulls.

- **Reduction of Gull Presence in JFKIA Airspace**

The reduction of gull presence in active airspace can be achieved through reduction of the utility of JFKIA airspace for gulls, or through reduction of the number of gulls most likely to enter the JFKIA airspace.

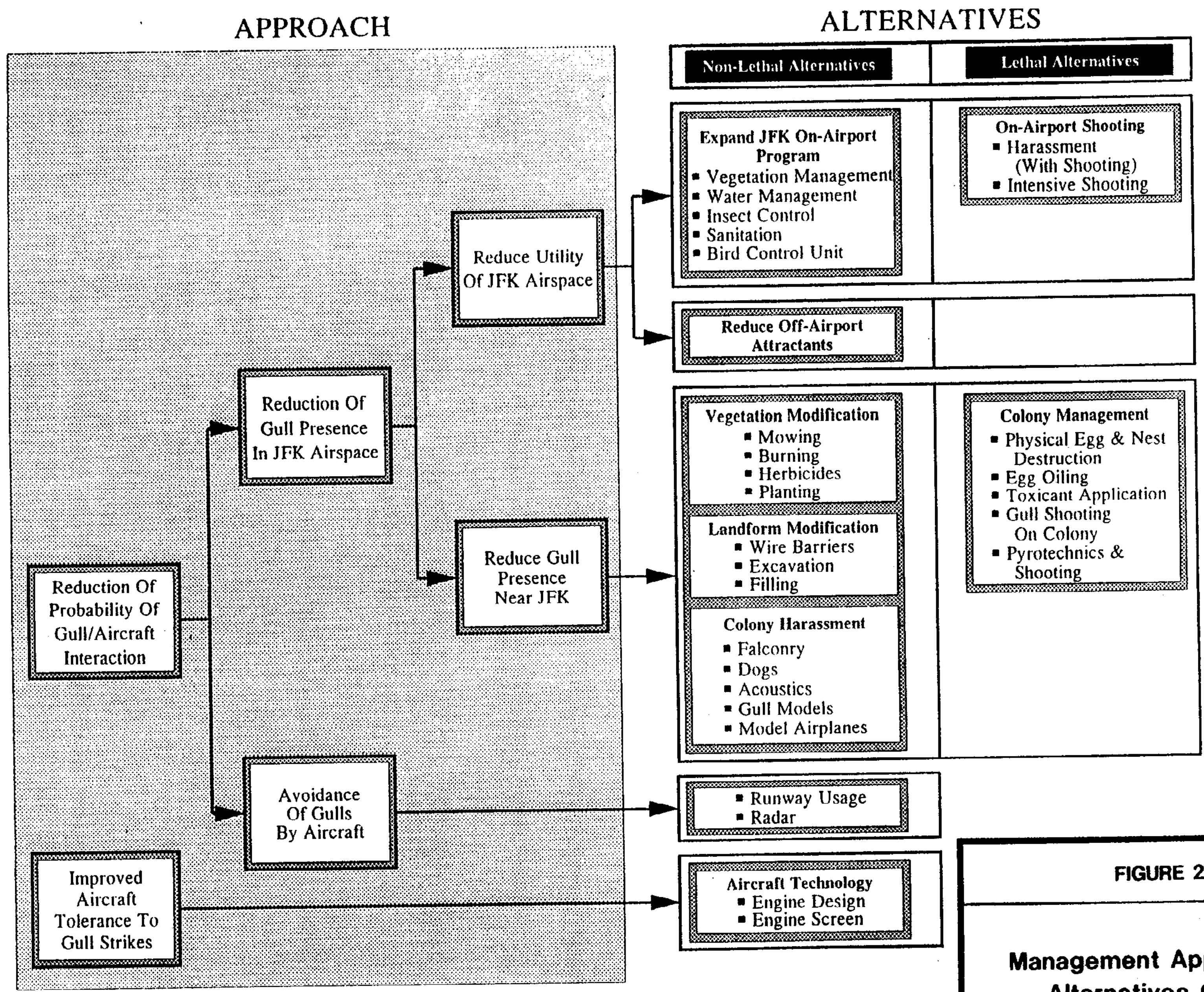

FIGURE 2-1

Management Approaches and Alternatives Considered

■ **Reduction of the Utility of JFKIA Airspace for Gulls**

Utility of JFKIA for gulls can be provided by the airport itself as a destination ("destination utility"), or by the fact that JFKIA airspace is in the gulls' flight path to destinations elsewhere ("transgression utility").

Destination Utility of JFKIA

The destination utility of JFKIA would be due to the presence of on-airport attractants such as food, nesting and roosting sites, and water. An alternative which will be evaluated is the reduction of the destination utility of JFKIA by reducing on-airport attractants through vegetation management, water management, insect control and containment of refuse.

Transgression Utility of JFKIA

The transgression utility is based on the fact that many gulls fly through JFKIA airspace on their way to attractants beyond the airport, such as off-airport food sources. One alternative which would be evaluated is to reduce potential off-airport attractants. It should be noted that while the on-airport alternatives can be directly controlled by the airport operator, the off-airport alternatives cannot be directly influenced by the airport operator.

■ **Reduction of Gulls Prior to Entering JFKIA Airspace**

As strike data indicate the prevalence of gulls among those species entering JFKIA airspace and responsible for the larger portion of birdstrikes, reduction of the amount of gulls entering JFKIA airspace could conceivably contribute to a substantial reduction in birdstrikes. Reduction of the gull presence in JFKIA airspace could be achieved by inducing abandonment of the Laughing Gull nesting colony site at the end of Runway 4 Left, since this site is the prime origin of Laughing Gulls entering JFKIA airspace. This could be achieved through physically rendering the habitat unattractive for future breeding or by direct Laughing Gull population management. From a behavioral perspective, population reduction may work because it has been documented for similar species that colony size is a factor in attracting individuals and consequently large colonies tend to attract even more birds. Secondly, the repeated reduction of the population every year could result in a shift of preference for nesting from the marshes adjacent to the airport to other sites where Laughing Gulls have not experienced repeated nest failure and/or Laughing Gull mortality. Alternatives to be evaluated for this approach are as follows:

Physical Modification of Nesting Habitat

Vegetation Modification

- Mowing (devegetation)
- Burning (devegetation)
- Herbicides (devegetation)
- Deterrent Vegetation (shrubs)

Landform Modification

- Wire Barriers
- Marsh Excavation
- Marsh Filling

Population Reduction/Colony Abandonment

Nonlethal Methods—Harassment

- Falconry
- Dogs
- Acoustics
- Gull Models
- Model Airplanes (radio-controlled)

Lethal Methods—Population Reduction

- Physical Destruction of Eggs and Nests (reproductive failure, harassment)
- Egg Oiling (reproductive failure)
- Toxicants (mortality)
- Shooting (mortality, harassment)
- Predators (mortality, reproductive failure, harassment)

From a behavioral perspective, population reduction may work because it has been documented for similar species that colony size is a factor in attracting individuals. Consequently, large colonies tend to attract even more birds, including nonbreeders, immatures, and breeding birds. Secondly, the repeated reduction of the population every year could result in a shift of preference for nesting from the marshes adjacent to the airport to other sites where Laughing Gulls have not experienced repeated nest failure and/or Laughing Gull mortality.

■ **Removal of Gulls Within or Near JFKIA Active Airspace**

Gull presence in JFKIA active airspace could be reduced through active removal of gulls once they have entered JFKIA airspace. The alternatives to be evaluated for this approach include the following:

- Harassment (lights, radar, laser beams, avicide repellant, stakes)
- Intensive shooting on airport

2.1.2 Avoidance of Gulls by Aircraft

■ **Gull Avoidance**

Gull avoidance could be achieved through changes in the airport's operational schedule. The feasibility of this approach is dependent on a variety of conditions, including wind, weather, maintenance and noise abatement requirements. Consequently, the applicability of this approach is infrequent and unpredictable. Assuming that certain airspace usage patterns by aircraft have a higher potential for birdstrikes, airport operational schedules might be devised that reduce such patterns. This alternative will be evaluated.

- **Incidental Gull Avoidance**

Gull avoidance could also be achieved on an incidental basis, without requiring the permanent change of airspace usage patterns. This would be achieved through the use of gull tracking and warning devices. The feasibility of incidental gull avoidance depends on the effectiveness of technologies (e.g. radar) to locate a substantial gull presence early enough for avoidance measures. This alternative will be evaluated.

2.1.3 Improved Aircraft Tolerance of Gull Strikes

The reduction of the hazardous effect of gull strikes on aircraft could possibly be achieved by preventing the gulls from being ingested into the engine or by making the engine more tolerant of gull ingestions through the application of more strike-resistant aircraft technologies and materials. The feasibility of such alternatives depends to a large extent on the availability of appropriate technologies and materials, cost, consistency with existing aviation safety standards, and the time frame within which these technologies could become operational for the next generation of aircraft. The status of ongoing research developments in this area will be evaluated.

2.2 Alternatives Analysis

Because of the broad range of potential solutions to the gull hazard, a tiered, selective method was developed for this EIS to address all reasonable alternatives, consistent with 40 CFR Part 1502.14,[1] and to focus on those alternatives which combine the highest effectiveness and feasibility with the lowest environmental impacts.

2.2.1 Tier 1: Initial Range of Alternatives Considered

2.2.1.1 Selection of Feasible and Effective Alternatives

Literature Review: Through an extensive literature review, an initial inventory was made of all alternatives identified in the literature. Their applicability to the gull hazard problem at JFKIA was identified. This analysis is contained in Section 3 of the EIS. The literature review was augmented with interviews with parties involved with the problems at JFKIA and birdstrike hazards in general. In addition, unsolicited suggestions to solve the gull hazard were considered.

2.2.1.2 Feasibility and Effectiveness Analysis

Subsequently, all alternatives that could conceivably reduce the gull hazard were subjected to an assessment of the technical feasibility of their implementation, as well as their effectiveness in reducing the gull-aircraft strike hazard. This determined the range of feasible and effective alternatives that would be advanced for further assessment of environmental impacts. Feasibility and effectiveness of alternatives were determined through review and analysis of data in literature, including case studies at other

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1 "Rigorously explore and objectively evaluate all reasonable alternatives and, for alternatives which were eliminate from detailed study, briefly discuss the reasons for their having been eliminated."

locations, interviews with professionals, and analysis of the specific conditions under which the alternatives would have to be implemented. This included analysis of gull behavioral characteristics and their response to different measures according to literature and case study sources.

Laughing Gull Colony Population Simulation: The effectiveness of alternatives which sought to reduce the Laughing Gull population in Jamaica Bay was assessed by use of a computer model which simulated the population characteristics and the probable size of the Jamaica Bay Laughing Gull population. To do so, the model included parameters such as reproductive capacity and survival rate similar to those considered to be relevant for the Jamaica Bay population. Various levels of population reduction resulting from different alternatives were subsequently simulated in the computer model to determine what the long-term and short-term effects would be on the size of the hypothetical Laughing Gull population. This was then used as a relative indication of how effective different alternatives could be in reducing the Laughing Gull population in Jamaica Bay and—assuming a relationship between the Laughing Gull population in Jamaica Bay and the number of Laughing Gull strikes at JFKIA—how effective different alternatives could be in reducing the Laughing Gull hazard.

2.2.1.3 Elimination of Alternatives

Alternatives that were determined to be infeasible from a technical perspective or which were determined to be ineffective in reducing the gull hazard were excluded from further analysis, as they did not adequately address the gull-aircraft strike hazard.

Among the alternatives considered, the No-Action Alternative was advanced for environmental analysis as well, despite its low effectiveness. This alternative was included for further analysis consistent with NEPA regulations and to establish a baseline against which the environmental impacts of other alternatives could be compared.

It should be noted that because of the wide variety of alternatives, the limited applicability of existing data, the specificity of the situation at JFKIA, and the variety of methods and level of accuracy by which effectiveness and feasibility of different alternatives could be assessed, uniform and/or quantitative criteria for all alternatives which could permit a quantitative ranking of alternatives was considered neither feasible nor desirable. However, as the purpose of this analysis was to eliminate rather than rank alternatives, the absence of detailed and uniform evaluation criteria was not considered an impediment to an adequate treatment of alternatives.

2.2.2 Tier 2: Range of Feasible and Effective Alternatives

- **Analysis of Environmental Impacts**

The alternatives which were determined effective and feasible were subsequently assessed regarding their potential environmental impacts and the level of their environmental compatibility. This evaluation considered the alternatives' effects on the following:

- Ecological Resources
  - Wildlife
    - Gulls
    - Other Wildlife
    - Threatened and Endangered Species
    - Habitat
- Water Quality
- Parks and Recreation
- Socioeconomics
- Air Quality
- Ambient Noise
- Airport Operations and Safety
- Coastal Zone Management

This analysis is provided in Section 5 of the FEIS. Alternatives which were determined to have especially adverse environmental impacts were not advanced for consideration as a preferred alternative.

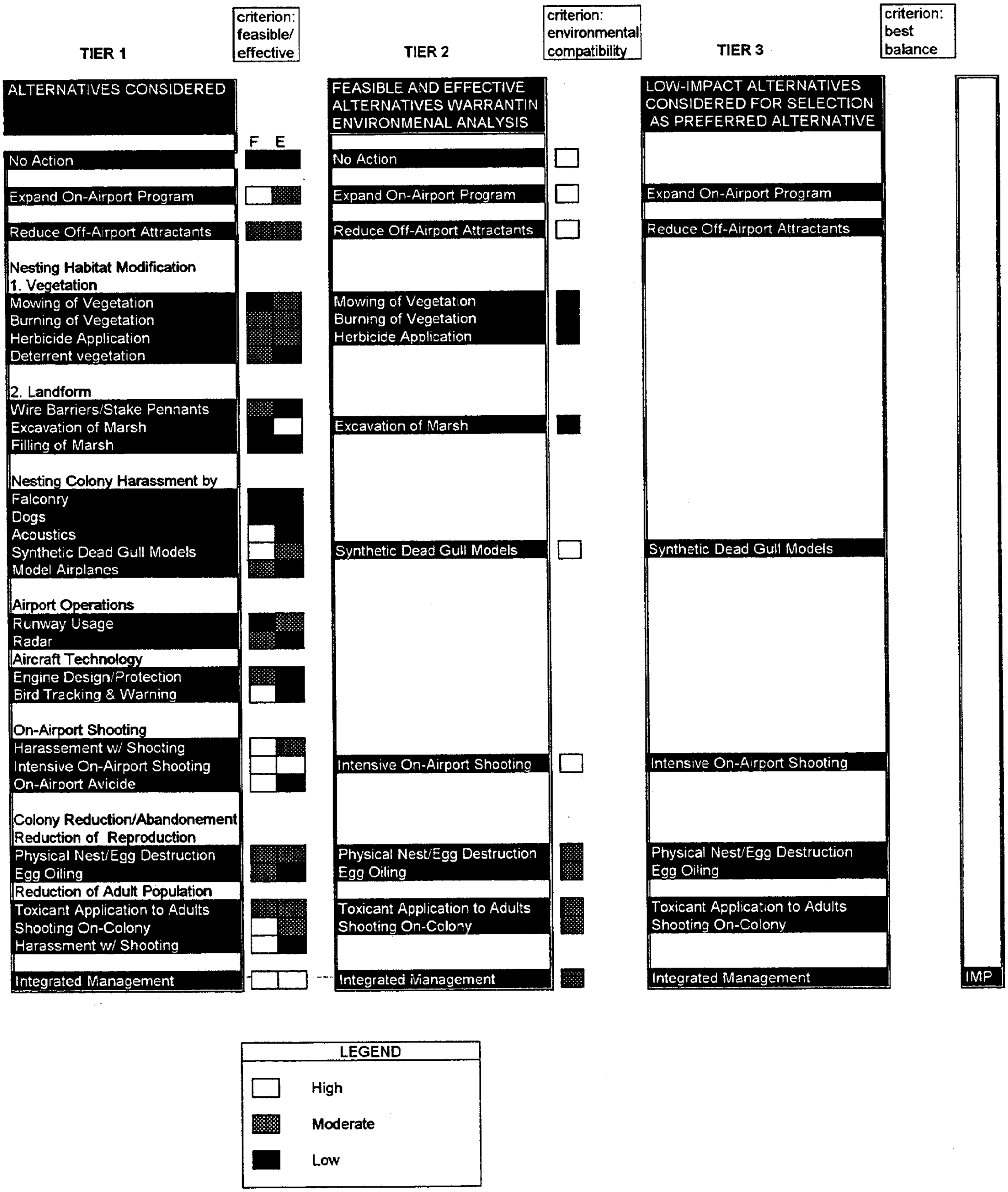
2.2.3 Tier 3: Range of Potential Preferred Alternatives

- **Selection of the Preferred Alternative**

Finally, all alternatives with relatively minor environmental impacts were compared regarding their feasibility and effectiveness. Subsequently, the alternative which provided the best balance between high feasibility, high effectiveness and low environmental impacts was selected as the Preferred Alternative. The comparison of alternatives and the selection of the preferred alternative are presented in Chapter 6 of the FEIS.

An overview of the methodology and a summary of results is provided in Figure 2-2.

Figure 2.2
Alternatives Analysis Methodology



3.0 EVALUATION OF FEASIBILITY AND EFFECTIVENESS OF ALTERNATIVES

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3.0 EVALUATION OF FEASIBILITY AND EFFECTIVENESS OF ALTERNATIVES

Alternatives to addressing the program need to reduce gull-aircraft collisions at JFKIA are described in this chapter. Throughout this chapter, the feasibility and effectiveness (operational and ultimate) of the considered alternatives are identified to establish a subset of alternatives that will be analyzed for environmental impacts in Chapter 5. Only those alternatives that are determined to be feasible and effective are advanced for environmental impact analysis. The considered alternatives are directed at reducing interactions between the four gull species and aircraft at JFKIA. With the exception of the Jamaica Bay Laughing Gull nesting colony alternatives, all alternatives address Herring, Great Black-backed, Ring-billed, and Laughing gulls. As described in Chapter 1, gulls present the greatest hazard to aircraft at JFKIA; the remaining 58 bird species together constitute a much smaller percentage (23%) of the aircraft striking birds, and combined, account for 25% of the reported damage to aircraft. All but one of these remaining 58 bird species accounted for no more than 2% of the aircraft striking birds; common barn owl accounted for 4% of the aircraft striking birds (no damage or delays). Due to gull preponderance in the birdstrike record, in terms of number of aircraft and extent of damage/delays, and due to the large and increasing local and regional abundance, gulls are considered for management. It should be noted that a number of the alternatives considered for gull hazard reduction also reduce hazards from these other 58 bird species: JFKIA's ongoing bird hazard control program (habitat management, insect and water control, operation of the Bird Control Unit, etc.), aircraft engineering to reduce the number and impact of birdstrikes, and reduction of off-airport attractants.

3.1 Methodology

As described in Section 2, evaluation of the possible alternatives to achieve the goals of the JFKIA Gull Hazard Reduction Program was conducted in a tiered manner. This section contains the first tier of analysis. It describes all alternatives initially considered and identifies their technical feasibility and effectiveness in reducing the gull-aircraft strike hazard. Those that are determined feasible and effective will be advanced for analysis of their environmental impacts in Chapter 5. The No-Action alternative is advanced for further analysis to provide a baseline against which the environmental impacts of other alternatives can be compared. For the purpose of this section, the alternatives are grouped into No-Action, Nonlethal, Lethal, and an Integrated Management Plan.

It should be noted that because of the wide variety of alternatives, limited applicability of existing data, the specificity of the situation at JFKIA, and the variety of methods and level of accuracy by which effectiveness and feasibility of different alternatives were assessed, a detailed ranking of alternatives was not considered feasible nor desirable.

The absence of uniform criteria was sought to be alleviated by conduct of an extensive literature analysis and modeling studies. Within the population reduction approach, the literature review and analysis is augmented with the results of the population simulation results, which form a more quantitative basis for comparing the different alternatives within this approach.

While not allowing for a detailed ranking of alternatives, the methodology described above does provide a basis for a general categorization in three categories: low, moderate and high. Following is a more detailed discussion of the method by which the alternatives were evaluated for feasibility and effectiveness.

3.1.1 Technical Implementation Feasibility

An alternative is determined technically unfeasible if there are technical aspects associated with its implementation that render it impractical. Such aspects may include physical conditions that prevent implementation of a particular alternative, as well as airport operation and safety requirements.

3.1.2 Effectiveness

Throughout this discussion of alternatives, "effectiveness" is evaluated with respect to both operational and ultimate effectiveness.

As discussed in Section 2.1 (Hazard Reduction Approaches), several types of measures can be considered to reduce the gull hazard. Some approaches are directed at reducing the gull presence in JFKIA airspace by reducing overflights through deterring birds from entering JFKIA airspace by harassment or shooting, while other measures seek to reduce the number of overflights by reducing the gull population in Jamaica Bay with the long term objective of relocating the gull colony altogether. An overview of the different approaches in reducing the gull hazard is presented in Figure 2-1.

By their very nature some hazard reduction approaches may be more likely to reduce the gull hazard than others, provided they can be implemented from a technical perspective. For example, because historic data shows a relationship between the number of gull-aircraft interactions and the size of the Laughing Gull nesting population in Jamaica Bay, the reduction of the Jamaica Bay gull population may result in a decrease in overflights and hence in gull-aircraft interactions. Similarly, reduction of gulls from entering JFKIA airspace (by reducing off-airport attractants, deterrence or by on-airport elimination) may be more or less effective as a general approach than other approaches. It should be noted that because of the variation in approaches and available data no definitive comparison of the success of different approaches is possible.

3.1.2.1 Operational Effectiveness

Within a particular approach there are different measures to realize that approach, all of which may vary in their effectiveness. The operational effectiveness within a certain type of approach depends on how well it "works" in reducing what are assumed to be conditions that contribute to the underlying reasons for the birdstrike hazard. The assessment of the operational effectiveness of alternatives is useful in assessing the effectiveness of different alternatives within one hazard reduction approach. For example, the approach of reducing the number of gulls entering JFKIA airspace may be more effectively achieved by reduction of off-airport attractants than by reduction of on-airport attractants. Similarly, reduction of reproduction (by egg/nest reduction) may be more effective than reduction of adult gulls (by shooting or toxicant application) in reducing the Laughing Gull population in Jamaica Bay.

The effectiveness of alternatives within the approach which seeks to reduce the Laughing Gull population in Jamaica Bay was assessed by developing a computer model which simulated the population dynamics of the gull population, including reproductive capacity and survival rate. Various levels of population reduction resulting from different alternatives were subsequently simulated in the computer model to determine what the long-term and short term effects would be on the size of the hypothetical Laughing Gull population. This was then used as an indication of how effective different alternatives could be in reducing the Laughing Gull population in Jamaica Bay.

3.1.2.2 Ultimate Effectiveness

Ultimate effectiveness of a particular alternative depends on the extent to which it is expected to reduce the number of gull-aircraft interactions at JFKIA, which is the ultimate goal of the program. It represents the aggregate effectiveness of a general hazard reduction approach (e.g. colony size reduction) with the (operational) effectiveness of a specific measure which seeks to realize that approach. It is therefore possible that an alternative with a high operational effectiveness may not result in a high ultimate effectiveness, if the general approach that such an alternative seeks to realize in itself is found ineffective in reducing the gull strike hazard. Alternatively, an alternative which is operationally very ineffective, would not have a high ultimate effectiveness, even if it is part of an approach that has the capacity to be very effective. For example, alternatives which lead to a very limited reduction of the Jamaica Bay nesting population would have a very low ultimate effectiveness.

3.1.3 Basis for Evaluation of Alternatives

The first tier evaluation of each alternative concludes with a statement as to whether the alternative is technically feasible and can reasonably be expected to address the purpose and need of the project in a substantial way or, in other words, can be expected to lead to a reduction of the gull hazard at JFKIA. Alternatives that are technically not feasible and/or not effective are excluded from further consideration in Tier 2. It should be emphasized that the effectiveness and feasibility analysis in this section are not intended to rank the alternatives, but rather to establish the range of reasonable alternatives. Furthermore, the diversity of alternatives and the absence of quantitative data does not lend itself to an evaluation of alternatives based on uniform criteria. In an effort to compensate for the absence of quantitative data and the diverse range of case-studies, all of which have only limited applicability to the specific situation at JFKIA several inventory and analysis efforts were undertaken. They include an extensive and detailed literature and case study review, analysis of the statistical characteristics of the gull hazard, analysis of the physical environment of the study area and habitat and behavioral characteristics of gulls, especially Laughing Gulls, and the simulation of the population dynamics of the Laughing Gull population in Jamaica Bay.

3.1.3.1 Literature and Case Study Review

An extensive literature review was conducted, as well as interviews with professionals knowledgeable about various alternatives. Numerous literature sources and case studies were analyzed to provide a broad picture of all possible alternatives to reduce the gull hazard undertaken in past and present, within the United States as well as abroad.

3.1.3.2 Analysis of the Gull-Aircraft Interaction Hazard

Simultaneous with the literature review and case-study analysis, a detailed study was made of the specific aspects of the gull hazard at JFKIA. This included the geographic, temporal, seasonal, species-specific and aircraft specific statistical distribution of different types of gull-aircraft interactions at JFKIA as well as the physical environment of the area and the population characteristics of the Laughing Gull colony in Jamaica Bay. The findings of case studies were subsequently interpreted for the specific situation at JFKIA. Based upon this a professional assessment was made of the probable general level of effectiveness or feasibility of alternatives.

3.1.3.3 Computer Simulation of the Jamaica Bay Laughing Gull Population

To compare how much population reduction could result from different lethal alternatives, a computer model was developed, which simulates the population dynamics including reproductive age and survival characteristics of a Laughing Gull population representative to that in Jamaica Bay. The computer model then uses these characteristics to estimate the size of each subsequent Laughing Gull generation, as well as the total size of the population after a number of iterations. It should be stressed that the population size that results from the computer simulation does not reflect the actual population and does not reflect actual numbers. Predicting the absolute, rather than relative, effects would require much more refined input values that are not available for Laughing Gulls. However the simulation is useful as a general assessment of the relative effects of different lethal alternatives.

3.1.3.3.1 Model Construction

The model simulates the growth of the Jamaica Bay population through multiple breeding seasons. The JFKIA Laughing Gull simulation model was developed using STELLA (Richard et al. 1987). The design of the model was similar to that developed for Herring Gulls and Great Black-backed Gulls reported by Cavanagh and Griffin (1992). Figure 3-1 provides a schematic overview of the model used to simulate the Jamaica Bay Laughing Gull population.

In order to simulate the Laughing Gull population in Jamaica Bay, certain parameters had to be developed which characterize the population. These include age at first breeding, reproductive rate, survival rates, maximum nest capacity and the level of immigration of outside Laughing Gulls into the breeding colony. Input parameters were obtained from the scientific literature, measured in the field, or generated by the model itself . An overview of the population parameters, discussed in more detail below, is provided in Table 3-1.

Population dynamics can vary greatly among different species and can greatly determine the effectiveness of different types of alternatives in reducing the population. For example, certain animals have a relatively high reproductive rate and a low survival rate. Alternatives which reduce reproductive capacity will have a relatively larger population reduction effect on such species than reduction of the survival rate by killing adult individuals. Other species are characterized by a comparatively low reproductive rate and a high survival rate. Therefore it can be hypothesized that population reduction <u>may</u> be more effectively achieved through reduction of adult gulls, rather than by reducing reproductive capacity.

3.1.3.3.2 Model Parameters

- **Model Initiation Population**

For simulation purposes, it was assumed that the maximum number of nest sites that could be sustained at the Jamaica Bay Colony was 8,000 nests. This number was chosen based upon the extensive nest surveys in the Jamaica Bay gull colony conducted in 1990 by Griffin and Hoopes (1992). They marked and counted 7,629 nests on six marsh islands.

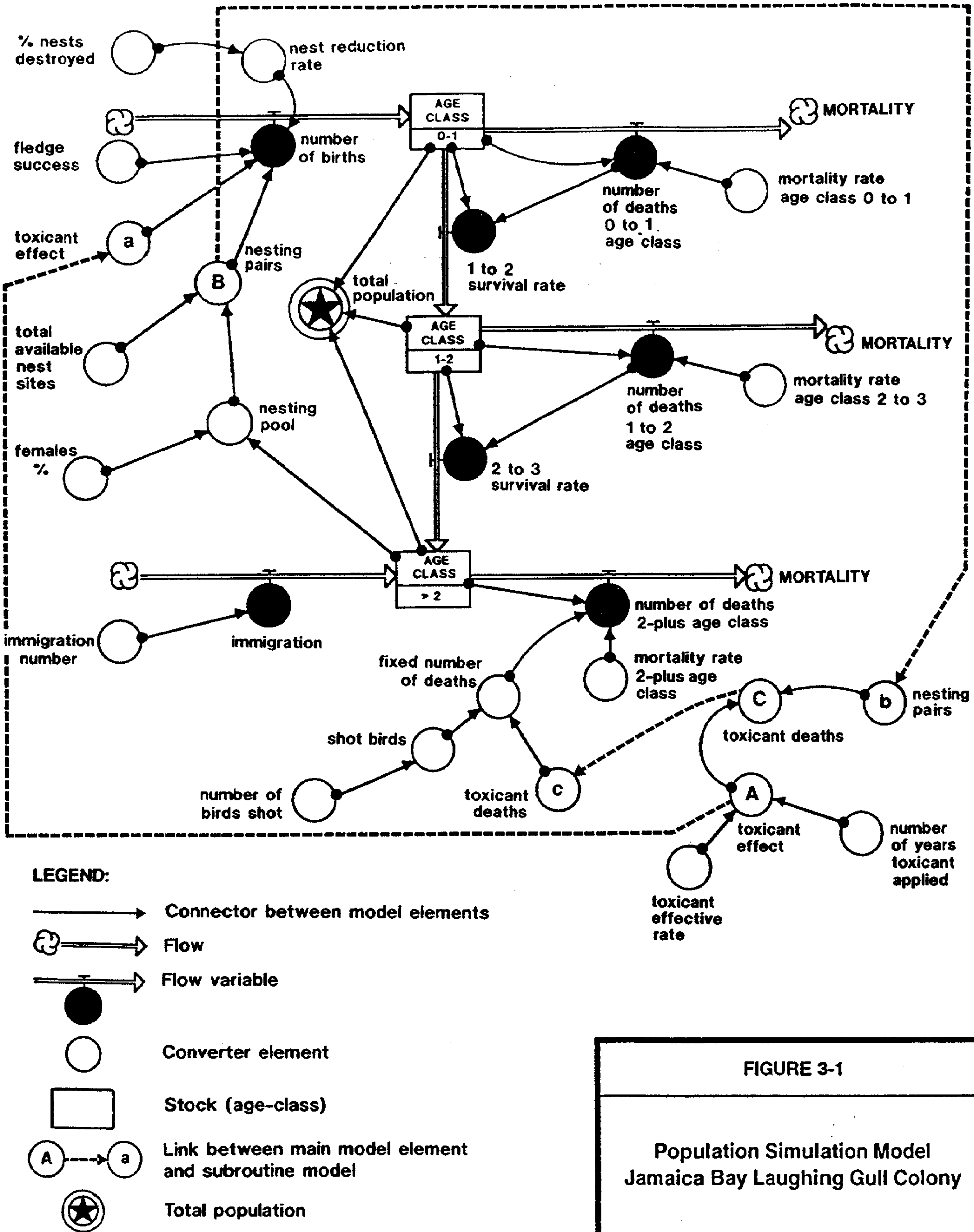


FIGURE 3-1

Population Simulation Model Jamaica Bay Laughing Gull Colony

Table 3-1

Population Simulation-Model Parameters

Parameter	Value	Source
Age at first breeding	3 yrs	Grant 1986
Reproductive rate	1.08 fledglings per nest	Griffin and Hoopes 1992
Survival rates		
First year	0.73	Kadlec and Drury 1968
All other years	0.797	Cavanagh and Griffin 1992
Maximum Nest Capacity	8,000	Griffin and Hoopes 1992
Immigration	3200, 6400, 9600	

- **Population Age Structure and Survival and Reproductive Parameters**

First-Year Birds: The model consists of three different age classes: birds younger than one year; birds between one and two years; and birds older than two years (adults). Each category is represented by a box. The age class of first-year birds represents birds fledged during the previous summer (< 1 year old). For simulation purposes it was assumed that the rate of fledged birds in the first year is 1.08 chicks per breeding pair. This number is based on the number reported by Griffin and Hoopes (1992) for this colony in 1990. During their first year, a proportion of the fledgling population dies of natural or other causes not related to gull reduction strategies. For simulation purposes, a rate of 73 percent survival of birds during their first year was used. In the absence of more recent reliable data for Laughing Gulls, this rate was based on the reported rate by Kadlec and Drury (1968) for Herring Gulls; a comparable species.

Population Reduction Potential: This starting population can be reduced by alternatives which reduce the number of successful breeding attempts in the subsequent year. This represents the first opportunity to reduce the population. Alternatives which fall in this category are those that limit the availability of nest sites up front by habitat alteration and those that reduce nesting activities once they are underway, such as nest and egg destruction and egg oiling.

Second-Year Birds: Some gulls die during their first year even without any man-induced population reduction, The fledglings which survive their first year until the mean hatching date the following year (approximately mid-June) become second year birds (≥ 1 year old to ≤ 2 years old). For modeling purposes it was assumed that 79.7 percent of the birds would survive their second year. In the absence of recent reliable data for Laughing Gulls, the rate was based on the adult rate for Herring Gulls estimated by Cavanagh and Griffin (1992). Because a rate of a different species was used, the initial size of the population and corresponding size of the population after treatments could vary depending on a higher or lower true survival level for Laughing Gulls than that for Herring Gulls. However, because the model is meant for comparative purposes only and is not meant to represent actual present or future population size, the use of Herring Gull survival rates instead of Laughing Gull rates would not affect relative differences in population reduction among the different alternatives simulated.

Population Reduction Potential: The model assumes that the number of second year birds cannot be reduced substantially by the proposed management strategies because relatively few birds in this age class return to the Jamaica Bay area until they are two years or older (adults). The relatively small number of gulls of this age class shot at JFKIA during 1992 (Dolbeer et al. 1993) suggests that this age class does not comprise a large proportion (9%) of the Jamaica Bay Laughing Gull population during summer.

Adult Birds (more than two years old): Those second year birds that do survive until the next breeding season are considered adults (> 2 years old). For modeling purposes it was assumed that 79.7 percent of the adult birds would survive annually, based on the rates for adult Herring Gulls estimated by Cavanagh and Griffin (1992).

For simulation purposes, Laughing Gulls at Jamaica Bay were assumed to first breed in their third year as adults. Grant (1986) reported that Laughing Gulls do not obtain adult breeding plumage until their third summer and are considered not to breed until this time. Therefore, the age class of adult birds represents both non-breeding adults and breeding adults. These birds remain in the population as breeders or non-breeders until they die. It was assumed that 50 percent of the chicks would be female and would become part of the reproductive cycle of the population.

Population Reduction Potential: This stage represents the second opportunity to reduce the population number. This involves the reduction of adults which can be achieved by toxicant application or shooting.

- **Simulated Reference Population (No Population Reduction)**

To assess the effects of different lethal alternatives on the Laughing Gull colony population, a hypothetical base population was established by simulating the development of the assumed carrying capacity population of the Jamaica Bay colony (8,000 pairs). The population growth of the 8,000-pair starting population was simulated for a period of for 40 years. After this period, the distribution of different age groups no longer substantially changed. It was therefore assumed that this represented the age distribution of the Laughing Gull population. Together with the other parameters described above, age distribution describes the hypothetical population on which the effects of different lethal alternatives were calculated. The stable age class distribution was 22 percent first-year birds, 16 percent second-year birds and 62 percent adults During these simulations, survival rates and recruitment rates were assumed constant. The total hypothetical reference population, after stabilization of the age structure, was calculated to be 39,230 Laughing Gulls, of which 34 percent were non-breeding.

For several reasons, the size of the simulated maximum population varies, and is higher than the actual size of the breeding populations, which has been counted during several years. This is because 1) Most Laughing Gulls, after the year of birth do not return to the colony site until they are two years old. However, contrary to the actual situation, the model assumes that all age classes of Laughing Gulls are included and not only birds more than two years old; 2) the simulated total also includes non-breeding adults and not only; those that are nesting and 3) in some simulations the totals also take into account possible immigration of substantial numbers of Laughing Gulls which are not counted as part of the nest counts of the Jamaica Bay Laughing Gull colony. The effects of immigration on the simulated Laughing Gull population are discussed below.

- **The Effect of Immigration on the Simulated Reference Population**

Another aspect of the Laughing Gull population which can affect its development over time and its susceptibility to population reduction alternatives is the potential for immigration of Laughing Gulls into the Jamaica Bay population which were not born in Jamaica Bay. Generally speaking, a high level of immigration can counteract the population reduction achieved by different alternatives. Furthermore, the population reduction achieved by certain types of alternatives may be more affected by immigration than others.

Band recovery data (Dolbeer et al. 1993) and nest counts (R.A. Dolbeer, pers. comm.) indicate that Laughing Gulls from elsewhere migrate into the Jamaica Bay Laughing Gull colony. Band recoveries were made at JFKIA from Laughing Gulls banded as chicks outside Jamaica Bay. (in New Jersey, and several as far away as Virginia). Additionally, the fact that high numbers of Laughing Gulls were nesting in Jamaica Bay in 1993 (more than 6,000 pairs; R.A. Dolbeer, pers. comm.) despite two seasons of extensive shooting of gulls at JFKIA (total of 26,038 gulls shot) further suggests that there is extensive immigration into the area.

No data are available which would provide a basis for determining the extent of immigration into the Jamaica Bay population. In addition to the assumption of no immigration it was therefore assumed for simulation purposes that immigration might contribute 20 percent, 40 percent or 60 percent of the breeding population (16,000 gulls) to the Jamaica Bay Laughing Gull population annually. While the simulation does allow immigrant birds to enter the general Jamaica Bay population at the beginning of the breeding season, they are considered non-breeders during their first year of entry. For simulation purposes it is assumed that none of these immigrant birds start breeding and enter the breeding population until the following year, even if a nest site becomes open as a result of a particular alternative.

Because all immigrant birds are considered non-breeders at their time of immigration, the level of immigration directly affects the proportion of breeding adults in the Jamaica Bay Laughing Gull population. Furthermore, the influx of varying numbers of adult immigrant birds increases the proportion of adult birds in the Jamaica Bay Laughing Gull population and thus affects the age distribution of a simulated population. As these are determining aspects of population, growth, hypothetical baseline populations were calculated for all four assumed levels of immigration.

- **Reference Populations Resulting From Different Assumptions of Immigration**

As mentioned before, a base population assuming no immigration was calculated to be 39,230 Laughing Gulls, of which 34 percent were non-breeding. In light of the information considered above, the base population was also calculated assuming different levels of immigration. During each of the 40 years of simulation, the pertinent number of immigrant birds (3200 or 20 percent, 6400 or 40 percent, or 9600 or 60 percent) was added to the population. Survival rates and recruitment rates were assumed constant, similar to the calculation of the base population for the no-immigration scenario. The increase in the breeding proportion of the Laughing Gull population as a result of immigration over a period of 40 years was substantial. It increased from 34 percent of the adult population under the no-immigration scenario to 77 percent under the maximum immigration scenario. Consequently, the simulated base population for the maximum immigration scenario was calculated to be 85,990 Laughing Gulls, which is substantially higher than the calculated base population assuming no immigration into the Jamaica Bay colony (39,230). As mentioned earlier, none of the non-breeding adults are assumed to enter the breeding population until the following year even if a nest site becomes open due to a gull management action. An overview of the reference population for different immigration assumptions is presented in Table 3-2.

3.1.3.3.3 Alternatives Simulated

Effects of several alternatives were simulated regarding the extent to which they could result in reduction of the Jamaica Bay Laughing Gull population. The simulations were conducted assuming various levels of immigration and consequently, various calculated base populations. The simulations were conducted for a period extending 20 years to determine the immediate, short-term and long-term population reduction effects of different alternatives under different immigration conditions. The results are tabulated in Table 3-3[1] and graphically depicted for each alternative in the section which discusses the operational effectiveness in reducing the Jamaica Bay Laughing Gull population. In addition, for the purpose of impact analysis, the reduction of the regional Laughing Gull population as a result of these alternatives was also simulated. The impacts on the viability of the regional Laughing Gull population are presented in Table 3-3 and graphically depicted in Figure 5-2 in Section 5.6.1.1.

- **Types of Population Reduction Simulated**

Simulations were conducted for two types of effects on the Jamaica Bay Laughing Gull population that might occur as a result of implementing different alternatives. One category of simulations reflects those

[1] Total reference populations in Table 3-3 represent actual model inputs. They differ slightly from the reference population numbers presented in Table 3-2. However, this is solely due to rounding and has no effect on simulation results.

Table 3-2

Age Class Distributions Derived for Simulated Laughing Gull Populations in Jamaica Bay and the Regional (MA, NY, & NJ) Models

	Year Class[1]				
Assumed Immigration Levels	**First[1] n (%)**	**Second[2] n (%)**	**Adult[3] n (%)**	**Total**	**% Nonbreeding Adults**
No immigration	8,640 (22)	6,307 (16)	24,283 (62)	39,230	34%
20% immigration	8,640 (16)	6,307 (11)	39,740 (73)	54,687	60%
40% immigration	8,640 (12)	6,307 (9)	55,196 (79)	70,143	71%
60% immigration	8,640 (10)	6,307 (7)	70,653 (83)	85,599	77%
Regional model	73,440 (22)	53,611 (16)	206,405 (62)	333,456	33%

[1] birds fledged during the previous summer (< 1 year old)

[2] birds that survive until the mean hatching date (approximately mid-June) of the year following their hatch year (≥ 1 year old to ≤ 2 years old)

[3] all second year birds that survive at least until the next breeding season or longer (> 2 years old)

Table 3-3
Gull Hazard Reduction Alternatives
Simulation Results

HAZARD REDUCTION ALTERNATIVES	STARTING POPULATION (0 Years)	% REDUCTION (cumulative) 3 Years		5 Years		10 Years		15 Years		20 Years	
A. Nest Reduction (average)		-21.56%		-29.54%		-42.80%		-42.45%		-43.54%	
1. No Immigration (average)		-31.73%		-43.48%		-57.72%		-62.50%		-64.10%	
a. No nest reduction	39,127	0.1%	39,177	0.2%	39,196	0.2%	39,220	0.2%	39,224	0.3%	39,230
b. 30% nest reduction	39,127	-14.6%	33,424	-20.0%	31,312	-26.5%	28,753	-28.7%	27,895	-29.4%	27,607
c. 65% nest reduction	39,127	-31.7%	26,713	-43.5%	22,114	-57.7%	16,542	-62.5%	14,674	-64.1%	14,047
d. 100% nest reduction	39,127	-48.9%	20,000	-67.0%	12,916	-88.9%	4,331	-96.3%	1,452	-98.8%	487
2. 20% Immigration (average)		-22.65%		-31.04%		-41.21%		-44.61%		-45.76%	
a. No nest reduction	54,391	0.3%	54,535	0.4%	54,590	0.5%	54,657	0.5%	54,679	0.5%	54,687
b. 30% nest reduction	54,391	-10.3%	48,782	-14.1%	46,706	-18.8%	44,190	-20.3%	43,346	-20.8%	43,064
c. 65% nest reduction	54,391	-22.7%	42,070	-31.0%	37,507	-41.2%	31,979	-44.6%	30,125	-45.8%	29,504
d. 100% nest reduction	54,391	-35.0%	35,358	-48.0%	28,309	-63.7%	19,768	-68.9%	16,904	-70.7%	15,944
3. 40% Immigration (average)		-17.55%		-24.05%		-46.28%		-34.57%		-35.45%	
a. No nest reduction	69,654	0.3%	69,892	0.5%	69,983	0.6%	70,094	0.7%	70,131	0.7%	70,143
b. 30% nest reduction	69,654	-7.9%	64,139	-10.8%	62,099	-14.4%	59,627	-15.6%	58,798	-16.0%	58,520
c. 65% nest reduction	69,654	-17.6%	57,428	-24.1%	52,901	-75.0%	17,416	-34.6%	45,577	-35.5%	44,960
d. 100% nest reduction	69,654	-27.2%	50,716	-37.3%	43,702	-49.5%	35,205	-53.5%	32,356	-54.9%	31,400
4. 60% Immigration (average)		-14.29%		-19.58%		-25.98%		-28.13%		-28.85%	
a. No nest reduction	84,918	0.4%	85,250	0.5%	85,377	0.7%	85,531	0.8%	85,582	0.8%	85,599
b. 30% nest reduction	84,918	-6.4%	79,497	-8.7%	77,492	-11.6%	75,064	-12.6%	74,250	-12.9%	73,977
c. 65% nest reduction	84,918	-14.3%	72,785	-19.6%	68,294	-26.0%	62,853	-28.1%	61,028	-28.9%	60,417
d. 100% nest reduction	84,918	-22.2%	66,073	-30.4%	59,096	-40.4%	50,642	-43.7%	47,807	-44.8%	46,856
B. Toxicant Application (average)		-59.0%		-68.5%		-64.3%		-53.1%		-40.0%	
1. No Immigration (average)		-81.85%		-91.03%		-92.22%		-89.35%		-85.19%	
a. No toxicant	39,127	0.1%	39,177	0.2%	39,197	0.2%	39,220	0.3%	39,227	0.3%	39,230
b. Toxicant for 3 years	39,127	-81.9%	7,100	-78.8%	8,282	-70.8%	11,430	-59.3%	15,907	-43.4%	22,132
c. Toxicant for 5 years	39,127	-81.9%	7,100	-94.1%	2,318	-91.3%	3,409	-87.9%	4,736	-83.2%	6,590
d. Toxicant for 10 years	39,127	-81.9%	7,100	-94.1%	2,318	-99.7%	124	-99.5%	180	-99.4%	250
e. Toxicant for 15 years	39,127	-81.9%	7,100	-94.1%	2,318	-99.7%	124	-100.0%	7	-100.0%	10
f. Toxicant for 20 years	39,127	-81.9%	7,100	-94.1%	2,318	-99.7%	124	-100.0%	7	-100.0%	0
2. 20% Immigration (average)		-63.94%		-73.08%		-62.09%		-46.38%		-29.28%	
a. No toxicant	54,391	0.3%	54,535	0.4%	54,590	0.5%	54,657	0.5%	54,679	0.5%	54,687
b. Toxicant for 3 years	54,391	-63.9%	19,615	-40.3%	32,498	-12.2%	47,731	-3.5%	52,508	-0.7%	54,006
c. Toxicant for 5 years	54,391	-63.9%	19,615	-81.3%	10,177	-34.0%	35,880	-10.3%	48,791	-2.9%	52,840
d. Toxicant for 10 years	54,391	-63.9%	19,615	-81.3%	10,177	-88.1%	6,493	-41.3%	31,934	-12.6%	47,558
d. Toxicant for 15 years	54,391	-63.9%	19,615	-81.3%	10,177	-88.1%	6,493	-88.4%	6,295	-41.8%	31,646
e. Toxicant for 20 years	54,391	-63.9%	19,615	-81.3%	10,177	-88.1%	6,493	-88.4%	6,295	-88.4%	6,284
3. 40% Immigration (average)		-49.73%		-60.50%		-54.43%		-39.77%		-23.71%	
a. No toxicant	69,654	0.3%	69,892	0.4%	69,903	0.6%	70,094	0.7%	70,131	0.7%	70,143
b. Toxicant for 3 years	69,654	-49.7%	35,015	-30.6%	48,322	-10.0%	62,658	-2.4%	68,003	-0.3%	69,476
c. Toxicant for 5 years	69,654	-49.7%	35,015	-68.0%	22,311	-18.4%	56,841	-6.0%	65,487	-1.4%	68,687
d. Toxicant for 10 years	69,654	-49.7%	35,015	-68.0%	22,311	-81.2%	13,066	-26.7%	51,073	-7.9%	64,167
e. Toxicant for 15 years	69,654	-49.7%	35,015	-68.0%	22,311	-81.2%	13,066	-81.9%	12,594	-27.1%	50,798
f. Toxicant for 20 years	69,654	-49.7%	35,015	-68.0%	22,311	-81.2%	13,066	-81.9%	12,594	-82.0%	12,568
4. 60% Immigration (average)		-40.63%		-49.44%		-48.55%		-36.70%		-21.79%	
a. No toxicant	84,918	0.4%	85,250	0.5%	85,377	0.7%	85,531	0.8%	85,582	0.8%	85,599
b. Toxicant for 3 years	84,918	-40.6%	50,415	-24.9%	63,743	-7.3%	78,752	-1.7%	83,458	0.0%	84,934
c. Toxicant for 5 years	84,918	-40.6%	50,415	-55.6%	37,733	-16.7%	70,728	-4.7%	80,942	-0.9%	84,145
d. Toxicant for 10 years	84,918	-40.6%	50,415	-55.6%	37,733	-72.9%	22,984	-22.2%	66,103	-6.4%	79,491
e. Toxicant for 15 years	84,918	-40.6%	50,415	-55.6%	37,733	-72.9%	22,984	-77.5%	19,124	-23.9%	64,659
f. Toxicant for 20 years	84,918	-40.6%	50,415	-55.6%	37,733	-72.9%	22,984	-77.5%	19,124	-77.8%	18,864
C. ANNUAL SHOOTING (average)		-30.37%		-45.83%		-56.00%		-57.45%		-65.35%	
1. No Immigration	39,127	-54.6%	17,750	-77.3%	8,868	-96.0%	1,549	-99.3%	271	-99.9%	47
2. 20% Immigration	54,391	-37.8%	33,843	-57.1%	23,336	-77.7%	12,137	-82.4%	9,569	-83.2%	9,120
3. 40% Immigration	69,654	-29.4%	49,201	-44.3%	38,831	-49.7%	35,020	-49.5%	35,155	-62.7%	26,010
4. 60% Immigration	84,918	-24.0%	64,558	-36.1%	54,224	-40.6%	50,457	-40.4%	50,606	-50.1%	42,336

COMBINED STRATEGIES

D. NEST REDUCTION & TOXICANT (3 YRS)		-70.6%		-64.3%		-56.2%		-53.6%		-52.7%	
1. 20% Immigration (average)		-79.4%		-72.9%		-63.5%		-60.4%		-59.4%	
a. 65% nest reduction	54,391	-76.1%	12,999	-67.2%	17,853	-53.2%	25,453	-48.5%	28,018	-47.0%	28,822
b. 100% nest reduction	54,391	-82.6%	9,437	-78.5%	11,672	-73.8%	14,271	-72.3%	15,087	-71.8%	15,342
2. 40% Immigration (average)		-61.8%		-55.8%		-48.9%		-46.7%		-46.1%	
a. 65% nest reduction	69,654	-59.2%	28,399	-50.4%	34,523	-40.5%	41,474	-37.3%	43,653	-36.3%	44,337
b. 100% nest reduction	69,654	-64.3%	24,837	-61.1%	27,094	-57.3%	29,719	-56.2%	30,542	-55.8%	30,800
E. NEST REDUCTION & ANNUAL SHOOTING		-59.5%		-80.7%		-86.7%		-87.0%		-87.1%	
1. 20% Immigration		-66.9%		-86.0%		-88.4%		-88.7%		-88.8%	
a. 65% nest reduction	54,391	-60.7%	21,378	-79.5%	11,135	-82.8%	9,366	-83.3%	9,084	-83.4%	9,035
b. 100% nest reduction	54,391	-73.0%	14,667	-92.4%	4,108	-94.1%	3,202	-94.1%	3,200	-94.1%	3,200
2. 40% Immigration		-52.1%		-75.4%		-84.9%		-85.3%		-85.5%	
a. 65% nest reduction	69,654	-47.3%	36,736	-68.8%	21,748	-79.1%	14,582	-79.8%	14,053	-80.4%	13,658
b.. 100% nest reduction	69,654	-56.9%	30,024	-82.0%	12,550	-90.8%	6,424	-90.8%	6,405	-90.7%	6,491
F. ANNUAL SHOOTING & TOXICANT (3 YRS)		-84.1%		-84.7%		-83.6%		-78.8%		-76.0%	
1. No Immigration	39,127	-91.2%	3,440	-96.0%	1,551	-99.4%	225	-99.9%	34	-100.0%	5
2. 20% Immigration	54,391	-85.0%	8,141	-84.4%	8,476	-83.5%	8,960	-83.4%	9,016	-83.4%	9,023
3. 40% Immigration	69,654	-76.1%	16,672	-73.6%	18,400	-67.8%	22,429	-53.1%	32,689	-44.7%	38,493
G. ANNUAL SHOOTING, NEST REDUCTION, & TOXICANT (3 YRS)		-90.4%		-90.7%		-89.9%		-89.7%		-89.7%	
1. 20% Immigration (avg)		-92.7%		-92.8%		-92.7%		-92.7%		-92.7%	
a. 65% nest reduction	54,391	-91.3%	4,738	-91.5%	4,604	-91.2%	4,770	-91.2%	4,771	-91.2%	4,771
b. 100% nest reduction	54,391	-94.1%	3,200	-94.1%	3,200	-94.1%	3,200	-94.1%	3,200	-94.1%	3,200
2. 40% Immigration (avg)		-88.1%		-88.6%		-87.1%		-86.7%		-86.7%	
a. 65% nest reduction	69,654	-85.6%	10,056	-86.5%	9,422	-84.4%	10,861	-83.7%	11,328	-82.8%	11,949
b.. 100% nest reduction	69,654	-90.7%	6,494	-90.8%	6,400	-89.8%	7,085	-89.6%	7,210	-90.6%	6,533

H. ANNUAL SHOOTING REGIONAL IMPACTS (1 of 10 simulations)	333,308	-5.2%	315,977	-7.9%	307,095	-10.5%	298,251	-10.5%	298,172	-9.1%	303,095

alternatives which might result in reducing the reproductive capacity of the Laughing Gull colony by reduction of nests. Alternatives in this category are reduction of nesting opportunities up front by reducing the available area for nesting sites by devegetation or landform alteration, and by the reduction of successful breeding attempts by destruction of nests or eggs or egg oiling. These alternatives were simulated in the model by reducing the number of successfully hatched chicks in the population. A second category reflects those alternatives which result in the reduction of adult Laughing Gulls. Alternatives in this category include toxicant application to adult gulls and shooting of adult gulls. These alternatives were simulated in the model by reducing the number of adults in the population.

The following alternatives were simulated for their effect on the Jamaica Bay Laughing Gull population.

1. Alternatives with no effect on the population (including the No-Action alternative):

- Reference populations assuming different levels of immigration.

2. Alternatives which Reduce Reproductive Capacity:

- Reduction of available area as nesting habitat or reducing of suitability of colony site through vegetation alteration (burning, mowing herbicides, deterrent vegetation) or permanent landform alteration of the colony site to reduce the numbers of potential nest sites.

- Annual destruction of nests and eggs; all eggs in the colony site oiled annually.

The successful reduction of all nests, either by destruction or oiling, by 30 percent, 65 percent and 100 percent was simulated. For vegetation and landform alteration alternatives this was assumed to be realized by eliminating 30, 60 or 100 percent of the suitable nesting habitat.

3. Alternatives which Reduce the Adult Population:

- Toxicant application prior to and during the nesting period for 3 years, 5 years, 10 years, 15 years and 20 years.
- Shooting of Laughing Gulls annually at levels comparable to those obtained during the 1991-1993 gull management programs at JFKIA.

For toxicant application, a successful adult reduction rate of 69 percent was assumed for simulation purposes. This rate is based on Herring Gull control efforts conducted on Ram Island, Massachusetts in 1990. Two toxicant applications at this location resulted in a mortality of 69% of nesting female Herring Gulls (Cavanagh and Griffin 1990).

For shooting, the adult reduction rate was varied randomly between 4,000 and 13,000 Laughing Gulls annually for a period of twenty years. The lower and upper limit reflect the adult reduction as a result of on-airport shooting during the 1990-1993 period.

For modeling purposes, it was assumed that nest sites that had become available as a result of the elimination of breeding adults would not be occupied by non-breeders until the subsequent breeding season.

Similarly, the age class distribution was determined from the regional Laughing Gull model to estimate the numbers of non-breeding adults in the population. To initialize the model, the age distributions were set for the first two age classes at 73,440 first year birds and 53,611 second year birds. The same recruitment and survival parameters were used as in the Jamaica Bay model above. The number of breeding pairs in the region was set at 68,000 pairs. The population was simulated for 30 years to derive a stable age distribution. This simulation provided an estimate of 33 for the percentage of non-breeding adults in the regional population. The regional population was considered closed to immigration.

3.2 No-Action Alternative

Under the No-Action Alternative, The Port Authority would continue its bird-hazard reduction program it currently operates in an effort to manage the birdstrike hazard. It should be emphasized that this does not include the Interim Operational Gull Control Program involving intensive on-airport shooting. The existing program consists of five major elements: vegetation management (tall grass management), water management, insect control, sanitation management, and Bird Control Unit (BCU) (described in Chapter 1, and supporting documentation is provided in Appendix C).

3.2.1 On-Airport Vegetation Management (Tall Grass Management)

Under the No-Action Alternative, the Port Authority would continue its implementation of management elements recommended in the vegetation management study conducted on behalf of the Port Authority in 1987 (Gurien 1987). Like many bird species, gulls utilize short-grass areas for loafing and feeding. Short grass permits acquisition of insect foods, as well as unobstructed visibility. The objective of JFKIA's grass management regime is to maintain grass at a height that will not be utilized by gulls and other birds. Airside areas of JFKIA will be excluded from grass cutting from May 1 through August 1, in order to reduce the attractant value for birds, especially gulls (Figure 3-2). For aviation safety and fire hazard concerns, limited grass cutting will continue to occur near specific small areas, such as immediately around propane scare guns, approach lighting, and signs.

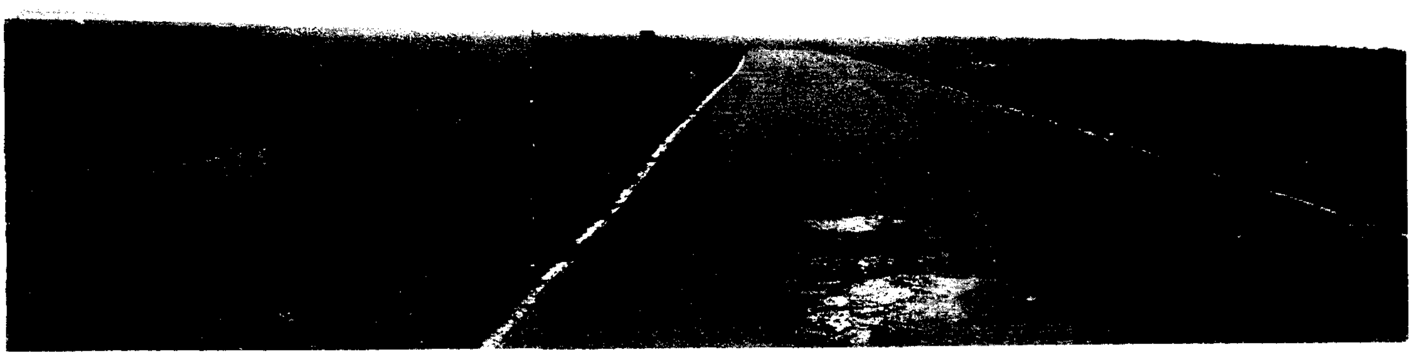
According to literature (Blokpoel 1976, Brough and Bridgman 1980) and studies conducted for the Port Authority (Gurien 1987), maintaining tall grass can be effective in discouraging birds, especially gulls, from using these areas.

Timing of grass cutting will continue to occur during the fall and spring periods only and no more than four times per year. Grass would continue to be cut during one-week intervals on landside areas adjacent to the Van Wyck Expressway, cargo areas and North Boundary Road. These areas have not been shown to provide substantial attractant to the four gull species and represent a very small percentage of all grass areas at JFKIA.

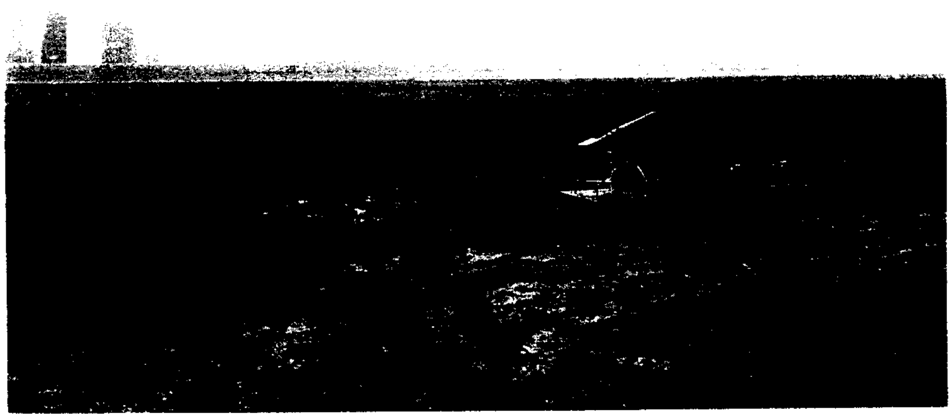
In addition to the long-grass management policy, under the No-Action Alternative, the Port Authority would continue to conduct the following activities:

1. Review of landscaping and redevelopment plans to ensure continued absence of plants that may be attractive to wildlife. Wildlife biologists from the USDA will continue to review proposed plans, as will offices within the Port Authority.

Existing On-Airport Management Program: Site Views



Existing On-Airport Management Program: Long Grass Management.



Existing On-Airport Hazard Management Program: Deterrence Sound Devices.

Source: Louis Berger & Associates, Inc., 1993.

FIGURE 3-2

2. Utilization of Non-Bird Attracting Plantings and Design Structures. Landscaping will conform to the list of approved plantings (Section 1.4.3.2).

3. Continued monitoring of existing vegetation to determine bird attractant values over time.

3.2.2 On-Airport Water Management

Under the No-Action Alternative, the Port Authority would continue its program to eliminate accumulations of water on the airport and/or make such areas unattractive to gulls, consistent with the recommendations of past studies (Gurien 1987, Griffin and Hoopes 1991). These studies indicated that areas of standing fresh water were an attractant. The existing water management program has included elimination of ponded areas identified in these studies, either through improved drainage (between taxiways H and J) or filled with topsoil (near 31R middle marker). No other major wet areas have since developed or were allowed to persist. In addition, the Port Authority has initialized the construction of a drainage system running the full length of the north/south runway and taxi network (see Figure 3-3). During 1992, the Port Authority completed eight (8) major projects to improve drainage through installation of wick drains, and conduct of repaving and filling projects (see Figure 3-4).

The Bird Control Unit (BCU) would continue with its monitoring of water pools after heavy rainfall. Small pools of water that accumulate after heavy rains and are identified by the BCU are dispersed for more rapid evaporation, eliminated by grooves carved in the pavement, and the BCU will submit work requests for draining or filling.

Under the existing management program, the use of a U.S. EPA-registered bird taste repellent (Methyl Anthranilate, or MA) would be used operationally, pending formal registration with the EPA. MA would be applied to water in the intervening period before such ponding can be eliminated by drainage or fill, in order to deter birds from utilizing these locations. Final registration of MA for operational use on airports may occur as early as May, 1994; MA registration is currently pending EPA approval. Once formal registration is complete, the Port Authority will incorporate its operational use at JFKIA. All temporary pools of water will be treated with MA until long-term water reduction activities occur or as appropriate.

Continued reduction of water on the airport will reduce the area's attractiveness to Herring Gulls, Ring-billed Gulls, Great Black-backed Gulls, and Laughing Gulls.

3.2.3 On-Airport Insect Control

The continuation of existing on-airport management strategies under the No-Action Alternative will also include the continued reduction of the attractant value of grassy areas at JFKIA through reduction of the amount of insects present in these areas. To the extent that insects (especially beetles) in these areas are a potential food source for Laughing Gulls, the reduction of the availability of this food may reduce the presence of Laughing Gulls at the airport and thus reduce the potential for birdstrikes. According to insect control procedures in effect at JFKIA during the past ten years, insect control focuses on beetles and chafers. Current practice is a tiered approach that involved monitoring, initial treatment with ABATE-4 and follow-treatment with Di-Brome-14. The presence of Japanese beetles is monitored by USDA APHIS, to determine if and when intensive spraying is required. The treatment is repeated every

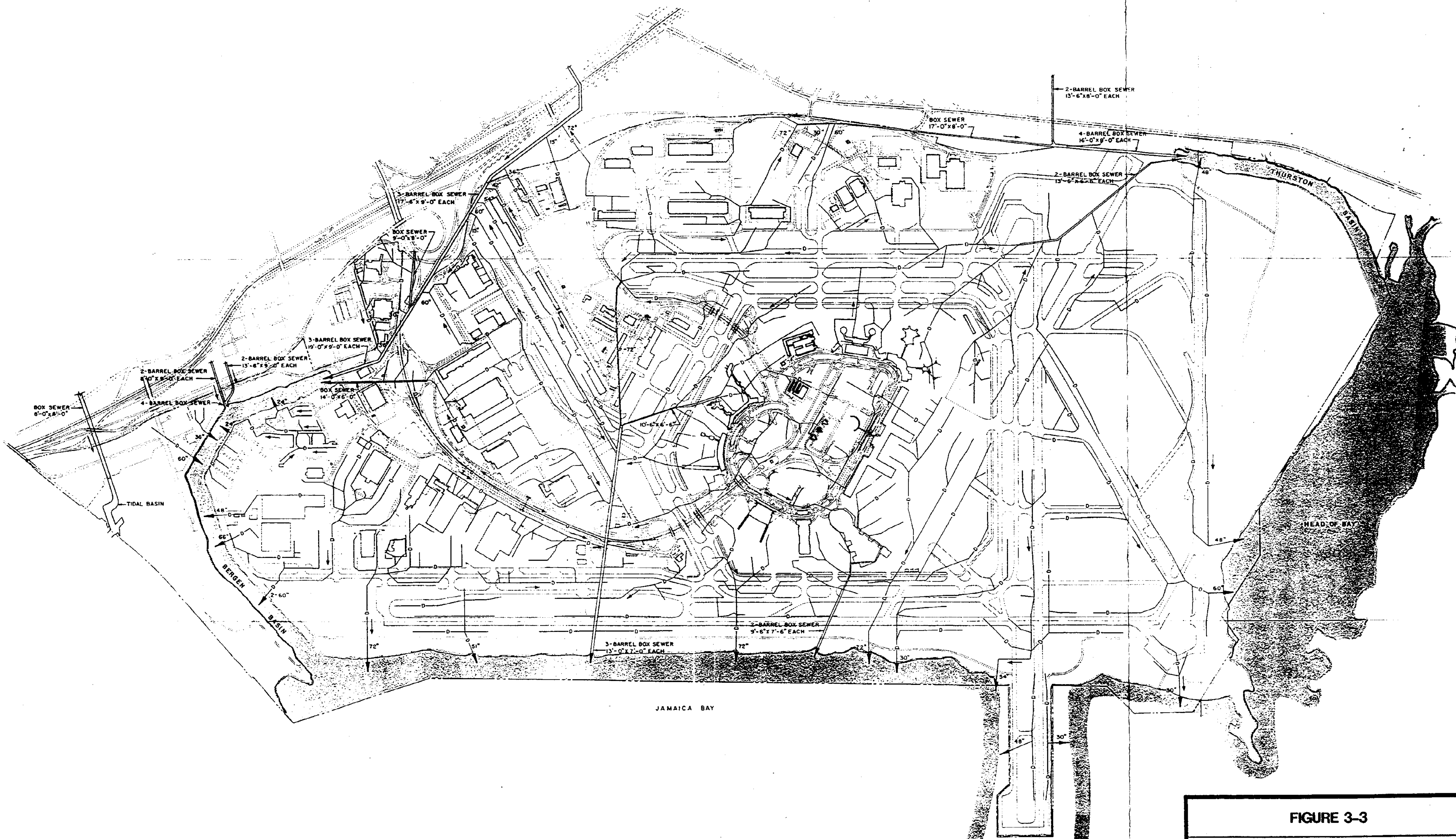
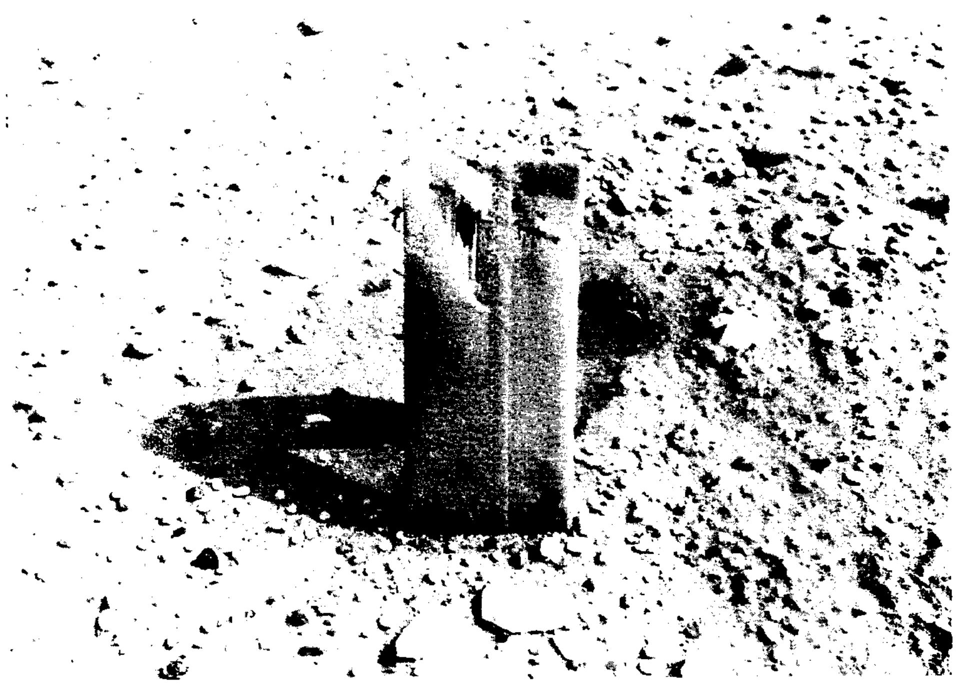


FIGURE 3-3

Airport Drainage Plan
(in progress)

Source: Port Authority of New York & New Jersey, 1993.

Existing On-Airport Management Program: Wick devices to improve drainage and prevent ponding as an attractant.



Wick device detail.

FIGURE 3-4

two weeks if justified by the number of insects that have been trapped, indicating a resurgence of the insect population. Spraying is conducted primarily in the morning and is coordinated with airport operations to minimize potential risks to humans. Applications of insecticide will continue to be included as part of JFKIA's ongoing bird hazard reduction program. Continued monitoring will indicate emergence of new species or population changes of species already present.

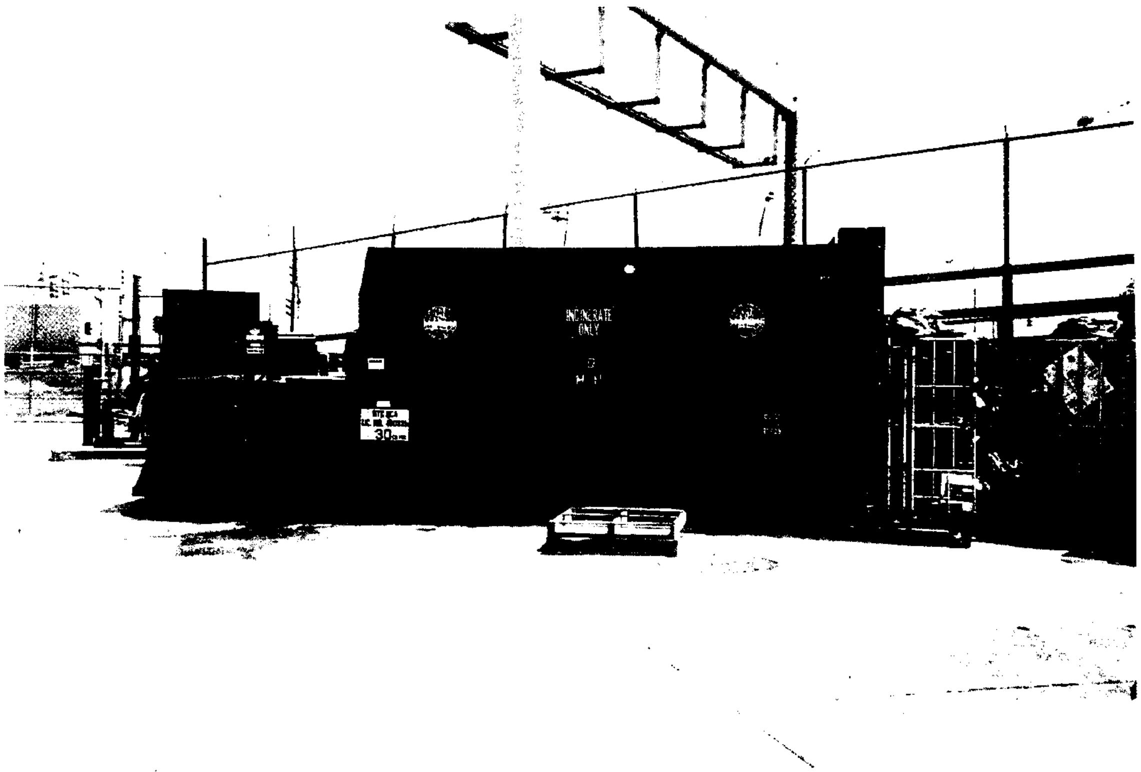
3.2.4 On-Airport Sanitation Management

On-airport sanitation management involves reduction or elimination of human-generated waste materials, many of which are potential food items or are otherwise attractive to Herring, Ring-billed, Great Black-backed, and Laughing gulls, as well as other bird species. Waste reduction activities at JFKIA are evolving, and include refuse containment practices, taxi driver education program (to reduce the extent of feeding of birds by taxi drivers), roving trucks to collect bulk debris, and sanitation policy enforcement. These activities are set forth in Chapter 1 (Section 1.4.3.3).

The expert panel of ornithologists on the JFKIA bird-aircraft collision hazard in 1989 found that "...most of the Laughing Gull strikes involve adult birds traversing the airfield whilst collecting food for their young," and therefore that on-airport food sources—if any—are not the main cause of Laughing Gull-airport collisions at JFKIA. However, it appears that the large majority of the Laughing Gulls involved in collisions are traversing JFKIA airspace as they travel between the Jamaica Bay colony and off-airport feeding sites that are abundantly distributed throughout Queens and western Long Island. In order to reduce the possibility of Laughing and other gull attractants on JFKIA, it has been the Port Authority's goal to reduce any potential for such attraction to the greatest extent possible by implementing a rigorous sanitation protocol for the airport. The control of waste on the airport will reduce the area's attractiveness to all four gull species: Herring Gull, Ring-billed Gull, Great Black-backed Gull, and Laughing Gull, and will also serve to reduce presence of other birds such as pigeons, starlings, and English sparrows.

The Port Authority has installed on-airport trash compactors which, in combination with a clearly dictated protocol for refuse disposal to airlines, reduce the presence of non-recyclable refuse on the airport (Figure 3-5). It is also the Port Authority's policy that all organic matter is placed in plastic garbage bags and maintained in closed containers, which are emptied five to seven times per week. The Port Authority conducts ongoing efforts to minimize any attractants to birds at taxi stands by posting signs prohibiting the feeding of birds and mandating the placement of trash in trash cans (see Figure 3-5).

In addition, the existing taxi driver education program would be continued via the posting of signs and handbills. The removal of any bulk debris along airport highways and side roads will continue to be assured by three roving trucks. The long-standing policies at JFKIA to report airside and landside bird observations, place trash in closed containers, and prohibit bird feeding will continue to be communicated to airport users with increased vigor. Finally, the Port Authority periodically reminds commissaries to use waste management equipment and methods that do not attract birds. The Port Authority also monitors their compliance.



Existing On-Airport Management Program: Compactor at Terminal 1A-Recyclables to the right.

Existing On-Airport Management Program: Trash prevention measures in taxi areas.

FIGURE 3-5

3.2.5 On-Airport Bird Control Unit

As part of the No-Action Alternative, the JFKIA BCU will continue to conduct its established program in accordance with accepted and prescribed aeronautical standards, and as fully described in Section 1.4.4. Activities conducted by the Bird Control Unit at JFKIA to reduce the incidence of bird-aircraft collision are as follows.

- collection of birdstrike information (Section 1.1.1).
- runway sweeps prior to each runway opening, and as required and requested by the tower (Section 1.4.4)
- use of pyrotechnics, propane scare guns, and taped distress calls to harass bird away from the airport (Section 1.4.4)
- shooting to reinforce harassing effects of nonlethal techniques (Section 1.4.4)
- continue to issue Breach of Rules violations wherever airport tenants are observed creating attractants for birds (Section 1.4.4)
- monitoring and control of water accumulations

Additional information relative to the BCU activities and protocols is provided in Appendix C.

Activities of the BCU are directed at reducing collisions between all birds and aircraft at the airport; since gull present the most significant source of hazard, BCU activities are directed primarily at the four gull species: Herring Gulls, Laughing Gulls, Ring-billed Gulls, and Great Black-backed Gulls.

3.2.6 Evaluation

- **Technical Implementation Feasibility**

This approach is feasible, as it represents the procedure currently conducted at JFKIA.

- **Effectiveness**

Operational Effectiveness: As noted above, the bird hazard reduction procedures utilized at JFKIA are the standard ones recommended in the literature, and they are supposedly effective for dispersing birds that are roosting, loafing and feeding on the ground at the airport. Even when performed effectively, however, the BCU's procedures do not deter gulls from flying over the airport. Overflights of JFKIA by gulls were observed during systematic observations of the JFKIA environment by Griffin and Hoopes (1991), and during the several-day observations conducted by Buurma et al. (1989).

Ultimate Effectiveness: The increasing numbers of birdstrikes at JFKIA (USDA 1992) are clear evidence that standard bird control procedures conducted by the BCU on the airport have not been effective in controlling the birdstrike hazard posed by the proximity of the Laughing Gull colony to the airport.

- **Conclusion**

Although this alternative does not appear to be effective, it will be advanced for further environmental analysis as its effectiveness and environmental impacts are a benchmark against which the effectiveness and environmental impacts of other alternatives will be compared.

3.3 Nonlethal Gull Hazard Control: Off-Airport Alternatives

3.3.1 Nesting Habitat Modification

Of the four gull species that create hazards to aircraft at JFKIA, the Laughing Gull presents the single greatest threat to safe aircraft operations, and is the only species that occurs within a nesting colony adjacent to the airport's runways. The Nesting Habitat Modification alternatives (Marsh Devegetation, Planting of Breeding Areas With Shrubs, and Landform Alteration) are all directed at management of the Laughing Gull nesting colony that is located at the end of JFKIA Runway 4L. Ring-billed Gulls do not nest in the vicinity of JFKIA. Herring Gulls and Great Black-backed Gulls nest in a number of Jamaica Bay nesting colonies (Section 4.1.1.3 and 4.1.2.2), none of which are adjacent to the runways of JFKIA or appear to be directly linked to the increase in birdstrikes. For these reasons, the Nesting Habitat Modification Alternatives are directed at the Laughing Gull colony.

The rationale for habitat modification is to alter the existing nesting habitat at the Laughing Gull colony site in JBWR so that it would become unsuitable for Laughing Gull breeding. This would prevent the gulls from breeding successfully and would discontinue the attraction of Laughing Gulls to the site, thereby reducing the number of Laughing Gull-aircraft collisions at JFKIA.

- **Relation Between Birdstrikes and Colony Presence**

Most discussions of bird-control methodologies stress that habitat modification on or near the airport should be considered the most effective and longest-lasting element of a control program (Wright 1968, Blokpoel 1976, Thomas 1987, Burger 1983b, Transport Canada 1992). As discussed in Chapter 1, a large percentage of the gulls present in JFKIA airspace are adult Laughing Gulls that nest on the JoCo, Silver Hole, and East High Meadow salt marsh islands, which are adjacent to JFKIA. This colony consisted of 7,629 pairs in 1990 and 6,000 pairs in 1993. According to an international panel of bird-control experts convened to analyze the problem (Buurma, et al. 1989), "it is self-evident that the Laughing Gull colony in its present location presents an unacceptable hazard to aircraft operations at JFKIA." This is illustrated in Figure 1-5, which shows the correlation between Laughing Gull strikes and the number of nests in the Laughing Gull colony. Eliminating this breeding colony would probably substantially reduce the number of Laughing Gulls overflying the airport. It should be noted, however, that this action may not completely eliminate the problem of Laughing Gull flyovers, depending on the extent to which nonbreeding Laughing Gulls utilize Jamaica Bay and are responsible for birdstrikes.

- **Existing Nesting Habitat Characteristics of the Colony Site**

The explosive growth of the colony at this location indicates that these marshes and their environs provide excellent habitat for Laughing Gull nesting. The marshes meet many of the criteria discussed in Zale and Mulholland (1985) as contributing to habitat suitability for Laughing Gulls (although this model was designed for the Gulf Coast Laughing Gull population, many elements are also applicable to East Coast colonies): the maximum ground elevation is less than 2 feet, they are flat, they have essentially 100% coverage with herbaceous vegetation, and they support a low percentage of woody cover.

An important aspect of the substrate for this colony is that it consists of regularly flooded ("low") salt marsh interspersed with numerous pockets of irregularly flooded ("high") salt marsh (NYSDEC Tidal Wetlands Maps). Whereas most areas of low salt marsh are flooded twice daily by the tides, the elevation of high salt marsh is above that of mean high tide, and it is generally flooded only during abnormally high tides generated by storms. The vegetation of these high salt marshes is dominated by *Distichlis spicata, Spartina patens,* and the short form of *Spartina alterniflora*. Laughing Gulls typically nest in the higher areas of low salt marsh, or in areas of *alterniflora/patens* overlap (Burger 1979). By nesting in this location, the gulls generally face the hazard of severe flooding of their nests only by exceptionally high tides. During lesser flooding events, the tall grass helps to prevent the nest from washing away (Bongiorno 1970, Montevecchi 1978). However, it is critical that when nests in these areas are washed out by such tides, areas of high salt marsh be available for renesting attempts (Burger and Shisler 1980a). Flooding is a common cause of colony-wide reproductive failure in Laughing Gulls (Montevecchi 1978).

- **Alteration of Nesting Habitat Parameters to Discourage Nesting**

By altering one or more of the variables that are important to the suitability of these marshes for Laughing Gull nesting, the habitat could be rendered sufficiently unsuitable so that Laughing Gulls would either no longer be attracted to the marshes, or would be unable to reproduce successfully. Several methods of altering habitat parameters (e.g. vegetation, flooding) will be discussed in the following sections. In a study of colony and nest site selection in Laughing Gulls, Burger and Shisler (1980a) concluded that although gulls exhibit strong colony site tenacity (i.e, they always return to their original colony site), if they find that site to be unsuitable they will shift to a better one—Laughing Gulls forced to relocate by exceptionally high tides were observed to move to other islands within two or three kilometers of the original site. However, another colony that did not have nearby islands for relocation did not move and experienced severe reproductive failure.

3.3.1.1 Marsh Devegetation Measures

Because Laughing Gulls in this region nest only on tidal salt-marsh islands and strongly prefer tall *Spartina alterniflora* for their nest site, devegetating the colony site might cause Laughing Gulls to discontinue nesting on the present colony site. Three methods of devegetation have been considered: mowing, burning, and herbicide application. The model simulations conducted for vegetation alternatives fall in the category of reduction of the reproductive capacity of the Laughing Gull colony by reduction of nests by reducing the available area for nesting sites These alternatives were simulated in the model by reducing the number of successfully hatched chicks in the model population. For vegetation alternatives this was assumed to be realized by eliminating 30, 60 or 100 percent of the suitable nesting habitat.

Results of population modeling of the overall Jamaica Bay Laughing Gull population (not just the breeding colony) indicate that, for any type of management designed to reduce the number of nests, the number of gulls remaining in the Jamaica Bay population would vary depending on the level of reduction of nest sites and the amount of immigration into the colony from outside Jamaica Bay. Although the simulation model indicates that annual reduction of nests would reduce the number of gulls in the Jamaica Bay population substantially (especially for the 65% and 100% reduction scenarios) (Figures 3-11 and 3-12), this management strategy would not completely eliminate the Laughing Gull population unless nest destruction was 100% and immigration was zero. However, based on the apparent high replacement rate of breeders killed by on-airport shooting—the total of 24,000 adult Laughing Gulls shot in 1991-92 represents nearly 160% of the number of nesting individuals present in 1990—there is an abundant pool of nonbreeding birds in Jamaica Bay (Dolbeer et al. 1993).

3.3.1.1.1 Marsh Devegetation through Mowing

Devegetating the colony site through mowing might remove an important component of nest-site attraction, thus deterring at least some Laughing Gulls from nesting. Laughing Gulls arrived on colony sites in this region from mid to late April, when there is little evidence of live vegetation but when the previous year's dead marsh grasses are still present (Burger 1976). They do not begin to build nests for about 4 weeks (Montevecchi 1978). Laughing Gulls in a New Jersey salt marsh selected nest sites in *Spartina* about 35 cm (24 in) in height (Montevecchi 1978). Bongiorno (1970) found that within a large nesting colony in New Jersey, more Laughing Gull nests were built in *Spartina alterniflora* taller than 0.6 m (26 in) than in *Spartina* or mixed vegetation shorter than 0.4 m (16 in), and no nesting by Laughing Gulls occurred on 20x20-m plots on which the vegetation was mowed to a height of 3 cm (1.2 in) in April.

- **Technical Implementation Feasibility**

This form of habitat modification can be accomplished with "low-pressure" mowing machines designed to operate on soft substrates, assuming that the machines can be transported to the colony islands. Due to the unevenness of the terrain and presence of numerous ditches, the feasibility of this alternative is highly questionable.

Bongiorno (1970) indicated that the very wet conditions of his study site limited mowing (with an ordinary rotary power mower) to times when dry weather prevailed and no tidal inundation occurred. He mowed only once during the nesting season, but it should be anticipated that in this case more than one mowing might be necessary to retain the deterrent effect, since colony-site tenacity is likely to be exceptionally strong in gulls faced with no nearby alternative site (Burger and Shisler 1980a).

The colony site occupies about 114 ha (282 ac) of the 242 ha (605 ac) encompassed by the three marsh islands (Belant and Dolbeer 1992). Owing to the difficulty of operating in the salt-marsh terrain, it is probable that some portions of the entire colony site will be inaccessible and remain unmowed. At least some birds would probably nest in such areas, and others may move to the unmowed areas even though this may represent a suboptimal habitat. Hand-mowing is not considered technically feasible given the large area (282 acres) that needs to be treated.

If mowing proved to be an effective deterrent to Laughing Gulls, it would have to be done annually, or possibly even more often to keep grass at optimal short length.

- **Effectiveness**

Operational Effectiveness: If the Jamaica Bay Laughing Gulls react as negatively to mowing as those studied by Bongiorno in New Jersey, they may desert the colony site to search for more suitable habitat. Assuming they move to distant areas such as Great South Bay to the east, the population of Laughing Gulls in the immediate vicinity of JFKIA would be considerably reduced. It is not certain, however, that mowing would deter Laughing Gulls from nesting at this long-established site. Although no rigorous study has been done of the nest-site characteristics of the Jamaica Bay colony, an impression gained from a visit to the site in early July 1993 is that the Laughing Gulls at the Jamaica Bay colony site are nesting on *S. alterniflora* that is mostly relatively short (<0.6 m/24 in), with some nests on *S. patens* and *D. spicata* that tend to grow essentially horizontally (thus forming a matlike substrate). Therefore, mowing the vegetation on the Jamaica Bay colony site might not present as strong a contrast, nor have as strong a deterrent effect, as on Bongiorno's site in New Jersey.

Also, Bongiorno mowed only 20x20-m sample plots within a very large colony, so birds deterred by mowing apparently could relocate with relative ease on the same marsh. If the Laughing Gulls at the Jamaica Bay site encounter the entire colony site altered, leaving no close alternative site, they might simply accept the mowed site rather than move a considerable distance. (There is no equivalent area of suitable habitat in Jamaica Bay, and the closest possible site is 6 km (3.8 mi) east on Lawrence Marsh just inside East Rockaway Inlet.)

Population modeling for this study indicates that unless habitat modification is 100% effective at eliminating nest sites for Laughing Gulls, and unless no immigration occurs, the population will not be eliminated (Section 3.1.3.3).

Ultimate Effectiveness: Since more than 90% of the Laughing Gulls killed in the interim shooting program at JFKIA, which targeted only gulls entering JFKIA airspace, appear to be breeders from the Jamaica Bay colony (Dolbeer et al. 1993), it is likely that reduction of the colony would also reduce the number of gull strikes at the airport.

However, an additional complication to evaluating the probable ultimate effectiveness of this method of colony management is that the population of nonbreeding Laughing Gulls utilizing Jamaica Bay is apparently very high. Whereas the colony in 1990 totaled approximately 7,600 nests or more than 15,000 individuals (Griffin and Hoopes 1991), in 1991 and 1992 a total of about 24,000 adult Laughing Gulls were shot (Dolbeer et al. 1992). Yet 6,000 pairs still nested in 1993, indicating the presence of a large nonbreeding population available to replace breeders removed in the shooting program. These nonbreeding birds may roost in large numbers at the colony site. Since gulls typically roost in very open areas (Bent 1921), mowing the marsh is not likely to reduce its acceptability as a roosting site (and may even increase it); thus the area may remain an attractant to gulls even if the breeding birds are dispersed. In fact, if the site is not occupied by breeders, even more gulls (of several species, including the larger Herring and Great Black-backed gulls) may roost there than with the colony in place. Utilization of the site as a roost may tend to further concentrate airport overflights into the early- and late-day periods when the greatest number of gulls leave and enter the colony/roost (Griffin and Hoopes 1991).

The presence of a large and expanding New Jersey Laughing Gull population (Jenkins et al. 1989), also indicates that immigration from the New Jersey colonies into Jamaica Bay will continue to contribute to the Laughing Gull population in New York. Several Laughing Gulls were shot at JFKIA during June and July of 1991 1992 that had been color-marked at Southern New Jersey sites several weeks before. There is a unknown amount of immigration occurring into Jamaica bay throughout the summer that would contribute to this techniques limitations in effectiveness.

- **Conclusion**

The probable effectiveness of mowing the colony site to achieve the ultimate objective of reducing the number of gull-aircraft strikes at JFKIA varies depending on the method's effectiveness at discouraging use of the colony site by breeding and nonbreeding gulls. This alternative will be advanced for further environmental impact analysis due to the probability for some level of effectiveness and because it represents a potential nonlethal gull hazard reduction alternative.

3.3.1.1.2 Marsh Devegetation through Burning

Vegetation on the colony site could also be removed by burning, producing an unvegetated substrate unattractive to nesting Laughing Gulls, which generally do not nest in areas devoid of vegetation (Zale and Mulholland 1985, Bongiorno 1970). This technique would temporarily remove even more vegetation than mowing, since the previous year's dead grasses would also be removed.

- **Technical Implementation Feasibility**

The best type of burn for the intended purpose would be a cover, or wet burn. Such burns are done when the water level is above the root horizon, thus preventing roots from being killed, and permitting eventual regeneration of the marsh vegetation (Daiber 1986). Turner (1987) experimentally burned study plots in *Spartina alterniflora* at low tidal amplitude (midway between full moon and new moon) when low tide occurred at midday, to allow for maximum drying. Logistics would be much easier than mowing, since large machinery would not have to be transported to and operated on the islands. Burning would inevitably be uneven, possibly requiring two or more burns per island. Burning would have to be repeated annually, or possibly more than once per breeding season if the grasses regenerate rapidly enough to attract nesting birds.

- **Effectiveness**

Operational Effectiveness: If the reaction of breeding Laughing Gulls to devegetation by burning is similar to that demonstrated by Bongiorno (1970) for mowing, they may relocate to another site. The different visual and tactile conditions produced by burning might have an even stronger deterrent effect than mowing.

However, the same unpredictability applies as for mowing, in that the breeding gulls may utilize the burned substrate if no other site is available.

Ultimate Effectiveness: Since a large proportion of the Laughing Gulls killed in the interim shooting program at JFKIA appear to be breeders from the Jamaica Bay colony (Dolbeer et al. 1993), it is possible that reduction of the colony would also reduce the number of Laughing Gull strikes at the airport, assuming that the displaced birds leave Jamaica Bay.

However, strikes by nonbreeding Laughing Gulls (and other gull species) that roost in the marsh are unlikely to be reduced, because the habitat will probably remain attractive for roosting purposes. Gull strikes may actually increase, if larger numbers of roosting gulls use the marsh owing to the absence of the breeding colony.

The presence of a large and expanding New Jersey Laughing Gull population (Jenkins et al. 1989), also indicates that immigration from the New Jersey colonies into Jamaica Bay will continue to contribute to the Laughing Gull population in New York. Several Laughing Gulls were shot at JFKIA during June and July of 1991 1992 that had been color-marked at Southern New Jersey sites several weeks before. There is a unknown amount of immigration occurring into Jamaica bay throughout the summer that would contribute to this technique's limitations in effectiveness.

- **Conclusion**

The probable effectiveness of burning the colony site at achieving the ultimate objective of reducing the number of gull-aircraft strikes at JFKIA would vary, therefore, depending on its effectiveness at discouraging use of the colony site by breeding and nonbreeding gulls. The probable continuation of Laughing Gulls immigrating into Jamaica Bay from New Jersey could limit the ultimate effectiveness of burning. Similar to mowing, this alternative will be advanced for further environmental analysis.

3.3.1.1.3 Marsh Devegetation through Herbicide Application

Devegetation of the colony site could also be effected by killing the marsh grasses with herbicide. This would be accomplished by aerial spraying. It is possible, however, that in the year of application the previous year's dead grasses would still be acceptable for nesting and that in the second year regeneration would provide sufficient vegetative cover, so that there would actually be little impact on nesting. It might be necessary to burn the dead grasses first and then apply herbicide. This approach might also be necessary simply to achieve contact between the herbicide and the emerging new growth.

This technique could be more effective than mowing or burning, since regeneration from the seedbank is likely to be considerably slower than recovery from either of those modifications, resulting in a very long period with virtually no vegetation on the site (especially if the marsh is also burned). Since the gulls locate their nests partially by vegetational cues (Bongiorno 1970), the complete failure of new vegetation to appear may disrupt the gulls' nest-site selection behavior sufficiently to deter nesting.

- **Technical Implementation Feasibility**

Herbicide could be applied to the colony site easily, quickly, and relatively inexpensively if aerial spraying is possible. Application would be labor intensive and expensive if hand-sprayed, but would present no severe logistical problems other than the need to engage numerous workers. The manufacturer recommends that, for best results, Rodeo be applied "at late growth stages approaching maturity" (Monsanto Company 1982). RODEO is currently the subject of a Draft Environmental Impact Statement in New York State; its registration is pending completion of SEQR requirements and DEC decision-making regarding its operational use within the state.

In this region, *Spartina alterniflora* blooms in late July; *S. patens* in early July, and *Distichlis spicata* in early August (Hough 1983). Thus, if RODEO does become registered, two applications might be necessary, one in early summer and one in midsummer, to kill the three dominant species of marsh vegetation. Results may be uneven under any method, requiring more than one application. The deterrent effect might extend for more than one breeding season, depending on the rapidity of regeneration from the on-site seedbank or external sources. As with other devegetation methods, herbiciding would probably have to be repeated in future years.

- **Effectiveness**

Operational Effectiveness: As with mowing and burning, this approach could be very effective at displacing the breeding colony if the deterrent effect of devegetation is not outweighed by unavailability of sites for relocation.

Devegetation by herbicide is also unlikely to deter roosting by nonbreeding gulls of several species, and may actually render the site more attractive.

Ultimate Effectiveness: Since a large proportion of the Laughing Gulls killed in the interim shooting program at JFKIA appear to be breeders from the Jamaica Bay colony (Dolbeer et al. 1993), it is likely that reduction of the colony would also reduce the number of Laughing Gull strikes at the airport, assuming that the displaced birds leave Jamaica Bay, and assuming that Laughing Gulls immigrating north from New Jersey do not replace those deterred from Jamaica Bay by herbiciding.

However, strikes by nonbreeding Laughing Gulls (and other gull species) that roost in the marsh are unlikely to be reduced, because the habitat will probably remain attractive for roosting purposes. Strikes involving Herring, Great Black-backed, and Ring-billed gulls may actually increase, if larger numbers of roosting gulls use the marsh owing to the absence of the breeding colony.

■ **Conclusion**

The probable effectiveness of applying herbicide to the colony site to achieve the ultimate objective of reducing the number of gull-aircraft strikes at JFKIA would vary; therefore, depending on its effectiveness at discouraging use of the colony site by breeding and nonbreeding gulls its ultimate effectiveness would vary. Given the possibility that this alternative will—to some degree—reduce the gull hazard, it will be advanced for environmental analysis.

3.3.1.2 Planting of Breeding Areas with Shrubs

Typical breeding habitat for Laughing Gulls in the Northeast south of Massachusetts is *Spartina alterniflora* salt marsh (Bull 1964, Buckley and McCaffrey 1978, Burger and Shisler 1980). In New Jersey, Laughing Gulls prefer to nest on topographically high areas of salt marsh (Bongiorno 1970, Burger and Shisler 1978) that support *Spartina alterniflora* 0.8 m (31.5 in) or taller (Bongiorno 1970). They do not nest under or near shrub growth such as *Iva frutescens* (Burger and Shisler 1978), which generally grows on slight natural elevations in the marsh or on spoil banks created by ditching. Owing to their apparent aversion to shrubs, it might be possible to render the colony site (which now has very few shrubs) unattractive to Laughing Gulls by extensively planting *Iva frutescens* and/or *Baccharis halimifolia,* which are the only shrub species adapted to the salt marsh habitat that are indigenous to Jamaica Bay (Bridges 1976).

■ **Technical Implementation Feasibility**

As there is currently very little growth of *Iva* or *Baccharis* on the colony site, although these species occur elsewhere in Jamaica Bay (Bridges 1976), suitable conditions apparently are not currently present to support these shrubs. Since a very large number of plants (400-1000/acre) would be required to achieve a density sufficient to deter Laughing Gulls, it would be necessary to contract with a nursery to grow them specifically for this project. After some research into salinity levels and flooding regimes in the soil at the site, the grower may be able to condition the plants to tolerate expected conditions. It still might be extremely difficult to achieve a satisfactory survival rate among the transplanted stock. Alternatively, enough fill could be placed on the marsh to provide suitable conditions.

■ **Effectiveness**

Operational Effectiveness: Assuming that satisfactory survival of planted shrubs could be achieved, this habitat modification technique could prove highly effective, although it is likely to take several years for the shrubs to become large and dense enough to produce a noticeable decline in the colony population. However, in addition to the deterrent element of the shrubs themselves, is the fact that their presence could attract nesting Herring Gulls, which, when they nest in salt marshes, prefer to nest in *Spartina patens* near shrubs (Burger 1977, Burger and Shisler 1978, 1980a). The presence of nesting Herring Gulls forces Laughing Gulls into suboptimal areas of the marsh where their nests are more vulnerable to tidal flooding, and also exposes them to predation from the larger species (Burger 1977). Thus Herring Gulls could both displace breeding Laughing Gulls and reduce the productivity of those that remain on the colony site.

Ultimate Effectiveness: If planting the marsh with shrubs could deter Laughing Gulls without attracting other breeding species in their place, this habitat modification method could prove effective. However, it is unlikely that the modified marsh will remain unused. Although the population of Herring Gulls in Jamaica Bay has declined since 1985 (Litwin et al. 1993), probably because the closure of the Fountain Avenue Landfill and the Edgemere Landfill curtailed important local food sources, it is possible that a new colony could form on the modified site. Sillings (1993) noted the preponderance of Herring and Great Black-backed gull nests elsewhere on Jamaica Bay (Breezy Point) to be associated with shrubs, bushes, and other clumped vegetation. Even if the numbers of these other gull species do not equal the Laughing Gull numbers and the strikes by Herring Gulls at JFKIA are fewer, the enhancement of habitat for another gull species while reducing it for another gull species is not acceptable, since the objective of the program is to reduce gull-aircraft strikes. The shrubs could also attract numerous nesting Red-winged Blackbirds and Boat-tailed Grackles, which could pose yet another strike hazard at the airport. A particular hazard could occur in late summer when these species tend to form large flocks, if the site is used as a roost. Flocks leaving the roost at dawn or entering at dusk could be extremely hazardous if they overfly the airport. It is likely, therefore, that the ultimate effectiveness of planting the marsh to deter nesting by Laughing Gulls would be low.

■ **Conclusion**

Due to the questionable success of establishing the plants in the existing marsh and the fact that the newly planted vegetation will likely attract other birds (and thereby increase JFKIA's birdstrike hazard), this alternative is not considered feasible nor effective and will no longer be considered or advanced for environmental analysis.

3.3.1.3 Landform Alteration

3.3.1.3.1 Filling Marsh

Laughing Gulls in the Long Island-Virginia region nest only on tidal salt-marsh islands (Bull 1964). Therefore, if the marsh supporting the Jamaica Bay colony site were filled (for example, with dredge spoil) and converted into a dome-shaped island, it could be rendered unattractive for nesting by this species.

Since optimal conditions for Gulf Coast spoil-island Laughing Gull colonies (Zale and Mulholland 1985) include elevations < 1.8 m (6 ft), placing fill to a greater depth would be desirable.

■ **Technical Implementation Feasibility**

Covering 114 ha (282 ac) of the 242 ha (605 ac) to a depth of 10 feet would require millions of cubic yards of clean fill material. Obtaining the required amount of clean fill could be difficult unless a local dredging project in search of a disposal site is in progress at the time the modification is implemented.

■ **Effectiveness**

Operational Effectiveness: This form of habitat modification could deter Laughing Gulls from nesting on the current colony site, as it would remove virtually all of the habitat suitability factors indicated by Zale and Mulholland (1985), and would eliminate the growth of *Spartina alterniflora,* the gull's preferred nest-site vegetation in this region. Greer, et al. (1988) noted that species nesting in highly dynamic habitats such as marshes would be unlikely to demonstrate extreme site tenacity, as this would result in reduced nesting success in many years, and they hypothesized that group adherence (the tendency to nest with conspecifics or other species) may be the dominant factor controlling selection of nesting islands, as this "allows rapid colonization of new sites which appear suitable after deterioration of previous colony sites." Burger and Shisler (1980b) suggest that, although all gull species exhibit site tenacity by initially returning to previously occupied colony sites, each species selects colony and nest site locations in a given year based on the local conditions encountered. If Laughing Gulls are deterred from using the colony site, it may be expected that the effect will be permanent, as spoil islands eventually become vegetated with woody plants and herbaceous species other than salt-marsh grasses (Soots and Landin 1978, Buckley and McCaffrey 1978), never returning to a salt marsh suitable for Laughing Gulls.

It should be noted, however, that the Laughing Gull as a species is plastic in its colony-site requirements. The Gulf Coast population nests on dredge-spoil islands and drier salt-marsh and barrier islands, preferring >50% cover of herbs <1 m, interspersed with shrubs < 1 m (Zale and Mulholland 1985), the Middle-Atlantic Coast population nests on salt marsh (Buckley and McCaffrey 1978), and the Massachusetts-Maine populations nest on rocky islands with upland vegetation (Bull 1964, Transue 1989). Therefore the innate behavioral plasticity of the Laughing Gulls might allow them to accept the altered site and continue to nest there, especially since it is an established colony site and there are no nearby suitable sites for relocation.

It is not possible, therefore, to predict confidently what the reaction of the colony would be to a site modified by filling.

Ultimate Effectiveness: Since more than 90% of the Laughing Gulls killed in the interim shooting program at JFKIA appear to be breeders from the Jamaica Bay Laughing Gull colony (Dolbeer et al. 1993), it is likely that displacement of the colony out of Jamaica Bay would also reduce the number of Laughing Gull strikes at JFKIA. The probable presence of a cohort of non-nesting Laughing Gulls and immigration of Laughing Gulls from New Jersey colonies throughout the summer, may dampen any positive effect marsh filling may have on gull-aircraft strikes at JFKIA. Since there is a high probability of Herring and Great Black-backed gulls nesting on the altered sites even if the Laughing Gulls are deterred, the number of gull strikes attributable to these species is likely to increase. Even if the numbers of these other gull species do not equal the Laughing Gull numbers and the strikes by Herring Gulls at JFKIA are fewer, the enhancement of habitat for another gull species while reducing it for another gull species is not acceptable, since the objective of the program is to reduce gull-aircraft strikes.

Until it became heavily vegetated, the site would also be attractive as a roosting site for nonbreeding Laughing Gulls and other gull species. Once shrub- to tree-size woody vegetation, or even dense *Phragmites*, became established, breeding colonies of Herons, Egrets, Ibis, Red-winged Blackbirds and others might become established on the island. These species could also present a substantial birdstrike hazard, although they probably would not overfly the airport to the same extent as gulls.

The probable effectiveness of filling the colony site to achieve the ultimate objective of reducing the number of gull-aircraft strikes at JFKIA will therefore vary according to its effectiveness at discouraging use of the colony site by breeding and nonbreeding gulls.

- **Conclusion**

Due to the difficulty in implementation and the fact that the fill areas will be attractants to other gulls, this alternative is not considered feasible nor effective and will therefore no longer be considered or advanced for environmental impact analysis.

3.3.1.3.2 Excavating Marsh

If the mean elevation of the marsh were reduced to below that of mean high tide, the entire colony site would be flooded almost daily. Areas subject to regular tidal inundation are not utilized by Laughing Gulls for nesting (Zale and Mulholland 1985, Bongiorno 1970).

- **Technical Implementation Feasibility**

The process would be expensive and lengthy, and finding a suitable site for disposal of spoil could be a problem, unless ocean disposal is possible, or the material is used to create wetlands for mitigation. Lowering the present elevation of 114 ha (282 ac) of the 242 ha (605 ac) of marsh by one foot would require the removal and disposal of well over a million cubic yards of spoil material.

- **Effectiveness**

Operational Effectiveness: This would be a highly effective method of preventing Laughing Gulls from nesting on the present colony site. As a result of his study of nest-site selection in New Jersey Laughing Gulls, Bongiorno (1970) suggested that between their return to the colony and the actual beginning of nesting (a period of up to one month), "Laughing Gulls orient to drier areas as the tide rises and by repeatedly confining their activities within boundaries delimited by high tides, they eventually come to select sites which are uniformly above a certain minimum height." Laughing Gulls returning to an excavated colony site in Jamaica Bay would be exposed to twice-daily flooding conditions throughout the site (as well as a devegetated surface produced by the excavation), and most would probably not attempt to nest. Any that do will likely experience one or more nesting failures and will be discouraged from further use of the site. Since the rate of accretion of salt marsh sediments is relatively slow, it will take many years before the elevation of the marsh again becomes suitable for nesting by Laughing Gulls.

Ultimate Effectiveness: Excavation would eliminate both the breeding colony site and use of the marsh as a roost, thus reducing two possible sources of birds that overfly JFKIA. If the birds that lose their nesting habitat disperse permanently from Jamaica Bay, and any roosting birds shift to another site from which overflights of the airport are less likely, this technique could be highly effective at reducing the number of birdstrikes. Immature Laughing Gulls and immigrants from the New Jersey colonies may continue to be present in the vicinity of the airport, and could contribute to the birdstrike hazard.

- **Conclusion**

Although the technical requirements to implement this alternative are substantial, the alternative could—if properly implemented—eliminate the colony site and reduce the gull hazard. Therefore it is advanced for further environmental analysis.

3.3.1.3.3 Physical Obstruction (Monofilament, Cordage, or Wire Barrier)

Monofilament Line: Access to the Laughing Gull colony site could be prevented by erecting a barrier over the colony of monofilament line, stainless-steel wire, or cordage (all called "lines" hereafter). In this method parallel lines are strung between posts set around the perimeter of the area of exclusion. In some cases, vertical or horizontal lines are also strung so as to prevent entrance under the barrier at the perimeter. If the line spacing is small enough, gulls are reluctant to descend through it to the ground. Monofilament lines have been used to exclude Ring-billed Gulls from a colony site on a breakwater (Tessier and Blokpoel 1992), and from a public square (Blokpoel and Tessier 1984) stainless steel wire substantially reduced the numbers of gulls feeding at a landfill (McLaren et al. 1984a,b), and Kevlar-coated cordage repelled Herring and Great Black-backed gulls from an 89-ha (220-ac) truck fill site at a Staten island landfill (Dolbeer et al. 1988). At this site, it was observed that Laughing Gulls were not excluded by the cordage barrier.

Stake Pennants: This alternative proposes the construction of stake pennants on the nesting colony, as well as at the perimeter of JFKIA bordering Jamaica Bay in order to deter gulls from nesting at the colony site and from entering JFKIA airspace. The structure consists of a line of single stake pennants, with the omission of some unnecessary supporting stakes. The remaining stakes are linked with a line. Stakes are approximately 3 feet high and are spaced ten feet apart

- **Technical Implementation Feasibility**

Monofilament wire: For a site of this size (the area utilized by gulls totals about 114 ha/282 ac), this method would be expensive in terms of labor, material, and installation time. Excluding nesting Ring-billed Gulls from 3.6 ha of breakwater required 19,500 m (21,000 yd) of monofilament line (Tessier and Blokpoel 1992)—by extrapolation, excluding Laughing Gulls (which have a shorter wingspan than Ring-billed and therefore might require closer spacing of the wires) from 114 ha of marsh could require at least 620,000 m (678,000 yd) of line. Dolbeer et al. (1988) found that Laughing Gulls at a landfill were not deterred by lines with 3 m (10-foot) spacing when the lines were not in the same horizontal plane. It might be difficult to set support poles properly in the soft marsh sediments. Also, for monofilament and wire, constant maintenance would be required because of frequent breakage (McLaren et al. 1984a,b). Stainless steel wire is stronger and longer lasting than monofilament, but much more expensive and difficult to install, owing to its tendency to kink; monofilament is economical and easy to install, but deteriorates in sunlight and can also be broken when struck by birds (Krzysik 1989). The system would have to be maintained permanently in order to prevent gulls from returning to the colony site, which would essentially mean rebuilding it every spring.

Stake Pennants: The feasibility of installing these structures on the colony site cannot be conclusively determined at this time, since the characteristics of the system when made suitable for large areas is not known. Feasibility also depends on the ability of the structure to maintain stability in the marsh environment, which is subject to frequent tidal inundation and soil plasticity.

The pilot program which is proposed as part of this alternative could be feasible provided that conditions are present elsewhere that mimic the JFKIA context adequately in terms of size, bird species, size of bird population, and environmental conditions, in order to draw conclusions regarding effectiveness. As this alternative is in the early stage of application, engineering design research would be necessary to increase it effectiveness.

- **Effectiveness**

Operational Effectiveness - **Monofilament Wire:** A wire barrier could be effective at preventing Laughing Gulls from nesting on the present colony site, although Dolbeer et al. (1988) observed that Laughing Gulls were not excluded from a landfill on staten Island by installation of a grid. A monofilament grid was completely effective in eliminating nesting by Ring-billed Gulls on a smaller site. Also, as long as the correct wire spacing is used, gulls do not habituate to the barrier (McLaren et al. 1984b). Although the majority of Laughing Gulls may be excluded, because this is a long-established nesting area, without a nearby replacement the birds may be particularly persistent in attempting to penetrate the grid. At least a few Laughing Gulls will get past the intact grid, and others will penetrate at breakage points or around the perimeter.

***Operational Effectiveness* - Stake Pennants:** This technique has presumably been effective in deterring birds on a small scale. The effectiveness of this alternative is undetermined for large expansive areas, such as the gull colony and the airport boundary with Jamaica Bay.

■ **Conclusion**

As described above, establishing and maintaining a barrier over the marsh would present many technical problems and is impractical. For this reason and due to the possible ineffectiveness of this technique on Laughing Gulls, this alternative will no longer be considered and will not be advanced for environmental analysis. The effectiveness and implementation feasibility of stake pennants has not been established. The product is still in the development phase and conditions in which it has been proven effective differ substantially from the conditions at JFKIA. As further development and pilot studies would need to be conducted in the future, this alternative was not considered feasible for addressing the immediate gull strike hazard which exists at JFKIA. It is therefore not considered further and not advanced for environmental analysis.

3.3.2 Discouraging Use of Colony Site through Harassment

Colonial waterbirds are most likely to desert the colony site during the courtship and nest-site selection stages (Buckley and Buckley 1976). Since Laughing Gulls devote about 4 weeks to this process, beginning in mid-April (Montevecchi 1978), an extended period is available during which the colony might be induced to move through various forms of nonlethal harassment.

3.3.2.1 Harassment by Means of Falconry

A number of airports have utilized falconry to harass and disperse problem birds (mainly roosting or loafing flocks). A colony of breeding gulls was dispersed by this method at an airbase in Scotland (Blokpoel 1976). This method relies upon the birds' instinctive fear of a natural predator to cause them to flee. Utilizing falconry would necessitate obtaining the services of at least two licensed falconers with several appropriate birds (Peregrine Falcons or Gyrfalcons) trained to attack gulls, and provide daily harassment during the period of colony formation. In some cases the falcons have been used to actually kill individuals of the target species, whereas in others merely flying the falcons overhead has proved effective.

■ **Technical Implementation Feasibility**

Two or more falconers plus assistants would probably be required, as well as special facilities to house, feed, and care for the falcons. Several airports have tried and abandoned falconry owing to the cost (Blokpoel 1976, Helmke and Silliman 1991). The cost of for year-round falconry program at JFKIA was estimated at over $200,000, after a startup cost of $150,000 (Helmke and Silliman 1991). Possibly, falcons could be used on a contractual basis for the Laughing Gull breeding season only, at considerably less cost. Many falcons molt sequentially, and would be capable of flight during the Laughing Gull nesting period. Falconry can only be implemented in good weather. Falcons can and will fly in clear weather, during periods of light rain, fog and light snow, but are reluctant and inconsistent fliers during heavy snow, rain, and low visibility. The program would have to be continued indefinitely, as Laughing Gulls are likely to attempt to nest on the colony site every year.

- **Effectiveness**

Operational Effectiveness: The use of falconry could be temporarily effective during periods of good weather, especially as part of a comprehensive harassment effort. Blokpoel (1976) states that "local breeding gulls" were dispersed using falconry at Royal Naval Air Station Lossiemouth in Scotland. Although loafing gulls in Britain have been deterred from using airports by as little as a single falcon flight a day, in Canada loafing Glaucous-winged, California, and Mew gulls that were dispersed by a falcon frequently returned soon after the bird stopped flying (Blokpoel 1976). Considerably more harassment may be necessary to discourage the Laughing Gulls from using this established breeding site. Although falconry was effective at temporarily dispersing Missouri Prairie Chickens from a lek site straddling a runway, it did not succeed in permanently breaking the birds' strong attachment to this traditional, regionally important courtship area (Mattingly 1974). According to Hild (1984) a single falcon can perform a maximum of five 5-10 minute flights per day (although Mattingly [1974] reports flying birds for longer periods), therefore several birds might be necessary to provide sufficient harassment during the colony establishment period. Although falconry alone might not dissuade Laughing Gulls from nesting at this site, it might prove to be an effective component of a campaign involving multiple forms of harassment. (For example, as noted by Blokpoel [1976], at 6 bases of the USAF in Europe, falconry constituted 20% of the bird-control effort, but that 20% was considered essential.)

Ultimate Effectiveness: Harassing Laughing Gulls with falcons would involve putting the gulls to flight frequently, thus increasing the potential for strikes during the harassment period. The flying falcons could themselves pose a hazard to aircraft. However, they could perform a key function along with other forms of harassment that succeeds in dispersing the colony and thus in reducing birdstrikes at the airport. Use of falconry year-round as part of the Bird Control Unit could help to deter loafing by gulls on the airport, and possibly reduce use of the airport by many other bird species as well, and thus could result in even greater reduction in the number of birdstrikes. Falcons, ospreys, kestrels, and other raptors have been involved in strikes with aircraft at JFKIA; the presence of a large number of falcons in JFKIA airspace or over the nesting colony could present increased hazards to safe aircraft operations. The presence of falcons in or above the Jamaica Bay Laughing Gull colony could induce the gulls to tower, thereby increasing the already high Laughing Gull-aircraft strike hazard.

- **Conclusion**

The unreliable nature of this alternative, and the potential to increase the birdstrike hazard, make this alternative both technically unfeasible and ineffective. It is therefore no longer considered and not advanced for environmental analysis.

3.3.2.2 Harassment by Dogs

Harassment by trained dogs could be included in a multifaceted effort to force Laughing Gulls to abandon the colony site without attempting to breed. Mattingly (1974) utilized a dog to flush and harass Prairie Chickens utilizing runways and adjacent areas at an Air Force Base. Used in combination with falconry (falcons chased the flushed birds), this method was reasonably successful at temporarily moving birds, but did not break the birds' attachment to a traditional lek area that straddled a runway. Dogs could be either staked in the colony or work directly with a handler to roam around the colony site to disturb the nesting of Laughing Gulls.

- **Technical Implementation Feasibility**

Although there is virtually no literature regarding use of dogs to harass undesirable breeding-bird colonies, dogs may be useful in such an effort. Dogs can range much more quickly than a human through a colony, and would not be as hindered in their movements by the numerous tidal creeks and pools on the salt marsh. In addition, the impacts of trampling on the marsh environment would be considerably less than resulting from harassment activities by humans. Several breeds of dogs exist that might be adaptable to both the salt-marsh environment and the long hours of concentrated effort required (Kevin Behan, dog trainer, pers. comm.). Through extensive training, their movements can be controlled by a handler so that the dogs concentrate their harassment on desired areas. However, by definition dogs as animals have associated with them a varying level of unpredictability and uncontrollability. Some mortality of gulls and non-target species as a result of harassment actions could therefore not be avoided. Implementation of harassment activities could be through contracting with training professionals or by establishing dog harassment units within APHIS, which would require education, training and employment of professional staff and maintaining kennel facilities. Owing to the large area on which harassment activities would have to be carried out (242 ha/605 ac), the difficulty of the terrain, and the large numbers of gulls involved, several professional staff, dogs, and kennels would be necessary to achieve effective harassment.

The uncertain effectiveness, and the possibility of unacceptable nontarget birds being affected, render this alternative unfeasible or unacceptable from an impact perspective.

- **Effectiveness**

Operational Effectiveness: Dogs are known to be a major cause of disturbance to nesting of colonial waterbirds. Buckley and Buckley (1976) considered dogs (especially feral animals) to be "the most frequent [disturbance] problem" at bird colonies. Feral dogs reduced productivity to zero in several study plots in Griffin and Hoopes' (1991) study of the Jamaica Bay colony, but it was not reported whether birds deserted these areas. A major advantage of dogs is that they can move quickly and easily depending on the movement of the gulls; if it appears that birds displaced from one area of the colony are settling elsewhere on the site, dogs can very easily be directed or moved to the second location. Such harassment would have to be repeated annually to deter Laughing Gulls from attempting to reclaim the site for nesting.

Ultimate Effectiveness: Harassment with dogs would cause gulls occupying the colony site to take flight. These flights might take the form of "towering," or spiraling very high into the air in large groups (U.S. Dept. of Agriculture 1993), where they pose substantial hazards to aircraft. Also, birds that desert the colony may abandon breeding for the season and spend more time than they otherwise would feeding and loafing on the airport (Griffin and Hoopes 1991). Both such behaviors could increase the birdstrike hazard at JFKIA.

- **Conclusion**

Due to the high probability of dogs causing gulls to tower, and the resulting increase in the gull-aircraft strike hazard, the ultimate effectiveness of this alternative is extremely poor. In addition, this alternative has low technical feasibility. It is therefore not considered a feasible alternative and will not be advanced for environmental analysis.

3.3.2.3 Harassment Through Acoustics

Taped distress calls are frequently used to disperse birds from airports (Schmidt and Johnson 1983, Reznick 1984) and are also utilized in the JFKIA Bird Control Program (Helmke and Silliman 1991). This method exploits the species' instinctive aversive response to their own distress call, and sometimes to those of related species. Occasionally firing a shellcracker helps to reinforce the reaction (Blokpoel 1976). Many manufacturers also claim that pest birds can be dispersed with ultrasonic or other nonnatural sounds (Bomford and O'Brien 1990, Hamershock 1992), which supposedly produces physical discomfort that causes birds to leave the vicinity of the sound. These techniques might possibly be used on the Laughing Gull colony site to deter birds from nesting.

- **Technical Implementation Feasibility**

Both types of acoustic harassment would involve the installation and maintenance of numerous automated tape players/speakers run by 12-volt car batteries to provide coverage of most of the 114-ha (282-ac) colony site. Kress (1983) used such a system in playing taped colony sounds to attract nesting terns, although he required only two units. The batteries powered the sound systems for 3 weeks at 12 hours per day with no maintenance. It should be possible to place the systems on structures high enough to avoid damage by flooding. Vandalism may occur, although the fact that the only access to the site is by boat should minimize that problem.

- **Effectiveness**

Operational Effectiveness: **Distress Calls.** Although effective at dispersing loafing or roosting birds (Lucid and Slack 1979), distress calls may not be effective in a breeding colony, probably owing to the birds' strong attachment to the site, strong reproductive drive, and ability to habituate to distress calls if overused. Thomas (1972) reports that the Black-headed Gull (*Larus ridibundus*) habituated quickly to distress calls broadcast in a nesting colony. Breeding Glaucous-winged Gulls habituated to taped distress calls within half an hour (Stout, et al. 1975). Bomford and O'Brien (1990) concluded from a review of the literature on sonic deterrents that, although distress or alarm calls are effective, birds do habituate to them if the calls are played frequently or over a long period of time. It therefore seems obvious that birds exposed to continual automated playback on a colony site for two or three months are likely to habituate. It is unlikely that this method alone would be effective in reducing the size of the Jamaica Bay Laughing Gull colony.

Operational Effectiveness: **Ultrasonics.** Sounds with a frequency of more than 20,000 Hz (cycles per second) are considered to be ultrasonic. Since ultrasonic sound at very high frequencies can create heat and radiation pressure, accelerate chemical reactions, and block nerve impulses within living tissues, it is inferred that the broadcasting of an appropriate signal would cause sufficient discomfort to birds and other animals to cause them to disperse (Hamershock 1992). However, Bomford and O'Brien (1990) reviewed the literature on ultrasonic pest control and concluded that these devices do not meet the claims made by their manufacturers. Hamershock (1992) found that no experiment using ultrasonic bird repelling devices reduced bird populations by more than 5%. He concluded that these devices do not work because (a) of the 33 species of birds that have been tested, most cannot hear ultrasound; (b) to physically stress a bird requires a focused frequency of at least 1 MHz or a sound intensity of at least 140 dB at the bird's ear, whereas the maximum recorded sound levels produced by any available device are 50kHz and 135 dB; and (c) those species that can hear ultrasound habituate to it just as they do to sub-ultrasonic sound. Blokpoel (1976) further notes that the use of ultrasonics is impractical on large, open areas, because the strength of high-frequency sounds attenuates very rapidly with distance. It therefore seems highly unlikely that ultrasonic bird repellent devices would succeed in dispersing the Jamaica Bay Laughing Gull colony.

In reviewing the use of bird-dispersal recordings, Schmidt and Johnson (1983) concluded that recordings seldom provide the single solution to a nuisance bird problem but have proved to be valuable as one of the several components of integrated bird-management programs.

Ultimate Effectiveness: Since ultrasonics are unlikely to be operationally effective at dispersing birds, they would have no effect on the number of gull-aircraft strikes at JFKIA. Furthermore, this activity could cause gulls to tower, thereby increasing the birdstrike hazard at JFKIA. Use of distress calls, although effective in some situations, is unlikely to be effective at colony dispersal, and therefore also would not be effective in reducing the number of strikes.

- **Conclusion**

Due to the high probability of habituation of the gulls to the distress calls and ultrasound, this alternative is not determined to be effective. It will not be advanced for environmental analysis. It is noted, however, that distress call tapes are a part of the BCU's program on JFK.

3.3.2.4 Deterrent Display of Preserved Dead Gulls or Synthetic Models Representing Dead Gulls

One of the visual scaring methods used on gulls is to display dead gulls, preserved carcasses or stuffed specimens in unnatural positions, or models which look like dead gulls. The display of such items on the colony site might alarm Laughing Gulls sufficiently to prevent them from nesting.[2]

- **Technical Implementation Feasibility**

Dead gulls could be obtained from among those killed by airplane interactions on JFKIA. These could be distributed around the marsh and displayed on posts. It might be necessary to collect and preserve carcasses during the course of the year in order to have enough to cover this large area. Fiberglass models could also be constructed. Since the carcasses/models tend to lose their effectiveness with weathering, they would have to be maintained or replaced throughout the season.

The use of synthetic models representing dead Laughing Gulls could be used, and would eliminate these limitations in feasibility.

- **Effectiveness**

Operational Effectiveness: In some cases, displaying carcasses or models of dead gulls has been effective in dispersing roosting, loafing, and feeding gulls (Pimlott 1952, Stout et al. 1975). Blokpoel (1976) reports that although display of gull carcasses was temporarily effective at Holland airports, the carcasses had to be moved regularly to prevent habituation, and weathered carcasses lost all effectiveness. In New Zealand, some success was achieved at dispersing roosting gull flocks using gull corpses preserved with

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[2] It should be noted that the display of dead gull images is not for the purpose of attracting (or "baiting") non-target species (i.e. scavenger birds) that could be killed by other measures, such as shooting or toxicant application, if implemented simultaneously as part of a combined alternative.

formalin, and even plastic models of gulls, although where no alternative roosting sites were available, results were not as good. The "scarecrow" method, however, had little effect on breeding Black-headed Gulls, which habituated to this scare device within 3 hours (Thomas 1972). Stout, et al. (1975) dispersed Ring-billed Gulls from a landfill with models, and also briefly dispersed Glaucous-winged Gulls in a breeding colony. The relative effectiveness of dispersal in the colony was increased by simultaneous playing of distress calls, however even with this combination the birds generally began returning within less than one minute (although they would not approach the model closely). Overall, it seems unlikely that gull carcasses or models alone would provide a sufficient long-term deterrent to breeding gulls, especially when no replacement habitat is available nearby. Their use, though, could contribute to an overall program to reduce nesting in the Laughing Gull colony.

Ultimate Effectiveness: Display of models of dead Laughing Gulls by itself would probably not induce abandonment of the Laughing Gull colony, and it is unlikely to reduce the number of Laughing Gull strikes at JFKIA. There is some chance that it could possibly attracting avian scavengers such as crows. This nonlethal technique has some promise of effectiveness if it is used in combination with other approaches.

- **Conclusion**

Although the effectiveness of this alternative in discouraging gulls from nesting is low, it can be implemented very easily. It will therefore be useful in support of another more effective alternative and will be advanced for environmental analysis.

3.3.2.5 Radio-controlled Model Airplanes

Blokpoel (1976) discusses some preliminary studies in which model airplanes (usually shaped and painted to resemble very large falcons) were used to disperse nuisance birds at airports. Such models could be radio-controlled by the operator at distances up to one-half mile and had flying times of more than 30 minutes. Although results of these experiments were generally promising, virtually no follow-up studies have appeared in the literature, and recommendations for the use of such models do not routinely appear in bird-hazard reduction studies. In August, 1989, JFKIA hosted a field demonstration of a remote-controlled model airplane that fired pyrotechnics to frighten birds away from the airport. The demonstration, conducted by Air Birdstrike Prevention (Worcester, MA), consisted of two trial flights of the model airplane, and indicated the following:

a) The plane initially disturbed the birds, but they soon became accustomed to the disturbance and returned.

b) The plane has shown some success in keeping birds away from feeding sites (other site demonstrations), but has not been shown to deter birds from nesting areas.

c) Use of the plane over the Jamaica Bay nesting colony would depend on air safety requirements.

d) The use of model airplanes to deter birds away from JFKIA would require extensive time and expertise, and the potential effectiveness in deterring birds away from a nesting site are questionable.

- **Technical Implementation Feasibility**

The main limitation in employing remote-controlled aircraft at JFKIA to deter birds is that this technique has not been demonstrated to be effective in deterring birds from a traditional nesting area. It would also have to be determined whether the radio signals used in flying such planes would interfere with airport communications or the operation of actual aircraft. Flying the radio-controlled model planes is weather dependent, and would be limited to those times without high winds, heavy rain, fog, or snow, and limited visibility.

- **Effectiveness**

Operational Effectiveness: Although model airplanes appear to be able to disperse roosting or loafing flocks, their effects on breeding colonies are apparently untested. Since the "attacks" by model airplanes would never include a kill to reinforce the model's image as a predator, the birds would most likely easily habituate to their presence.

Ultimate Effectiveness: As with all other on-colony disturbances, use of radio-controlled model airplanes would put the birds to flight and thus temporarily increase the strike hazard in the vicinity of the airport. Given the preliminary state of knowledge of the effectiveness of this technique, it seems reasonable to conclude that used alone it is unlikely to reduce the size of the colony sufficiently to achieve a long-term reduction in the number of birdstrikes at JFKIA.

- **Conclusion**

Due to the limitations of using this method only when weather permits, and due to its apparent lack of effectiveness in deterring birds from traditional nesting areas, this alternative is not considered an effective way to reduce the strike hazard and will advanced for environmental analysis.

3.3.3 Reduction of Off-Airport Attractants

The importance of reduction of off-airport attractants must be considered in light of its potential to reduce overflights over JFKIA. As more than three-quarters of all birdstrikes at JFKIA involve gulls and more than half involve Laughing Gulls, the reduction of attractants for these species in particular is considered important. Areas that involve a flight line over JFKIA to reach the Laughing Gull colony site and are likely to provide potential staging opportunities for gulls in general and Laughing Gulls in particular should be considered as potential contributors to the birdstrike hazard at JFKIA. JFKIA is located within the New York City Metropolitan Area within the Borough of Queens; the area is inhabited by more than 10 million people, and it is surrounded by shopping malls, apartment complexes, schools, roadways, parks, and a multitude of private and public facilities, all of which could provide some type of attractants for birds, especially species such as gulls, starlings, pigeons, and others. The presence of human-generated waste (garbage, handouts), grassy areas (private lawns, parks, school playing fields), and the presence of appropriate nesting areas for gulls in Jamaica Bay and the Hempstead marshes make the entire area very attractive for gulls. The location of JFKIA immediately north of Jamaica Bay, between the nesting colonies and the abundant food resources of the metropolitan area create a hazardous situation in terms of potential bird-aircraft collisions. Although there are innumerable facilities in the area that provide attractive habitat features for Herring, Ring-billed, Laughing, and Great Black-backed gulls, historic references focus on two: Aqueduct Race Track and the Jamaica Bay Sewage Treatment Plant.

3.3.3.1 Aqueduct Race Track

Aqueduct Race Track is located 5.9 km (3.6 mi) northwest of JoCo Marsh. At this facility, Griffin and Hoopes (1991) observed Herring, Great Black-backed, and Laughing gulls (including color-marked gulls from the Jamaica Bay colony) utilizing the infield grass (for feeding, loafing, and resting) and reflecting pools (for drinking and bathing). Stone (1937) notes the predilection of Laughing Gulls for bathing in fresh water. Laughing Gulls traveling between Aqueduct and the colony would very likely overfly runway 13R/31L (the majority of all bird carcasses found in the summer of 1990 were Laughing Gulls and were on runway 13R/31L [Griffin and Hoopes 1991]). As their observation time at the race track was limited to business hours, they recommended future research to better evaluate the extent of gull usage of this facility. Subsequent research including field visits to Aqueduct Racetrack by APHIS and PA staff did not indicate any major gull activities at these locations. In 1993, weekly bird surveys of the Van Wyck Expressway and Federal Circle on JFKIA conducted by ADC Biologist between July 13 and September 6, indicated very minimal use of these areas by birds; the only birds observed were 15 European starlings on August 11, and 4 crows on September 6. The conclusion that Aqueduct Racetrack is the single major attractant and that intensive management would reduce the strike hazard therefore appears to be premature, and more intensive research would be necessary to confirm this conclusion. Furthermore, no substantive evidence has surfaced that indicates that the racetrack is any more of an attractant than the many other attractants that exist in the suburban environment north of the colony site, such as shopping malls, local parks, freshwater ponds, parking lots, etc. Rather, the absence of such readily available resources in the environment south of the colony site (i.e. the Atlantic Ocean and the coastal/marine zone) could be a general reason why the colony birds forage to the north and in doing so cross JFKIA active airspace.

Efforts are being made (Appendix D.2) to enlist the cooperation of Aqueduct Race Track in controlling gull usage by managing long grass in the infield and possibly by excluding gulls from infield ponds with a wire barrier. Aqueduct management has also been encouraged to prohibit the feeding of birds at the track, although it is not known to what extent gulls obtain food from people at the facility. However, the Port Authority lacks the jurisdiction to enforce any of these measures.

- **Technical Implementation Feasibility**

The cooperation of the New York Racing Association would be necessary to implement any of the following control measures at Aqueduct.

Long grass management: Physical implementation of long-grass management would be accomplished, assuming that the track possesses mowing machinery capable of producing the required 10-15 cm (4-6 in) height that is effective against gulls (Transport Canada 1992). The management's only probable objection might be one of aesthetics, since patrons may prefer a well manicured infield. However, since live racing is conducted at Aqueduct only during the period of October through May, uncut grass would be present only early in the growing season, when it would be least obvious. Although simulcast programs are run in July and August, patrons attending these televised events would probably pay relatively little attention to the infield environment. Also, track personnel have expressed concern for problems caused by droppings of pigeons and geese fouling the spectator area and the track. Maintaining long grass would probably markedly reduce the numbers of geese utilizing Aqueduct, thereby reducing the fouling problem. Long grass management would thus benefit both the track and the airport.

Exclusion device on ponds. Each of the infield ponds is 1 ha (2.5 acres). It should be relatively easy to install a barrier of parallel wire or monofilament lines above the water surface to deter birds from landing on these water bodies. The lines would probably be almost invisible to patrons in the grandstand, and attractive structural supports could undoubtedly be designed. An occasional bird may become entangled, and because of the barrier's location over water (unless the water is shallow enough to wade in), releasing such birds could be difficult. The track's management may object to the possibility of having patrons observe the struggles of entangled birds.

Prohibition of bird feeding. This would be a relatively easy and inexpensive program for track management to implement. With proper explanation of the safety-related goals of the program, widespread cooperation of the public and the track community could probably be gained. Since curtailing the food supply might reduce populations of Rock Doves, European Starlings, and House Sparrows at the track, the facility would benefit from a reduction in fouling problems caused by these species' droppings.

- **Effectiveness**

Operational Effectiveness: **Long-grass management.** Maintenance of long grass has proven to be an effective deterrent to use of open areas by gulls (and also geese), and is now one of the standard habitat management techniques recommended for airports. It should prove to be equally effective at Aqueduct Race Track.

Exclusion devices on ponds. Exclusion devices have been demonstrated to have the potential to be effective in preventing access by gulls to colony sites (Tessier and Blokpoel 1992), landfills (McLaren et al. 1984), and public spaces (Blokpoel and Tessier 1984), and from reservoirs (Amling 1980) and fish ponds (Ostergaard 1981). They are very likely to prove effective in this situation.

Prohibition of bird feeding. Reduction or elimination of food supply should be highly effective in reducing numbers of those species that utilize this resource at the track. Since Rock Doves, European Starlings, and House Sparrows are probably the species that can most easily avail themselves of human handouts in the track environment, this technique is likely to be most effective at lowering numbers of these species, rather than gulls.

Ultimate Effectiveness: **Long grass management.** This technique could be marginally effective in reducing the number of birdstrikes involving all species of gulls at JFKIA. If gulls no longer fly back and forth between the colony and the track (where they obtain food and water, bathe, loaf, and rest), the number of overflights of Runway 13R/31L should be reduced—especially the flights by large flocks that were observed by Griffin and Hoopes (1991) to fly from the track to the colony late in the day. A reduction in overflights should be noticeable as soon as the grass reaches a sufficient height to discourage gulls from loafing and feeding, although it may take a while for the birds to realize that this change is permanent. Of course, since the displaced birds will be searching for other areas to conduct these activities, the airport must be conscientious in its own long-grass management program.

Gull exclusion devices on ponds. This technique should also prove effective in reducing the number of birdstrikes at JFKIA. Once gulls are excluded from drinking and bathing in the track's ponds (as well as from utilizing the grass areas), there will be no reason for them to fly between the track and the colony; presumably, therefore, they should make fewer overflights of the airport. This technique would also reduce the large numbers of Ring-billed Gulls utilizing the track in the nonbreeding season. However, since Ring-billed Gulls are involved in many fewer birdstrikes than Laughing Gulls (Hoopes, et al. 1992), the resultant reduction in strikes by this species may not be as great.

Prohibition of bird feeding. Since the number of Laughing Gulls that are fed by people at the track is probably quite small, prohibiting their feeding will not have nearly as great an effect on reducing their utilization of the track—and hence their number of overflights of the airport—as will the preceding two management techniques.

3.3.3.2 Jamaica Bay Sewage Treatment Plant

The Jamaica Bay Sewage Treatment Plant is located approximately 4.9 km (3.0 mi) northwest of the Laughing Gull colony. To reach the sewage treatment plant from the colony, gulls cross runway 13R/31L, the area of most frequent interactions between Laughing Gulls and planes. Griffin and Hoopes (1991) conducted a season-long investigation that included 468 visits to the plant during all daylight hours. Their observations revealed an average of 14.5 Laughing Gulls at the plant (with a maximum of 77) from 0600 hours to 1800 hours, and an average of 40 per observation (and a maximum of 273) from 1801 hours to 2100 hours. Although these numbers are relatively low, they do indicate use of this facility by Laughing Gulls, whose principal activity was feeding. Solman (1981) discusses the "unseen" problem caused when only a few gulls at a time cross an airport, but these flights continue throughout the day (resulting in a very large total number of overflights). However, based on recent field observations (Sillings 1993a) the treatment plant does not appear to be a major attractant to gulls.

The weekly bird surveys conducted by ADC biologists in Summer, 1993 indicated moderate use of this site by Laughing Gulls and pigeons. With the exception of the August 8 survey, when 94 Laughing Gulls were observed there, the number of Laughing Gulls observed during any of the nine remaining surveys was less than 30. A one-day visit by NYCDEP staff to the Jamaica Bay Sewage Treatment Facility and ongoing discussions with the facility staff further indicated that use of the facility by Laughing Gulls was limited (Appendix D.1). On the day of the visit approximately 50 gulls were observed at the outdoor aeration tanks, of which more than 40 were Ring-billed Gulls, and only a few Laughing Gulls. Facility staff indicated that the number of gulls frequenting the facility does not vary by breeding season.

Griffin and Hoopes (1991) recommended excluding gulls from the sewage treatment plant with a wire or monofilament barrier.

- **Technical Implementation Feasibility**

A monofilament or wire exclusion device would be relatively easy and inexpensive to construct over open-water areas of the sewage treatment plant. As this facility is owned and operated by the New York City Department of Environmental Protection, the cooperation of this agency would have to be obtained to implement such a measure. Also, employees of the plant would have to be trained to properly maintain the device.

- **Effectiveness**

Operational Effectiveness: Such exclusion devices have been demonstrated to be highly effective in preventing access by gulls to colony sites (Tessier and Blokpoel 1992), landfills (McLaren et al. 1984), public spaces (Blokpoel and Tessier 1984), and water features (Amling 1980, Ostergaard 1981). Especially since the open-water elements of the sewage treatment plant occupy a relatively small area, an exclusion device should achieve similar success and be easy to maintain at peak effectiveness. Since every season will bring naive gulls into the Jamaica Bay that have not previously encountered the grid, it is likely that the grid will have to remain in place permanently.

Ultimate Effectiveness: As noted above, the birdstrike hazard from a continuous small stream of gulls crossing an airport runway is much higher than the numbers in sight at any one time might suggest (Solman 1981). Since the sewage treatment plant is consistently occupied by relatively small numbers of gulls that must cross a runway to reach it, it appears that exactly this type of situation exists. It is very likely that excluding gulls from this attractant would reduce the potential for birdstrikes.

3.3.3.3 Other Off-Airport Attractants

Many other off-airport attractants may exist in locations that cause gulls to traverse JFKIA airspace in traveling from the Jamaica Bay colony to the attractant location. Such attractant areas may include freshwater ponds and other large areas of standing water, (gravel) rooftops, shopping malls, etc. The attractiveness of such areas may also be due to the absence of predators. One alternative to reduce the number of gulls traversing JFKIA airspace would therefore be to identify and locate these attractant areas and reduce their attractiveness by a variety of means. The only surveys of the attractiveness of the off-airport environment have been the efforts of Gurien (1987) and Griffin and Hoopes (1991). However, both studies were limited to the area immediately around the airport, as far as Aqueduct Raceway, and did not identify any attractants that may be present at a greater distance. More study would be required of a larger area around the airport to determine the presence of off-airport attractants that, due to their geographic location, are likely to induce gulls to traverse JFKIA airspace. Such studies would also identify suitable measures to eliminate such attractants if they are located.

- **Technical Implementation Feasibility**

It is possible to undertake a survey of bird use of off-airport attractants by gulls; this would have to extend for at least one year in order to develop an adequate picture of the use of various areas in different seasons, times of day, weather conditions, etc., by different species. If substantial attractants were found on property not controlled by the Port Authority, the feasibility of implementing control measures would depend on the nature of the attractant and the cooperativeness of the property owner.

- **Effectiveness**

Operational Effectiveness: The probable operational effectiveness of any off-airport control measure would have to be assessed relative to each specific situation.

Ultimate Effectiveness: Any operationally effective off-airport control measure could reduce the numbers of gulls traversing JFKIA airspace, and thus could be effective in reducing the potential for birdstrikes at the airport.

- **Conclusion**

Reduction of off-airport attractants is feasible to the extent that cooperation can be obtained from pertinent agencies. Unless all major off-airport attractants can be identified and eliminated, this alternative is only low to moderately effective and by itself is therefore not considered effective. However, it may be beneficial in combination with other, more effective alternatives. It will therefore be advanced for environmental analysis.

3.4 Nonlethal Gull Hazard Control: On-Airport Alternatives

3.4.1 Expansion of JFKIA On-Airport Control Program

JFKIA currently conducts bird-hazard reduction activities in an effort to reduce bird utilization of the airport grounds and the passage of birds through JFKIA airspace and thus reduce the potential for bird interactions with aircraft (Section 1.4) (Appendix C). Some elements of this program could be capable of further improvement. The extent to which the airport can be made less attractive as a destination for gulls and other birds could contribute to a minor reduction in birdstrike hazards. The conduct of bird control activities at JFKIA address all bird species that present hazards to aircraft at JFKIA, and are concentrated on the control of gulls, since these four species (Herring Gull, Ring-billed Gull, Laughing Gull, and Great Black-backed Gull) create the greatest hazards. JFKIA's bird hazard reduction program activities are aimed at reducing strikes from all birds.

Several aspects of the airport's program could be considered for improvement:

3.4.1.1 Vegetation Management

Maintaining tall grass on airfields could be effective in discouraging use by birds, especially gulls (Blokpoel 1976, Brough and Bridgman 1980). A study on JFKIA indicated that this technique would be effective at deterring Laughing Gulls, and recommended that grass be maintained at 45 cm (18 in) for this purpose (Buckley and Gurien 1987). As discussed in the review of this study's recommendations (Appendix D, Haas, 1992), and as observed during several recent field visits to JFKIA (Appendix D, Sillings, 1993) by staff of the USDA Plant and Animal Health Inspection Service; the U.S. Fish and Wildlife Service; the National Park Service; and the New York State Department of Environmental Conservation, the Van Wyck Expressway and other grassy areas on the "streetside" of JFKIA do not form a major attractant to gulls and therefore do not pose a major strike hazard. Furthermore, the sparsely vegetated operational areas of the airport were observed during these site visits and were not considered to be a major attractant to gulls.

As indicated in the review of the study's recommendations, vegetation management is a standard recommendation for airports experiencing bird-hazard problems. JFKIA has been implementing tall grass management since 1985. However, the implementation of this technique may lend itself for some improvement. For example:

- The international panel of bird-control experts convened to investigate the JFKIA Laughing Gull problem noted the need for "a reappraisal of the financial commitment to habitat management," including "the further establishment and maintenance of suitable vegetative cover to discourage bird use throughout the airport" (Buurma, et al. 1989).

- The airport currently maintains the grass at 45 cm (18 in) along runways. However, in the Central Terminal Area short-grass management is still utilized. This study's recommended use of various tall native grasses in nonpublic areas (e.g., along roads), and of alternative ground covers, including gravel in public-use areas, has not been implemented.

- Griffin and Hoopes (1991) noted that portions of the infields on the operational areas of the airport had sparse or no vegetation, and could potentially attract gulls.

Possible Action(s): As part of an integrated management approach to the control of Laughing Gulls and other birds that represent a strike hazard, JFKIA could institute intensive long-grass management on nonoperational sections of the facility. In areas where long grass is not appropriate, alternative ground covers other than short grass could be utilized to the greatest extent possible. The progress and effectiveness of the airport's program of habitat modification could be carefully monitored and adequate funds allocated for proper implementation.

Additionally, JFK would develop written plans for vegetation management, and retain records of activities, effectiveness, and other pertinent information regarding vegetation management on the airport.

- **Technical Implementation Feasibility**

  Such a program is feasible.

- **Effectiveness**

Operational Effectiveness: Vegetation/habitat modification is a proven technique for reducing the numbers of birds that utilize airports (Mead and Carter 1973, Blokpoel 1976, Brough and Bridgman 1980), and a fully implemented program could slightly reduce the numbers of birds overflying JFKIA.

Ultimate Effectiveness: It is a widely utilized assumption that reducing the number of birds on an airport will in turn reduce the number of bird-aircraft interactions at that airport (Brough and Bridgman 1980). Given the fact that an extensive on-airport management program is already in place, any improvements would be marginal and the reduction in strike hazard would be proportional. An improved vegetation management program at JFKIA should therefore contribute to reducing birdstrikes.

3.4.1.2 Water Management

Buckley and Gurien (1987), and Griffin and Hoopes (1991) observed in 1990 that areas of standing fresh water constituted one of the principal attractants utilized by gulls and other birds at JFKIA. Both recommended intensive efforts to eliminate all such water sources in order to reduce the numbers of gulls bathing and drinking in them, and loafing near them. JFK would institute operational use of Methyl Anthranilate after it becomes commercially available.

JFK would develop written plans for water management, and would retain records of activities, results, and other information.

- **Technical Implementation Feasibility**

As noted by Hanna/Olin (1988), the airport's water problems stem from the fact that it is built on fill and therefore "subject to continuous settling." The continuous attention to identify newly emerging water problems and expedient implementation of remediation measures is technically feasible, as evidenced by the Port Authority's successful implementation of such measures since 1991 which has essentially eliminated such conditions.

- **Effectiveness**

Operational Effectiveness: A May-August 1991 study designed to test a chemical bird repellent in standing water at JFK commented on the "general lack of standing water on the airport for sustained periods of time" (Dolbeer and Clark 1991). This and recent field investigations (Appendix C.5.4) indicate that the Port Authority's water management measures have largely been effective in eliminating standing water on the airport as an attractant to gulls.

Ultimate Effectiveness: Since even temporary puddles can attract birds, one study (U.S. Dept. of Agriculture 1993) has recommended that all airport personnel operating vehicles on the airport grounds be instructed to drive through puddles so that the splashing will accelerate evaporation of the water. JFKIA has already implemented these measures, as indicated in the discussion of the No Action Scenario. Furthermore, field investigation by USFWS, NPS, and USDS/APHIS/ADC biologists reported a general lack of accumulated water on JFKIA in 1992 and 1993. Any further improvement would therefore be marginal.

3.4.1.3 Insect Control

It is important that the number of insects on the airport be controlled, as these can be important attractants for birds.

Gurien (1987) found that the diet of adult Laughing Gulls, found dead on the airport, consisted principally of beetles (84% by weight in 1985 and 74% in 1986). Griffin and Hoopes (1991) found insects in the stomachs of about 31% of adult Laughing Gulls found dead at JFKIA, although (possibly as a result of vegetation management following the Gurien study), beetles were not a major component of the gulls' diet. During the same study, large flocks of Laughing Gulls were observed feeding over the airport on swarms of flying ants, though whether these emerged on airport property was not known. Lightning bugs (*Lampyridae*) were apparently the major attractant to Laughing Gulls feeding in the grass along the Van Wyck Expressway. Other insects occurring in the diet were grasshoppers, ants, weevils, earwigs, crickets, and dragonflies.

Gurien (1987) emphasized the need for continual monitoring of insect distribution on the airport to determine the need for management in specific areas.

JFKIA has an ongoing insect control program which consists monitoring and tiered application of insecticide on the grassy strips along the runways and a property north of the airport (Figure 1-8) (Hanna/Olin 1988).

Possible Action(s): Airport management could maintain current management practices, as either the insecticide or the grass management appear to have eliminated beetles as an attractant to Laughing Gulls. Also, careful attention could be paid to flocks of feeding birds (especially gulls) and attempts made to determine what, if any, insects they are feeding on so that control measures could be implemented. Stomach contents of carcasses found on runways could also be analyzed for this purpose. For example, both Gurien (1987) and Griffin and Hoopes (1991) found grasshoppers to be a common component of the Laughing Gulls' insect diet.

JFK would develop written plans for insect control and retain records of activities, results, and other pertinent information.

- **Technical Implementation Feasibility**

Maintenance of current practices is obviously feasible. Monitoring of insect outbreaks and distribution would require motivation and vigilance on the part of the Bird Control Unit (and possibly expansion of patrols into nonoperational areas), and assistance from academic and/or pest-control consultants in identification and control of problem insects.

- **Effectiveness**

Operational Effectiveness: Current practices have either greatly reduced beetles on the airport or curtailed access to them by Laughing Gulls, and thus have been partially successful. Campaigns against other insect taxa, such as grasshoppers, might prove equally effective.

Ultimate Effectiveness: A basic tenet of bird-hazard control is to reduce food sources available to birds in the airport environment, in order to reduce the number of birds on the airport, and, presumably, the number of birdstrikes (Lucid and Slack 1979, Transport Canada 1992). Although food reduction appears to have been achieved at JFKIA by a reduction in beetles, this alone has been unable to offset the increase in birdstrikes associated with the growth of the Laughing Gull colony in Jamaica Bay during the past decade. However, as other measures succeed in decreasing birdstrikes, this method might be viable to achieve further marginal decreases in birdstrikes. Hence efforts should continue to be made to minimize all possible insect attractants on the airport.

3.4.1.4 Sanitation

The Port Authority conducts a program to reduce/eliminate feeding of birds by airport users and service employees and it has replaced dumpsters with contained trash compactors. In the past, there was some degree of feeding of birds at taxi stands (Griffin and Hoopes, 1991), and gulls were observed in rental car lots. Since then, the PA has posted signs prohibiting feeding of birds at taxi stands. Weekly bird surveys conducted during 1993 JFKIA taxi hold areas indicated low use by gulls and moderate use by pigeons. Laughing Gulls were observed during 6 of the total of 56 observations. No more than six Laughing Gulls were observed on any occasion. Additionally, field inspections at JFKIA by agency biologists have concluded that these areas do not attract gulls to any substantial degree, and that feeding occurs only at a minimal level, mostly involving pigeons.

Possible Action(s): The Port Authority could take stronger action than merely requesting cooperation from the taxi drivers. An active educational campaign could be undertaken, perhaps using explanatory leaflets distributed to drivers, or a patrol person to explain the problem to drivers observed feeding birds, or speakers at union meetings. If necessary, a system of fines or other penalties could be imposed.

JFK would develop written plans for sanitation and waste control, and would retain records of activities, results, and other pertinent information.

- **Technical Implementation Feasibility**

An educational campaign would be feasible, and would include written material and patrol persons. One problem could result from what is undoubtedly high turnover among drivers, thus necessitating constant educational efforts, and another might be that of lack of fluency in English among the drivers. However, both problems could be overcome with persistence and use of multi-lingual materials.

■ **Effectiveness**

Operational Effectiveness: If a no-feeding campaign is instituted as an enhanced ongoing program with continual monitoring of effectiveness and eventual penalties for noncompliance, it could prove highly effective in curtailing the feeding of birds on the airport.

Ultimate Effectiveness: The control of on-airport food sources is considered fundamental to bird-hazard reduction. In particular, it can be important to eliminate continuous "patrolling" for food by small numbers of birds at a time (such as probably occurs among gulls looking for handouts), since these actually add up to very large numbers of overflights in the course of each day (Solman 1981). Curtailing food handouts could have a reducing effect on the limited number of birdstrikes that can be attributed to the airport as a destination rather than flyover space.

3.4.1.5 Bird Control Unit

JFKIA's bird control program is outlined in its Airport Certification Manual pursuant to FAA Regulation Part 139.337, Wildlife Hazard Management. This section of JFKIA's Certification Manual was approved by the FAA on July 28, 1989, and contains information about the continuous bird patrol, runway sweeps, bird dispersal procedures, habitat management, issue of breach of rules violations, and an ecological study conducted by Gurien (1987).

Helmke and Silliman (1991) further examined the methods utilized by the JFKIA Bird Control Unit (BCU), identified opportunities for improvement, and produced a Procedures Manual. Further improvements may be achievable in some of the following areas: frequency of patrols and sweeps, staffing, professional expertise of staff, and equipment.

3.4.1.5.1 Frequency of Patrols and Sweeps

Griffin and Hoopes (1991) often observed loafing gulls on taxiways, inactive runways, and the concrete apron around the approach end of Runway 4L. They recommended "increased" and "continual" harassment patrols. Hanna/Olin (1988) reported "there has been a tendency to ease off on the patrol when bird sightings slow down," and emphasized "it is important to maintain the pressure at all times; otherwise birds will return." These observations indicate that, at the time they were made, harassment by the BCU was not continual. Now, the Procedures Manual calls for a "constant roving patrol," with two vehicles each covering an average of 96.5-129 km (60-80 mi) per 8-hour tour.

Currently, runway sweeps are conducted: 1) immediately after closure of a runway, 2) whenever there is a change in runway direction, 3) when requested to do so by the FAA Tower, 4) when requested to do so by a pilot or airline, 5) when the BCU detects birds, and 6) prior to a Concord landing or departure. The number of sweeps conducted by the BCU each year between 1979 and 1993 has ranged from 1750 to 4005.

Possible Action(s): The BCU patrol could be expanded to include more frequent patrols of nonoperational areas.

■ **Technical Implementation Feasibility**

The use of live ammunition would probably not be possible in nonoperational areas, and the use of pyrotechnics would have to be carefully evaluated; but other dispersal techniques could be utilized.

■ **Effectiveness**

Operational Effectiveness: Dispersal efforts in nonoperational areas could reduce the numbers of gulls using the airport. The level of need for BCU operations in nonoperational areas would provide information useful in evaluating the effectiveness of habitat modification measures in these areas.

Increasing runway sweeps before and after every aircraft operation would reduce the total number of operations permitted in a day.

Ultimate Effectiveness: Gulls that use nonoperational areas of the airport are likely to traverse operational areas when flying to or from Jamaica Bay. Assuming that dispersed gulls fly toward the bay, dispersing them may initially increase the number of birds in operational airspace and thus temporarily increase the strike hazard. However, the dispersal efforts in the long term should reduce the average number of gulls attempting to use nonoperational areas and thus should produce a reduction in the birdstrike hazard.

The conduct of runway sweeps before and after every aircraft operation at JFKIA could provide slight-moderate reductions in birdstrikes.

3.4.1.5.2 Staffing and Professional Expertise

Staffing: A total of 26 Port Authority personnel work on the BCU: one Operations Services Supervisor, ten shift supervisors, and 15 shift agents. The BCU covers the airport in constant roving patrols during two shifts each day that operate during all daylight hours. One supervisor and one agent comprise each shift. Shift supervisors and agents rotate in to work on the BCU for two-week tours every 4-6 weeks. Buurma, et al. (1989) and Griffin and Hoopes (1991) recommended increased personnel per shift of the BCU to conduct continual harassment of loafing birds on the airport. Heathrow International Airport in England had a bird-control staff of 21 full-time employees (Solman 1981).

Possible Action(s): Staffing of the BCU could be increased to provide additional patrolling of operational areas and/or expand patrolling of nonoperational areas.

Shift agents and supervisors could be permanently assigned to the BCU. This could be instituted over several years to provide continuity and compliance with existing staffing and personnel management regulations currently in place.

■ **Technical Implementation Feasibility**

Adding staff and redesigning positions to provide for permanent location in the BCU is feasible, and would require additional funding and organizational reordering.

■ **Effectiveness**

Operational Effectiveness: Since constant harassment is one of the keys to dispersing birds from airports, it is probable that additional BCU-dedicated staff used for patrols would increase the effectiveness of the BCU at reducing the number of birds using the airport.

Ultimate Effectiveness: The decrease in the number of birds on the airport resulting from increased patrols performed by added dedicated staff would probably reduce the birdstrike hazard to some degree.

Professional Expertise: The BCU staff does not include a wildlife biologist. Due to the specialized nature of bird control work and the unique situation at JFKIA, which requires extensive knowledge of bird identification, biology, and ecology and behavior, it would be appropriate to retain at least one person with professional wildlife biologist. Port Authority BCU personnel routinely participate in ADC-conducted bird hazard reduction training courses as required by the NY DEC as a condition for permit issuance. Training courses consist of bird identification, hazard control, reporting and documentation, permits and safety.

An international panel of bird-control experts (Buurma, et al. 1989), evaluating the Laughing Gull problem at JFKIA, stated, "Bird hazard management is a biological problem which requires the services of one or more wildlife biologists who have direct access to senior management in the Port Authority." Additionally, the U.S. Fish and Wildlife Service (1976) recommended that JFKIA retain a professional wildlife biologist on staff to coordinate and conduct the bird hazard reduction program. Airports with much less severe bird problems than JFKIA include professionals on their bird-control staffs (Helmke and Silliman 1991).

The practice of rotating personnel with other primary duties into the Bird Control Unit for two weeks, every 4-6 weeks may reduce the BCU's effectiveness. This practice makes it difficult for personnel to develop proficiency in bird identify and control work, and in most cases precludes staff from developing a working understanding of bird behavior and how it relates to bird-aircraft collision hazards. Reznick (1984) presents a well-reasoned differing view, explaining how at Portland International Airport the Operations staff is responsible for "overall airfield safety," of which bird control is one element.

Possible Action(s): The Port Authority would modify the staffing and responsibility structure of the BCU. This modification would include the following:

a) Expand the BCU to include a wildlife biologist (preferable an ornithologist with a minimum educational level of Master of Science) who could coordinate bird control work and serve as liaison to senior Port Authority management. This individual would be the direct supervisor of the Bird Control Unit, and would be responsible for conducted bird hazard assessment, control and monitoring activities. The wildlife biologist would assess and monitor the effectiveness of control programs.

b) If organizational structure prohibits this recommendation to employ a wildlife biologist within the BCU (Aeronautical Services Division), consideration should be given to employing a wildlife biologist to work within the Port Authority's Office of Environmental Policy and Management. This individual would be responsible for coordinating all aspects of the airport's bird hazard control program, including assessment, conduct and monitoring of bird control activities, and would serve as a liaison among the various divisions within the Port Authority that conduct activities that affect the birdstrike situation (maintenance, facilities, operations, etc.).

c) Over time, develop the staff of shift supervisors and agents to include individuals with formal educational training in entomology and wildlife management. This could be accomplished over time (3-6 years) to ensure program continuity and compliance with existing staffing and personnel management regulations currently in place.

d) Assign BCU staff full-time to bird control activities.

e) Retain detailed logs and records of all bird control goals, programs, results, and plans. Separate records of at least the following areas should be maintained: water, insect, and food (habitat) management, monitoring activities, BCU operations and staffing (training, expertise), future plans, other airport bird management programs, successes and failures, effectiveness of programs and techniques, birdstrike reports.

f) Conduct at least annual thorough reviews of JFKIA's overall bird hazard control program to evaluate effectiveness and develop new/alternative approaches as necessary to respond to evolving situations.

g) Develop written plans for all aspects of the bird hazard control program at JFK.

The Port Authority should continue to participate in USDA APHIS ADC-conducted training courses on bird identification and the control of wildlife-related hazards at airports, as required by the NY DEC.

- **Technical Implementation Feasibility**

These measures are feasible.

- **Effectiveness**

Operational Effectiveness: Continued participation of Port Authority BCU staff in ADC-conducted training courses would provide BCU personnel with current and most effective bird control techniques and would serve as a refresher course for long-term staff. Development of BCU staff to include a wildlife biologist will enable Port Authority to evaluate bird control needs when conditions change, and will improve timeliness and effectiveness of ongoing BCU activities. Dedicated BCU staff would increase program effectiveness by improved bird control skills, and probable increased motivation.

Ultimate Effectiveness: Further reducing the number of birds on the airport would reduce the birdstrike hazard to some degree, although it is noted that the majority of birdstrikes at JFKIA involve birds flying over the airport.

3.4.1.5.3 Equipment

Buurma, et al. (1989) noted the need for correct usage and regular replacement of distress tapes for all problem species. No Laughing Gull distress tape is currently commercially available. However, given the proximity of the Laughing Gull colony, such a distress tape could be produced in-house and maintained by the BCU.

Also recommended by Buurma, et al. (1989) to improve the BCU were increased availability of pyrotechnic equipment, proper deployment of automatic bird scaring equipment (gas cannons), and availability of fully-equipped vehicles for all staff. The Helmke and Silliman (1991) report, made more-specific recommendations regarding pyrotechnic equipment, but did not mention gas cannons. Currently, only the Supervisors utilize firearms with live ammunition and pyrotechnics. The role of the Agent is to survey the airport for bird hazards, conduct runway sweeps, play recorded distress calls, harass birds with the vehicle or horn, collect and record birds found dead, report observed birdstrikes, and to inform the shift supervisor of bird hazards that warrant direct employment of live rounds or pyrotechnics.

Possible Action(s): Acquire tape of Laughing Gull distress call. Add "variable playback" technique to Procedures Manual. Mandate use of binoculars and bird identification guides (a set for each vehicle). Provide distress tapes and playback system in all vehicles. Provide training to agents to permit their safe and effective use of pyrotechnics.

■ **Technical Implementation Feasibility**

All of the above are feasible.

■ **Effectiveness**

Operational Effectiveness: Utilizing the proper distress call for Laughing Gull, improving the playback technique, and providing the ability to broadcast distress calls from all vehicles should increase the BCU's effectiveness at reducing the number of Gulls and other birds on the airport. Using binoculars and field guides will permit accurate identification of the bird species that are causing problems so that the most effective deterrents can be employed against them; it is also critical to developing the knowledge of and interest in birds that is essential to the motivation of employees engaged in bird-control work. Improvements in all these areas are very likely to increase the operational effectiveness of the BCU.

Ultimate Effectiveness: If improvements in staffing, equipment, procedures, and motivation enhance the effectiveness of the BCU in reducing the number of birds using the airport, the birdstrike hazard may also be reduced, although that improvement may be marginal since the majority of birdstrikes involve gulls passing over the airport.

■ **Conclusion**

Expansion and improvement of existing programs may result in marginal increases in effectiveness. This alternative is not considered effective by itself. However, given the feasibility of implementation even a marginal increase in effectiveness is desirable and could make this alternative suitable in combination with another more effective alternative. This alternative will therefore be advanced for environmental analysis.

3.4.1.6 Redesign Bird Hazard Task Force Role and Operation

Currently, the Bird Hazard Task Force (Section 1.4.2) has a limited advisory role in the development and operation of JFKIA's bird hazard control program. All Task Force meeting agendas are proposed by the Manager of JFKIA's Aeronautical Service's Division, and are also chaired by that individual.

Possible Actions: The Port Authority could change the procedures and role of the Task Force to permit the following:

a) Actively invite agenda items and meeting dates from Task Force members at least 4-6 weeks prior to the approximate meeting date.

b) Provide Task Force members with reports and summaries of agenda items prior to the meeting to permit more active informed discussion during the meeting.

c) Permit a regular (perhaps annual) review of the JFKIA bird hazard control program by Task Force Members.

d) Record and circulate meeting notes after the Task Force Meeting.

e) Consider the appropriateness of requiring airlines that use JFKIA to report birdstrikes to the BCU or the FAA. Consider monitoring options.

The role of the Bird Hazard Task Force would continue to be advisory. The Task Force would regularly review the overall effectiveness of the Port Authority's bird hazard control program at JFK, and would provide recommendations to the PA on management, monitoring, and data collection programs. The Task Force would monitor implementation of these actions.

- **Technical Implementation Feasibility**

These modifications are feasible.

- **Effectiveness**

Operational Effectiveness: Strengthening the opportunity for discussion and enhancing the involvement of the Task Force in JFKIA's bird control program would require: 1) increased effort on the part of all Task Force members to become informed and 2) increased action by the Port Authority to request input. The steps outlined above are procedural and could be accomplished with minimal effort.

Ultimate Effectiveness: These enhancements of the role of the Bird Hazard Task Force would contribute to the long-term development of JFKIA's bird hazard reduction program by improving the likelihood of informed policies, decisions, and cooperation among the involved agencies. It would establish a meeting record for referral. In certain circumstances, it may decrease the birdstrike hazard at JFKIA by enhancing understanding of the problem and development of possible solutions.

- **Conclusion**

Because these changes could improve the long-term bird hazard problem at JFKIA, they are forwarded as part of the overall alternative (Expansion of JFKIA On-Airport Control Program) for further analysis.

3.4.2 Airport Operational Strategies - Runway Usage Patterns

3.4.2.1 Aircraft Operational Characteristics

The aircraft activity at JFKIA is unique not only in its diurnal and hourly patterns of activity, but also in the distribution of its aircraft fleet mix.

3.4.2.1.1 Aircraft Activity Volumes

The aircraft activity volumes at JFKIA increased over three percent each year between 1986 and 1992, reaching 322,700 aircraft operations. Peak month operations were 30,900 in August or 9.6 percent of the annual level. Aircraft activity levels increased during this period due to seasonal variations in offerings by both scheduled and charter carriers who are servicing the peak personal traveling public.

3.4.2.1.2 Daily Distribution

The hourly distribution of aircraft activity for a given day of the week tends to follow a constant pattern. The pattern of daily aircraft operations at JFKIA is highly peaked during the 3:00 PM to 9:00 PM time period. This peak reflects the major service patterns operated at JFKIA, particularly the European arrivals and departures. The peak arrival period occurs from 2:00 PM to 7:00 PM while the peak departure occurs from 5:00 PM to 10:00 PM. Aircraft operations from 7:00 AM to 2:00 PM are relatively constant and at about half the level as during the peak hours. During the nighttime hours from 11:00 PM to 6:00 AM aircraft operations are very limited, less than half the daytime off-peak hours. Table 3-4 shows the arrivals, departures and total aircraft operations by hour for a typical day.

3.4.2.1.3 Fleet Mix

The types of aircraft operated at JFKIA encompass the full spectrum of transport category used by carriers servicing the United States. Few private general aviation aircraft utilize the airport. The "smaller" aircraft serving the airfield are mostly "commuter" or regional aircraft powered by turboprop engines and carrying less than 50 passengers. Although both these and large wide-body aircraft can and will operate during all hours, a distinct pattern emerges. Table 3-5 shows the fleet mix of the aircraft operated into JFKIA by the following categories:

- twin engine turboprops
- two and three engine jets - narrow body
- two, three, and four engine jets - wide body
- supersonic jets

Figure 3-6 shows the operations by aircraft class by hour of the day. The peak period is dominated by wide-body transport operations. This is in direct contrast to the earlier hours when commuter and narrow body jets dominate.

3.4.2.2 Runway Use Configurations

The utilization and selection of runway use configurations at JFKIA is based upon three factors:

- wind speed and direction,
- demand volumes, and
- coordination requirements with La Guardia airport operations and to a lesser extent Newark airport.

Additional factors that affect runway use include noise abatement policies, runway maintenance, temporary operational closings for bird control sweeps or other safety factors. The combination of these factors limits the opportunities for the definition of other criteria to be defined which would be aimed at minimizing the risk of birdstrikes. The significance of these three primary runway use criteria are described in the following sections.

3.4.2.2.1 Wind Speed and Direction

The direction of wind in combination with its speed determines the safe orientation for aircraft operations. Aircraft depart into the wind as much as possible in order to maximize the flow of air necessary to

Table 3-4

Average Daily Aircraft Operations at JFK Airport
June 6 - June 12, 1993

TIME	ARRIVALS	DEPARTURES	TOTAL
1	5	8	13
2	3	2	5
3	2	2	4
4	1	2	3
5	1	1	2
6	9	2	11
7	15	3	18
8	28	19	47
9	16	28	44
10	13	41	54
11	20	18	38
12	24	19	43
13	15	31	46
14	24	20	44
15	48	13	61
16	60	22	82
17	55	31	86
18	31	43	74
19	26	59	85
20	26	53	79
21	37	30	67
22	20	19	39
23	14	16	30
24	9	20	29
TOTAL	499	504	1003

Source: C.A.T.E.R. II
Collection & Analysis of Terminal Records
Aviation Data Systems, Inc. (1993)

Table 3-5

Average Operations by Aircraft Type and Time of Day
June 6 - June 12, 1993

Hour	General Aviation Jet	General Aviation Prop	Commuter Prop	Air Carrier Jet	Wide Body Jet	Concorde SST	Helicopter	TOTAL
1	0	0	2	2	8	0	1	13
2	0	0	2	1	2	0	0	5
3	0	0	1	0	3	0	0	4
4	0	0	0	0	2	0	0	3
5	0	0	0	0	1	0	0	1
6	0	0	0	4	6	0	0	11
7	0	1	2	8	6	0	1	18
8	2	6	17	10	8	0	3	46
9	3	6	10	10	12	1	3	45
10	2	2	14	18	12	2	5	54
11	2	4	13	5	13	0	1	39
12	2	4	20	4	10	0	3	43
13	3	5	17	6	12	0	3	46
14	1	2	11	7	19	1	5	44
15	1	5	17	7	25	1	4	60
16	1	6	24	15	30	0	6	82
17	3	6	21	20	28	0	9	86
18	1	3	20	19	21	1	8	74
19	2	5	20	18	34	0	6	85
20	1	4	16	12	43	0	3	80
21	0	3	18	14	30	0	1	66
22	1	1	11	11	16	0	0	39
23	0	0	6	11	13	0	0	30
24	0	0	9	8	12	0	0	29
TOTAL	63	271	210	367	6	62	0	1003

Source: C.A.T.E.R. II
Collection & Analysis of Terminal Records
Aviation Data Systems, Inc. (1993)

remain airborne at slow speeds (less than 175 knots for large aircraft and lesser speeds for smaller aircraft).

Two wind parameters (crosswinds and tailwinds) define the minimum wind speed and direction (tolerances) for typical aircraft operating practices for safe flight operations:

- Crosswinds: These act at right angles to the direction of flight. For small and large aircraft the maximum tolerable crosswind is 15 and 20 mph, respectively, when runways are dry and 10 mph when runways have less friction due to precipitation.

- Tailwinds: These act on an aircraft in the direction of operation. The maximum tolerable tailwind is 5 mph for all aircraft sizes when runway conditions are dry and breaking action is good. When runway surfaces are not dry the tailwind component must be zero.

The airfield/runway configuration at JFKIA provides a pair of closely spaced, dependent runways in a northeast/southwest (4/22) orientation and a widely spaced, independent pair of runways in a northwest/southeast (13/31) orientation. By having full-use runways with different orientations, combined the airport can provide for operational capability under virtually all wind conditions. The wind coverage of the 13/31 and 4/22 runway pairs is 98.7 percent of all wind conditions. However, the operational capability is not equal for all wind directions.

3.4.2.2.2 Aircraft Operational Demand Volumes

The pattern of aircraft operations on a daily, monthly, and annual basis reflects the role and air service patterns of the airport. During periods of peak operational demands runway use configurations which offer the highest capacity and correspondingly the lowest delay are generally selected for the wind condition prevalent during the period.

The daily pattern of aircraft operations at JFKIA is distinct and is characterized by relatively low demand volumes in the morning hours and very high demand in the mid-afternoon and evening hours (See Figure 3-6). Fifty-five percent of the total daily aircraft operations occur between 3:00 PM and 9:00 PM. Outside of this peak period the hourly volumes are less than the capacity of a single runway. Similarly the hour departure volumes are less than the capacity of a single dedicated departure runway. During the peak period, two arrival and two departure runways are needed to accommodate the demand. The current pattern of demand at JFKIA may offer prospects for preferential runway use during non-peak periods which may reduce the exposure of aircraft to airfield locations where gull activities are less frequent.

3.4.2.2.3 Coordination with La Guardia Airport

The utilization of runways at JFKIA are also dependent upon the runways in use at La Guardia (LGA). The runway orientations at LGA are similar to those at JFKIA and they share similar weather conditions. The 4/22 runway at LGA is separated from the northwest 4/22 runway at JFKIA by approximately 9.5 miles and the 13/31 runways are separated by only 5.5 miles. Due to this combination of common weather, runway orientation, and their proximity to each other, results in overlapping climb and descent airspace allocated to each airport, this situation requires a highly coordinated approach to the air traffic management and operation of arrival and departure aircraft streams to the individual airports.

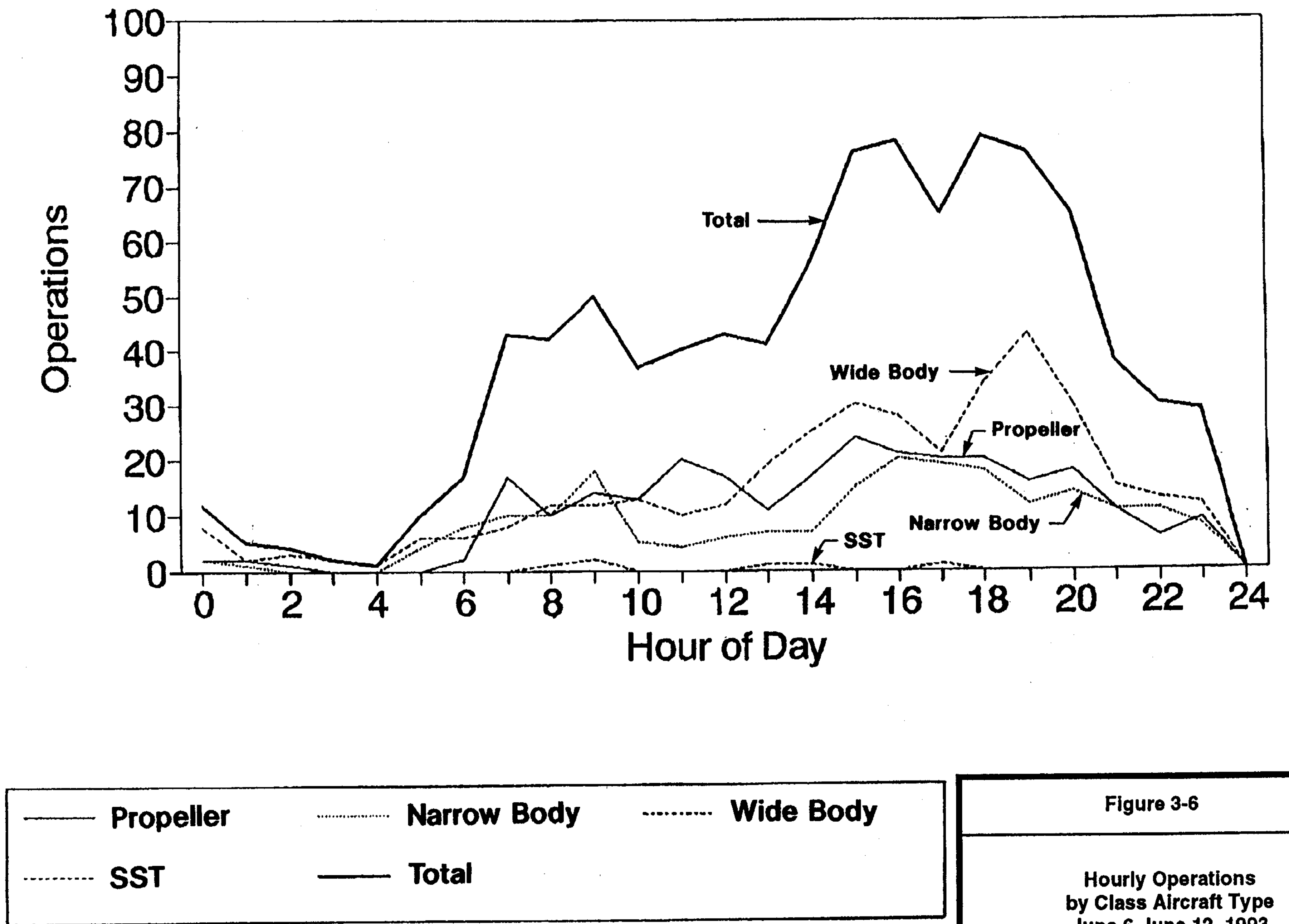


Figure 3-6

Hourly Operations
by Class Aircraft Type
June 6-June 12, 1993
JFK airport

3.4.2.3 Runway System Capacity Under Various Conditions

The runway system at JFKIA can provide a variety of capacities depending upon the runway configuration in use, the weather conditions, and the demand volumes and sequencing by aircraft types. Depending on the above conditions, a single runway may be adequate to accommodate arrivals and departures simultaneously, or all four runways may be required. This analysis was conducted to determine how different usage patterns (such as those to reduce the risk of birdstrikes) would relate to system capacity.

- **Single Runway with Simultaneous Arrival/Departure**

A single runway used for both arrivals and departures simultaneously under Visual Flight Rules (VFR) will enable a throughput rate of 22 - 25 arrivals and departures each per hour for a total capacity of 44 - 50 operations per hour.

- **One Pair of Departure-Only Runways with One Pair of Arrival-Only Runways**

Two runways each used for departures only and two runways each used for simultaneous arrivals in VFR conditions will produce an arrival rate of about 60 aircraft per hour and a departure rate of about 80 aircraft per hour assuming that no operational constraints are imposed on the airspace system. In practice, departure constraints often apply and limit runway departure capacity to as few as 50 aircraft per hour. Simulations of airfield capacity indicate that VFR capacity ranges from 89 - 114 operations per hour depending upon runway directions and configurations in use (KPMG Peat Marwick, 1989).

Figure 3-7 and Table 3-5 indicate that for virtually all non-peak period hours, the capacity available on one runway is sufficient. During the peak period from 2:00 PM to 10:00 PM two arrival runways and one departure runway are needed to accommodate the peak volume of arriving aircraft with reasonable delay while two departure and one arrival runways are needed to accommodate the departure peak. In the event that flights become bunched within an hour period, limited use of dual arrival and/or departure runways may be necessary to accommodate operational demands. Furthermore, factors such as very long haul flights, pilot requests, or airfield maintenance and airport construction operations may require the use of alternate or multiple runways.

3.4.2.4 The Relation Between Birdstrikes and Airport Operational Characteristics

An examination of the birdstrike and airport operational statistics[3] provides the following observations:

- Birdstrike rates vary substantially by runway (see Figure 3-8).

Figure 3-8 shows the number of strikes for every 10,000 operations in 1990 for each runway by bird species. This year was chosen because the on-airport shooting program was not in effect until 1991 and data prior to this would therefore not be skewed by this activity. The number of birdstrikes per operation (i.e the birdstrike rate) provides an indication of the birdstrike hazard per operation for each runway or, in other words, the propensity of each runway for birdstrikes, independent from the total volume of operations on each runway. It shows that certain runways have a higher propensity to result in birdstrikes from certain bird species than others. Among all runways, runway 4Left had the highest propensity for

[3] Source: Port Authority of New York and New Jersey, 1993

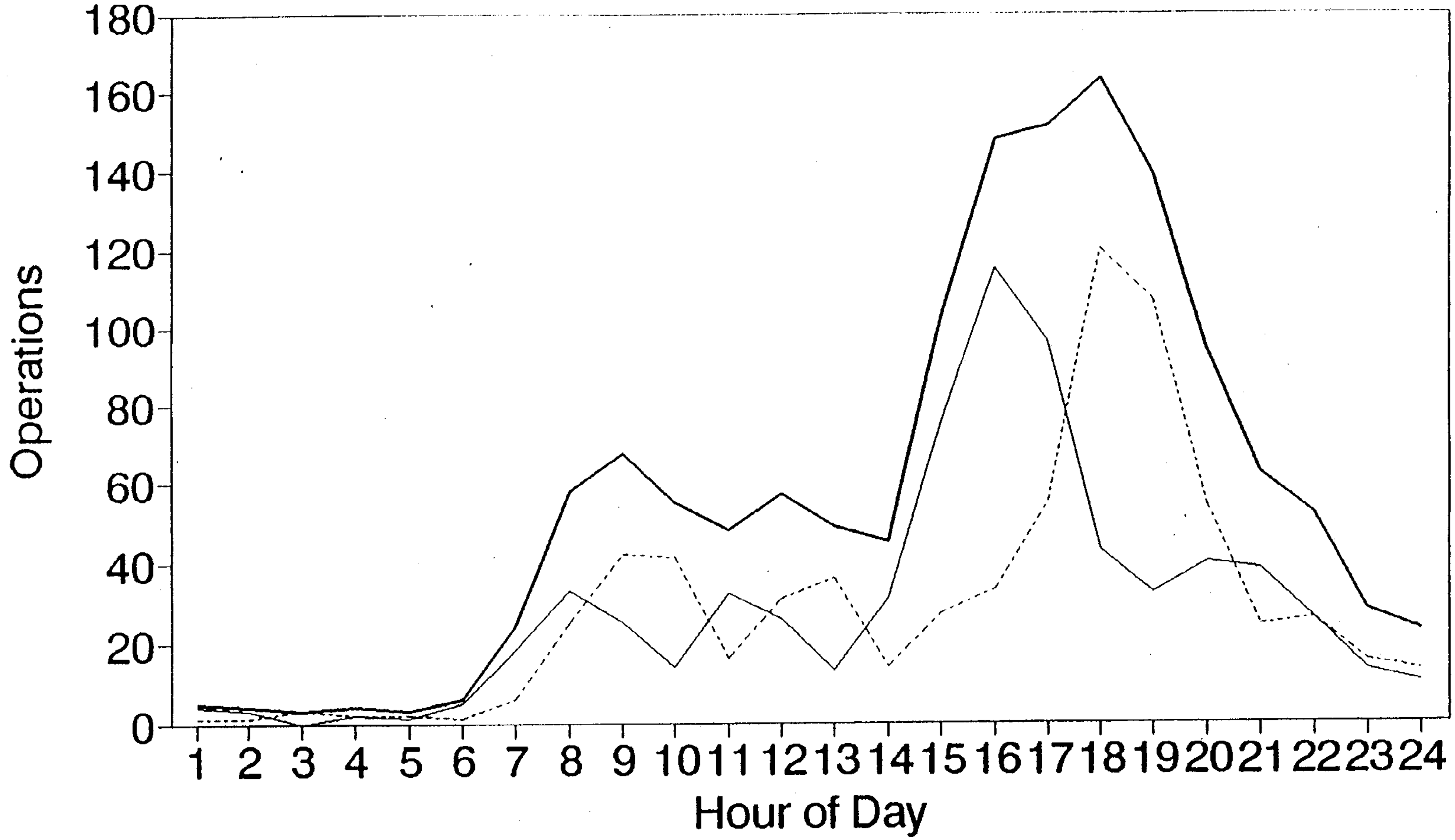


FIGURE 3-7

Hourly Airport Operations by Departures/Arrivals

Source: Louis Berger & Associates, Inc., 1993.

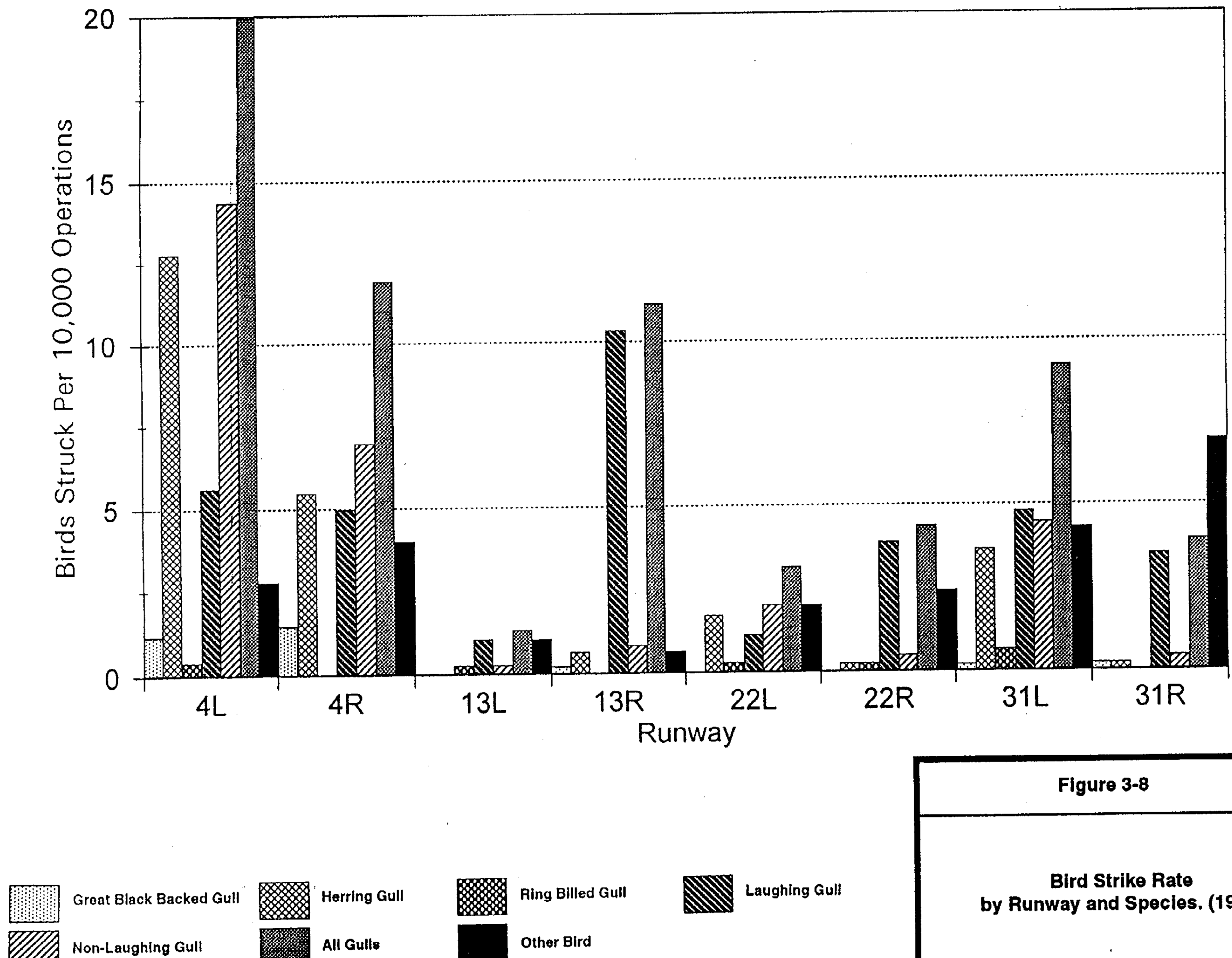


Figure 3-8

Bird Strike Rate by Runway and Species. (1990)

strikes in general, attributable largely to Herring Gulls and secondly to Laughing Gulls. Runway 13Right had the second highest general propensity for strikes, almost exclusively attributable to a high propensity for strikes by Laughing Gulls. Among the different bird species, runway 13Right had the greatest propensity to be subject to Laughing Gull strikes among all runways. Similarly, runway 4Left had the greatest propensity for strikes by Herring Gulls, and runway 31Right had the greatest propensity for strikes by birds other than gulls. The general strike rate for runway 31Left was similar to that of runway 31Right, but more or less equally divided between propensity for strikes by Laughing Gulls, Herring Gulls and birds other than gulls. Laughing Gulls comprised a substantial part of the birdstrike rate for the runways with the highest propensity for birdstrikes in general (4Left, 4Right, 13Right, 31Left and 31Right).

- Total number of birdstrikes varies by runway and the distribution of the total number of birdstrikes over different runways differs from the than the distribution of birdstrike rates over different runways (see Figure 3-9).

While the birdstrike rate by runway provides an indication of the birdstrike hazard by runway per operation, the actual birdstrike is defined by the total number of birdstrikes per runway. Furthermore, if the difference in the number of airport operations between different runways is taken into account and the actual number of strikes for each runway is counted, the <u>total</u> birdstrike hazard by runway on a daily basis (and not per operation on each runway) indicates that those runways which have the highest number of operations also have the greater propensity for strikes by Laughing Gulls compared to any other bird species. Laughing Gulls are responsible for the greatest number of strikes at the airport.

- Birdstrikes vary substantially by season (see Figure 3-10).

- Birdstrike rates vary substantially by time of day (see Figure 3-11).

- Serious birdstrikes occur more frequently on departure than arrival.

- Gulls are the overwhelming type of bird involved in early morning birdstrikes (see Figure 3-12).

- Single runway VFR runway capacity is generally sufficient between 10:00 PM and 2:00 PM to accommodate current demand levels.

Operational data indicate that for virtually all non-peak period hours the capacity available on one runway is sufficient. During the peak period from 2:00 PM to 10:00 PM two arrival runways and one departure runway are needed to accommodate the peak volume of arriving aircraft with reasonable delay while two departure and one arrival runways are needed to accommodate the departure peak. In the event that flights become bunched within one-hour period, limited use of dual arrival and/or departure runways may be necessary to accommodate operational demands. Furthermore, factors such as very long flights, pilot requests, or airfield maintenance operations may require the use of alternate or multiple runways.

In theory, the current pattern of demand at JFKIA could offer prospects for preferential runway use during non-peak periods which might reduce the exposure of aircraft to bird hazards by shifting operations to airfield locations where gull activities are less frequent. During periods of less aircraft activity the preferred runway to reduce gull strikes would be runway 13L/31R for both arrivals and departures. Analogously serious birdstrike risks may be reduced by utilizing the exposed bay runway preferentially for arrivals while assigning departures to alternate runways when practical and safe.

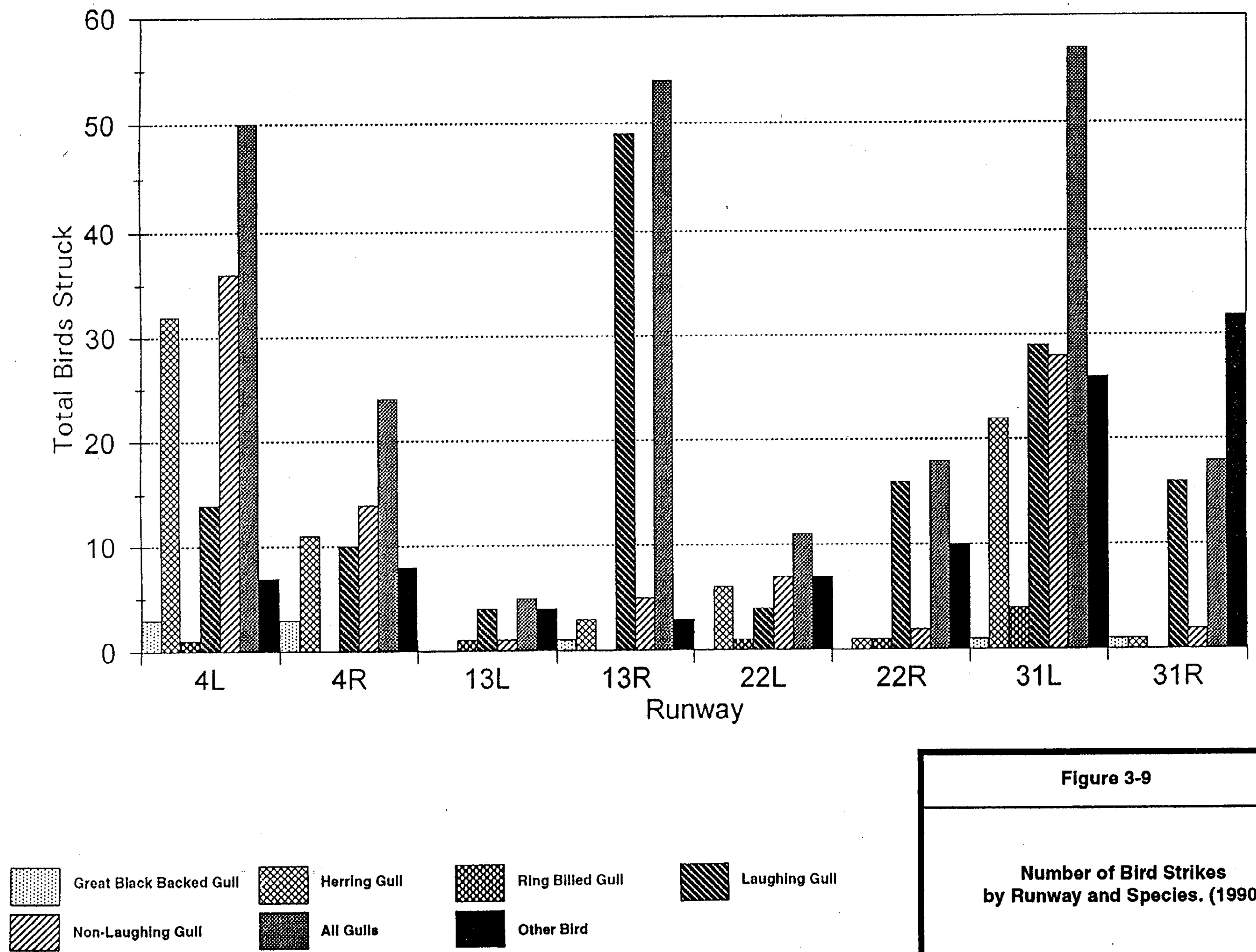


Figure 3-9

Number of Bird Strikes by Runway and Species. (1990)

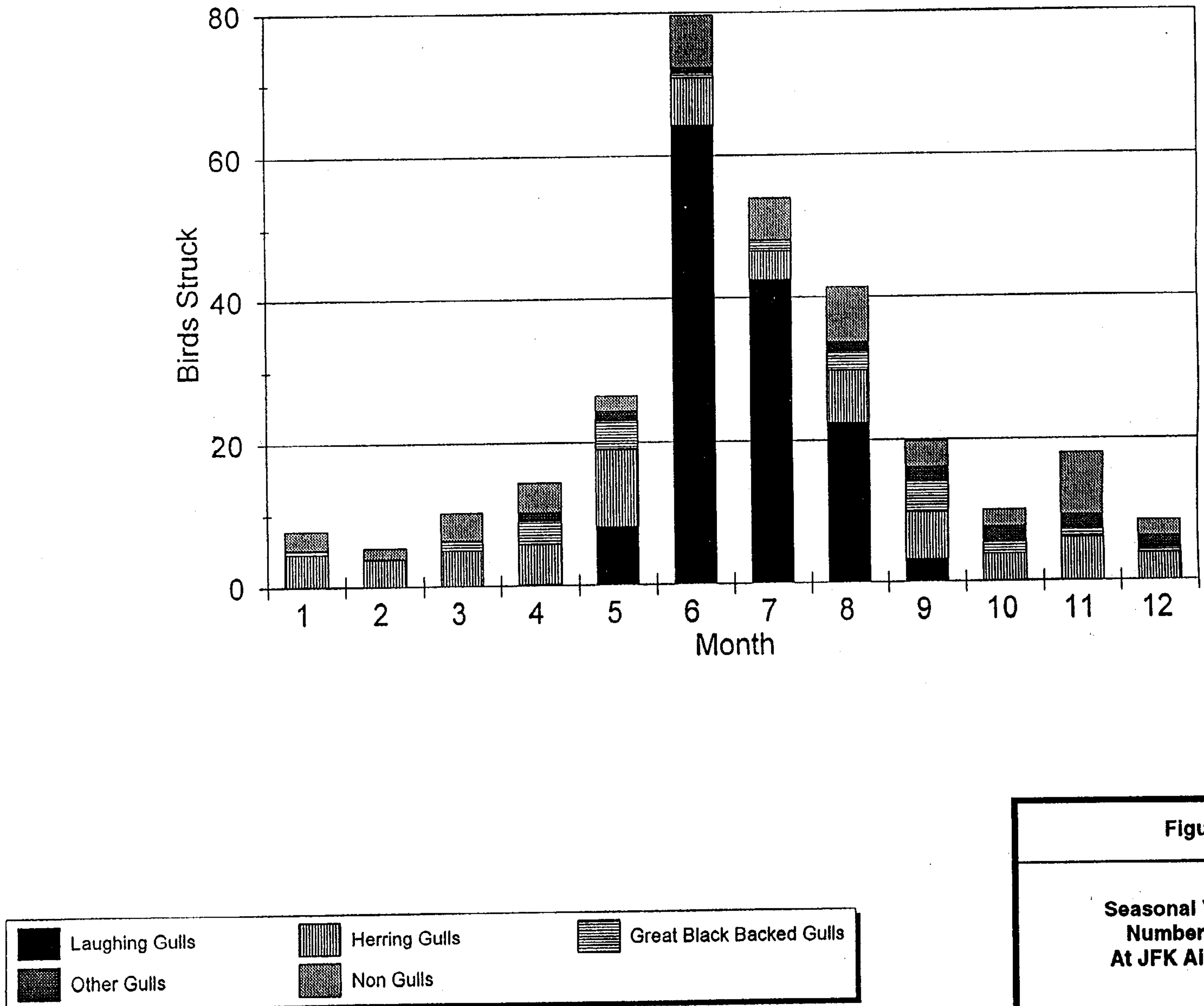


Figure 3-10

Seasonal Variation in Mean Number of Bird Strikes At JFK Airport 1986 - 1990

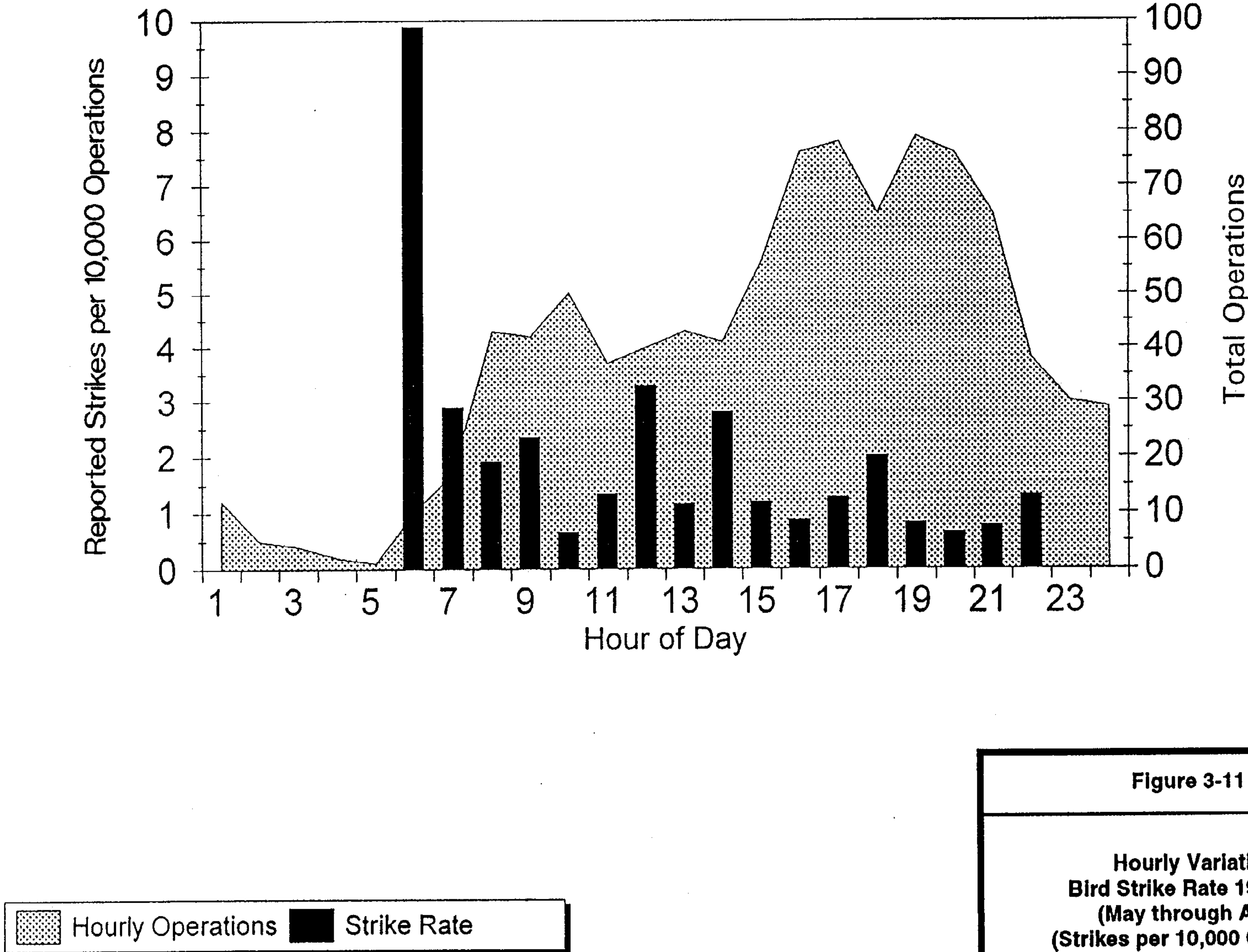


Figure 3-11

Hourly Variation in Bird Strike Rate 1986 - 1990 (May through August) (Strikes per 10,000 Operations)

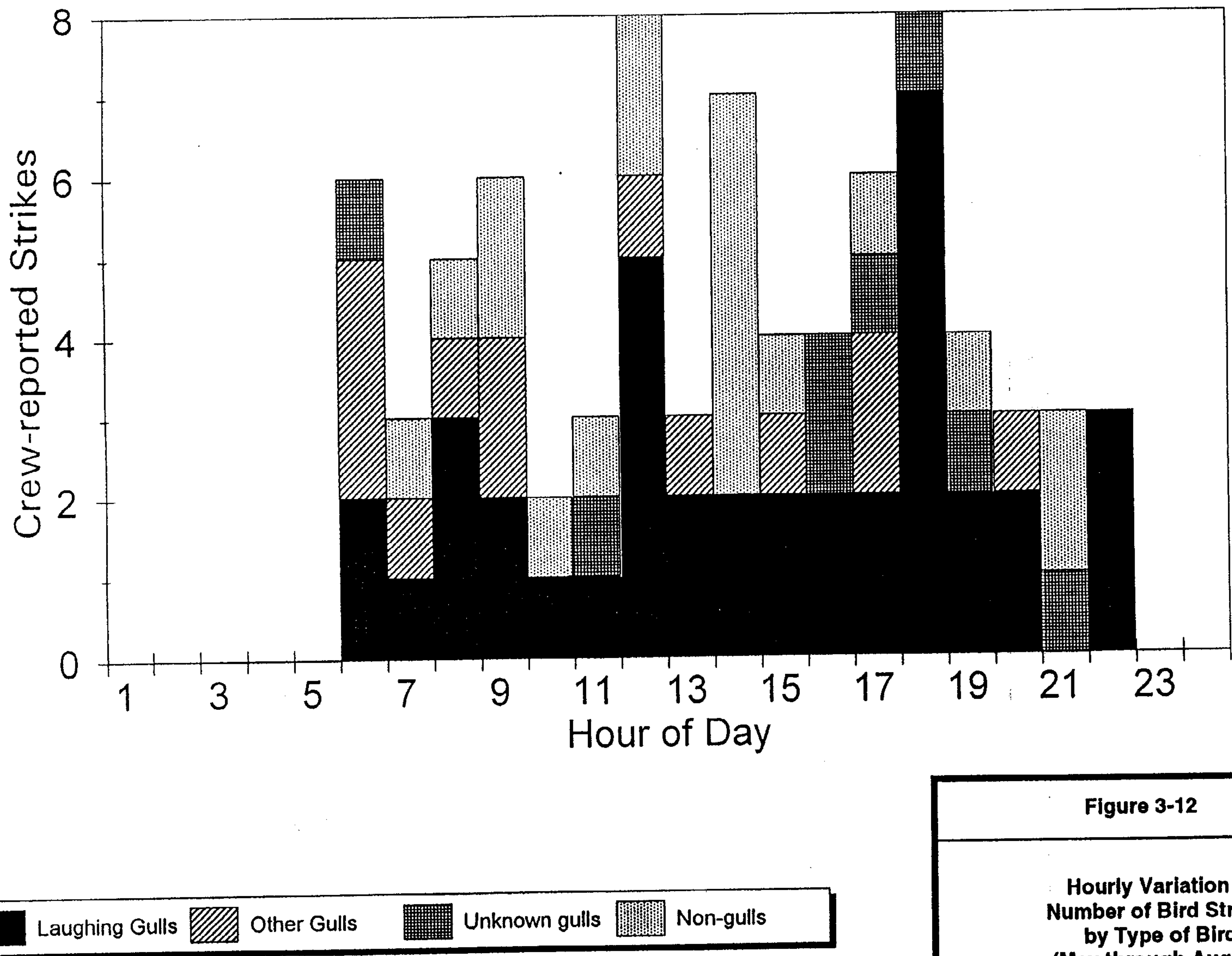


Figure 3-12

Hourly Variation in Number of Bird Strikes by Type of Bird (May through August) JFK Airport

■ **Technical Implementation Feasibility**

The feasibility of runway priority is reduced due to unpredictable meteorological conditions and aviation requirements related to compliance with noise standards, fuel efficiency and operational aspects such as aircraft maintenance.

Traffic volumes from 6:00 AM - 11:00 PM must be accommodated by the use of multiple runways to avoid excessive delays. While traffic between the hours of 11:00 PM and 6:00 AM could conceivably be accommodated by the use of a single runway for arrival and departure, the utility of runway 13L/31R for this purpose is limited for the following reasons:

- It would violate long-standing nighttime noise abatement policies of the PA and the FAA, which prioritize usage of runway 4R/D22R, assuming weather and wind conditions permit.

  - Due to its relatively short length, runway 13L/31R is primarily used as an arrival runway and is ill-suited to accommodate heavy jet departures which are very common at JFKIA and need a long runway.

  - Weather and wind conditions may force the use of other runways.

  - Because of its location and other airport operational aspects, runway 13L requires more extensive safety considerations, involving more constraining horizontal and vertical approach separation and clearance requirements for arriving and departing aircraft than other runways at JFKIA. The use of this runway is therefore more affected by less optimal weather conditions, such as those necessitating Instrument Landing System (ILS). The use of this runway under such weather conditions—for example to reduce the potential for birdstrikes—substantially reduces the airport's operational capacity.

  - Furthermore, as all major airports in the New York metropolitan area are linked in the processing of air traffic, the reduced operational capacity of JFKIA would negatively impact operations at LaGuardia Airport, Newark International Airport and Teterboro Airport in terms of air traffic congestion and the corresponding delays in departure and landing operations and potential effect on safety margins.

■ **Effectiveness**

Operational Effectiveness: This strategy offers a potential reduction in the birdstrike risk, but is severely limited to restricted conditions as to when it may be applied due to wind conditions, demand volumes, aircraft pilot preferences, ATC preferences, and airport operational factors.

Ultimate Effectiveness: Birdstrike rates and their seriousness vary by type of operation, arrival or departure, and by runway end in use. Based upon historical rates the strike rates vary as much as three or four times depending upon the runway utilized. If this method would lend itself to implementation on a continuous basis, it would be considered effective in contributing to an effective reduction of the strike hazard.

■ **Conclusion**

This alternative is only feasible when airport operations allow preferential use of Runway 13L/31R. As described under Technical Implementation Feasibility, a multitude of unpredictable and airport operation and safety-related factors render this alternative unfeasible for practical application as a strike reduction method. Therefore this alternative will not be considered further or advanced for environmental impact analysis.

3.4.3 Aircraft Engineering to Reduce Birdstrike Hazards

Research and development in terms of aircraft engineering to reduce the likelihood and/or impact of birdstrikes have been conducted by aircraft engine manufacturers and Federal agencies involved with birdstrike hazards in the United States and around the world. These attempts generally involve systems to deter or deflect birds from sensitive aircraft parts (especially engines) or to make aircraft components better-able to withstand a birdstrike if one occurs. The majority of serious bird-aircraft collisions involve birds striking aircraft engines and windscreens (Seubert 1990). A single bird that collides with an aircraft can result in the total loss of the aircraft and potentially, the loss of human lives. The components of an aircraft most-likely to be involved in a birdstrike are the forward-facing areas, including the nose of the fuselage, engine cowlings, engines, windscreen, and the leading edges of wings and tail (Blokpoel 1976). The results of a bird-aircraft collision depend on a number of important factors: size, weight and number of birds involved, aircraft component struck, impact velocity, and other features. Airworthiness requirements are imposed by Federal regulations in the United Kingdom and the United States. In the United States, the Federal Aviation Administration (FAA) has identified critical criteria and established criteria that newly FAA certified aircraft engines must meet; these are enumerated in 14 CFR 33.77 (Appendix E.1).

3.4.3.1 Technical Characteristics of Birdstrike Hazards

Bird-aircraft collisions that occur in civil aviation are most likely to occur at low-level during takeoff or landing (Blokpoel 1976, Seubert 1990). Bird-aircraft collisions have resulted in engine damage in about 50% of the instances where birds were ingested into turbofan engines (Seubert 1990). With recent trends in the aviation industry towards larger and fewer high bypass turbofan engines, the larger forward capture area may make these engines more vulnerable to birdstrikes. One recent study of high-bypass turbofan engines indicated that 90% of all known ingestion events involved birds (Alge 1993). This same study indicated that 98% of these strikes occurred at or near airports during takeoff, climb, approach, and landing flight phases (Alge 1993).

At JFKIA, birdstrike statistics have been recorded since 1979. A portion of these birdstrikes are those that were reported by pilots; for this group, details of the interaction are known, such as the exact time of day, location (runway and intersection), aircraft type, impact point, and other facts. A brief analysis of the 340 pilot-reported birdstrikes that have occurred at JFKIA between 1979 and 1993 was conducted to identify the aircraft types and impact points affected by birdstrikes at JFKIA (Tables 3-6 and 3-7). Boeing-747 and Boeing-727 were the aircraft involved in the greatest numbers of birdstrikes, accounting for 25% and 17% of the total, respectively. Lockheed L-1011 and McDonald-Douglas DC-10's each accounted for about 10% of the pilot-reported strikes. Impact points on the aircraft involved in pilot-reported birdstrikes at JFKIA were engines (17% of total), engines plus other components (5%), fuselage (11%) and others. These data are presented to give a general picture of a few of the technical aspects of birdstrikes at JFKIA.

Table 3-6

Frequency of Reported Birdstrikes for Various Models of Aircraft at JFKIA, 1979-1993

Company	Model	No. of Aircraft with Reported Strikes	% of Total
Boeing	B-747	85	25.1
Boeing	B-727	59	17.4
Lockheed	L-1011	34	10.0
McDonald-Douglas	DC-10	32	9.4
Boeing	B-767	13	3.8
Aerospatiale	ATR-42	13	3.8
Airbus Industrie	A-300	12	3.5
McDonald-Douglas	DC-8	9	2.7
Boeing	B-737	7	2.1
42 other models		76	22.3
Total		**340**[a]	**100**

[a] Information is reported to Port Authority (PA) voluntarily by pilots and air carriers; therefore, data are incomplete. These data do not include the 2,494 incidences unreported by air carriers in which 2,617 dead birds (that showed evidence of interacting with aircraft) were found by Port Authority personnel on active runways, 1979-1993.

Table 3-7

Point of Impact on Aircraft for 340 Aircraft for which Birdstrike was Reported at JFKIA, 1979-1993

Impact Point of Strike	No. of Aircraft with Reported Strikes	% of Total
Unknown	132	38.8
Engine(s)	58	17.1
Engine plus other	17	5.0
Fuselage	37	10.9
Nose or radome	25	7.4
Windshield	23	6.8
Land gear or tire	18	5.3
Wing or tail	16	4.7
Multiple points (non-engine)	14	4.1
Total	**340**[a]	**100.0**

[a] Information is reported to Port Authority (PA) voluntarily by pilots and air carriers; therefore, data are incomplete. These data do not include the 2,494 incidences unreported by air carriers in which 2,617 dead birds (that showed evidence of interacting with aircraft) were found by PA personnel on active runways, 1979-1993.

3.4.3.2 FAA Aircraft Engine Certification Regulations Regarding Birdstrikes

Within the FAA's general mission to enhance safe aircraft and airport operations, are several specific provisions for reduction of hazards created by wildlife. The establishment of engine certification criteria pertaining to birdstrikes was first undertaken by the FAA in the 1970s. The regulations set forth criteria that newly certified engines must meet.

Initial FAA Regulations Pertaining to Engine Criteria for Birdstrikes. Bird ingestion requirements were first added to the Federal Aviation Regulations as Amendment 6 to Part 33 (33.77), dated October 1, 1974. This regulation established that: 1. ingestion of a 4-lb. bird may not cause the engine to catch fire, burst, generate increased loads, or lose the ability to shut down. and 2. ingestion of a 3-oz. or 1.5-lb. bird may not cause more than a sustained 25% power or thrust loss, or require that the engine be shut down. The number of 3-oz. and 1.5-lb. birds to be included as the test criteria was determined by the size of the engine's inlet area, up to a maximum of 16 (3-oz.) and 8 (1.5-lb.) birds.

Modification of FAA Regulations Pertaining to Engine Criteria for Birdstrikes. Changes to the bird ingestion requirements in 33.77 were made with Amendment 10, dated February 23, 1984; Amendment 10 to 33.77 is the currently implemented FAA regulation pertaining to bird ingestion engine requirements (Appendix E.1). Additions provided for in this amendment are as follows:

- ingestion of 3-oz. or 1.5-lb. birds may not: 1) require the engine to be shut down within 6 minutes of bird ingestion, or 2) result in potentially hazardous conditions;

- ingestion of 3-oz. bird simulations must be aimed at select critical engine areas; and

- simulated aircraft speed in tests involving 4-lb. birds depend on certain engine characteristics (inlet guide vanes).

Proposed (1994) Changes to the FAA Regulations Pertaining to Engine Criteria for Birdstrikes. In 1976, the National Transportation Safety Board (NTSB) recommended that the FAA reevaluate the engine criteria related to birdstrikes. The recommendation was motivated, in part, by the 1975 DC 10-Herring Gull collision and crash at JFKIA. Since 1976, the FAA has worked closely with aircraft engine manufacturers (Pratt & Whitney, Rolls-Royce, and GE Aircraft Engines) to reevaluate the criteria and requirements relative to the number and weight of birds. In January of 1994, the FAA issued a Federal Register (Vol. 59, No. 4) Notice of Proposed Rules for 14 CFR 33.77 (Appendix E.1). The proposed rules include new, more stringent bird ingestion criteria for large turbofan engines for the B-747 aircraft. These upgraded criteria are designed to more realistically represent bird hazards to aircraft. The following are the newly-proposed criteria for medium and large birds:

- large-sized bird criteria is increased from 4-lb. to 4-, 6-, or 8-lb. birds; and

- medium-sized bird criteria is increased from a 1.5-lb. bird to up to a 2.5-lb. bird, under various flight conditions, depending on engine inlet size.

3.4.3.3 Research and Development into Aircraft Engineering to Reduce Birdstrike Hazards

Two approaches have been pursued in terms of attempts to make aircraft better-able to handle birdstrikes: 1) prevent birds from reaching the aircraft engine, and 2) change engine design to enable it to better-withstand impact of birdstrike.

3.4.3.3.1 On-Board Bird Deterrent Devices: Lights, Radar, and Laser Beams

There have been a number of attempts to develop on-board devices to clear flying birds out of the way of oncoming aircraft; the success of these devices would depend on the birds ability to detect the stimulus, react with an avoidance behavior, and then successfully maneuver to avoid the aircraft. Three types of electromagnetic energy (light, radar, LASER) have been investigated for the development of on-board bird dispersal devices (Blokpoel 1976).

Many pilots and airlines leave weather radar and landing lights on in flight to reduce birdstrikes; the idea is that the lights will enable a bird to more easily detect the aircraft and that birds' ability to detect microwave energy will cause them to avoid the oncoming aircraft. The use of landing lights around terminals and in flight is common, was recommended by NASA, and has been incorporated into many airlines standard operating procedures. This is motivated more to avoid mid-air collisions than to reduce birdstrikes. There is no proof or evidence that airborne lights reduce birdstrikes (Blokpoel 1976).

Early studies by the U.S. Fish and Wildlife Service indicate that lasers aimed at the heads of caged gulls did not elicit significant distress or alarm behaviors (Seubert 1963), which indicated a low probability of the success of an on-board laser device to deter birds away from planes. Lustick (1972) provides an account of the use of high intensity laser light on birds. The study indicated that a 0.3 cm laser beam at wavelengths of 454 to 515.1 nm and power levels above half a watt was effective on European starlings, mallard ducks, and Herring Gulls. At these intensity levels there was an avoidance response which was not diminished through habituation. The primary application identified was for scanning bird nesting and feeding sites, but that the technology was not safe or appropriate for use with flying aircraft. The intensity of laser required was sufficiently high to potentially cause harmful effects in humans.

Conclusion (On-Board Deterrent Devices)

Research indicates that radar, lights and microwave sources do not have utility to deter birds away from in-flight aircraft. High intensity laser beams can disturb, repel or paralyze birds, and cause them to drop away from an approaching aircraft (Tanner 1965). However, the power required to affect birds at ranges of over 0.5 mile would be extremely high and could lead to unacceptably high radiation dangers to people on the ground (Hunt 1973). If and when further research and development indicates otherwise, these technologies will be reviewed and considered by the airline industry and airport operators. Due to the relative ineffectiveness in reducing birdstrikes, and the potential to cause harm to humans, these technologies are not further advanced for environmental analysis.

3.4.3.3.2 Bird Screens

Large commercial aircraft are increasingly being powered by fewer and larger, high bypass ratio turbofan engines with high thrust capabilities and low fuel consumption (Alge 1993). Since the passage of a bird into the engine can cause the most hazardous situation relative to birdstrike hazards, it is often proposed that a screen be installed in front of the engine intake area to deflect birds away from the engine.

Devices of this sort have not been shown to be successful for use with turbofan engines (Aldrich 1969). A retractable inclined bird deflector has been developed for small turboprop engines (Horeff 1969), although one has not been successfully developed for use with turbofan engines. It is worth noting, that although the idea appears useful, there are several inherent problems with the installation of a structure in front of an aircraft engine's intake.

The installation of a bird screen introduces increased hazards from birdstrikes due to the probability of screening materials being forced through the engine (in addition to the bird) if the impact causes the screen to break. The 1960 crash of the Lockheed Electra at Boston's Logan Airport was caused when the aircraft lost power due to the intake screens being clogged by starlings. Sixty-two people were killed in that bird-aircraft collision. Screens have icing problems, present additional weight, reduce engine performance, interfere with efficient air flow dynamics, cause increased fuel usage, and may increase the hazards associated with birdstrikes.

Conclusion (Bird Screens)

Aircraft engine propulsion engineers attempt to develop optimal and efficient air flow through the engine. This provides for maximum performance and fuel efficiency. Any impediment to airflow, as would be created by a bird screen, compromise this efficiency. Bird screens placed in front of an aircraft engine increase the hazards associated with birdstrikes by increasing the amount of foreign object debris that is forced through an engine during a high-impact bird strike. Because of the increased birdstrike hazards created, and the technical problems with creating bird screens that do not compromise efficiency, this alternative is not advanced for further analysis.

3.4.3.3.3 Visual Alerting Patterns on Engine Blade Spinners

A number of airlines have adopted painted spinner patterns such as swirls, marques, commas or snake eyes on their engines in an attempt to reduce birdstrikes (Alge 1993). An evaluation of these approaches was conducted in Europe, and it was indicated that spirals painted on engine blade spinners showed no appreciable benefit in reducing birdstrikes. This technique, in order to be effective, would require that the flying bird detect the painted area, demonstrate an aversive response, and then successfully out-maneuver the swiftly-approaching aircraft. In general, long-winged birds with a slow wingbeat and a preference for gliding (such as gulls) are probably less capable of avoiding aircraft under these conditions than are other birds with relatively shorter wings and more-rapid wingbeats (Blokpoel 1976).

Conclusion (Visual Alerting Patterns)

Visual alerting patterns painted on engine spinners have not reduced aircraft's vulnerability to birdstrikes, and will not be further considered.

3.4.3.3.4 Other Aspects of Aircraft Engines

The FAA, aircraft engine manufacturers, the U.S. Air Force, and other Federal Agencies (USDA APHIS ADC) have worked cooperatively to investigate the birdstrike hazard as it relates to aircraft engine design, to develop reasonable and realistic design criteria, and to develop aircraft engines that are better-able to withstand birdstrikes. The engine components that are most-often affected by birdstrikes are inlet guide vanes, rotor blades, rotor discs, stator blades, compressor casings, and nose bullets (Blokpoel 1976). Research and development to identify relevant engine criteria and to provide for the development of safer engines able to better-withstand birdstrikes are ongoing pursuits of the FAA and the engine manufacturers; a few of the noteworthy recent investigations are summarized below.

The large U.S. aircraft engine manufacturers are working with the FAA to develop new large turbofan engines that satisfy the newly-proposed changes to FAA Regulation 14 CFR Part 33.77. Development tests with some engines have been conducted, and indicate their ability to withstand ingestion of an 8-lb. and 2.5-lb. bird at full takeoff thrust. Tests and development are ongoing.

The U.S. Air Force is currently funding an ongoing bird body density study that is being conducted by USDA APHIS ADC's Denver Wildlife Research Center (Sandusky, Ohio Field Station) and the USAF (Hamershock et al. 1993). The body density of birds struck by aircraft determines the force of impact and the resulting damage. FAA regulations are developed relative to bird body size and likely impact, which is related to body density. The development and manufacture of new aircraft engines and the vulnerability of certain aircraft parts (engines and windscreens, etc.) are evaluated through use of computer modeling and actual field testing. An accurate assessment of species-specific body densities is essential for the development of accurate models and tests that represent real-world situations. During 1992 and 1993, data on twelve species of birds were collected: gulls were collected from JFKIA, and other birds were collected from the Arnold Air Force Base in Tennessee, and various northern Ohio sites. Studies are continuing to assist in the development of this database.

The USAF is funding a study to investigate the utility and develop the technology for a stereographic camera system to film flocks and estimate flock densities (Appendix C.5.9). During the summer of 1994, field tests will be conducted at JFKIA to investigate this data for Laughing Gulls, Canada geese, and brant. This information could enhance the FAA and other (international) agencies' abilities to predict hazards, develop reasonable and realistic engine criteria, and provide accurate biological information to permit development of materials and strengths for aircraft engine and other components. These data will allow more accurate and realistic modeling and testing of individual bird and flock impacts on windshields, fan blades, engines, and other aircraft components for military and civilian aircraft.

In 1986, the FAA Technical Center in Pomona, New Jersey funded the University of Dayton Research Institute to conduct research on the engine bird ingestion experience of the Boeing 737 aircraft for 1986-89. The study was designed to determine the numbers, weights, and species of birds which were ingested into medium- and large-inlet area turbofan engines during worldwide operations and to determine the resulting damage. Three years of B-737 birdstrike data were collected by the engine manufacturers, the FAA, and the ICAO. The final report, issued by the FAA in 1992, identified that engine damage occurred in 39% of the 1054 engine ingestion events, and that most ingestion events occurred during takeoff or landing. Approximately 3% of all engine bird ingestions resulted in engine failure; eight (8) engine failures were caused by single birds that weighed less than 1 pound (Hovey and Skinn 1993). Thorpe (1984a) found that based on an analysis of five years of data collected by the British Civil Aviation Authority, that 30% of engine bird ingestions result in some form of engine damage.

Conclusion (Other Aspects of Engine Design)

Current industry-wide design trends are motivated in part by noise reduction and fuel economy requirements, and provide for larger, more powerful, and fewer high-bypass engines. The trend is for engines to be placed on the wings rather than the tail. These design trends do not reduce the hazards associated with the probability or impact of birdstrikes. Engine manufacturers are continually researching and developing aircraft engine designs that are better able to withstand birdstrikes. Development usually is directed at strengthening engine component materials, and increasing their ability to withstand strikes.

This research is current, ongoing, and may play a long-range role in the reduction of hazards created by birdstrikes at all airports, including JFKIA. This alternative, however, is not advanced for further environmental analysis because: 1) although newly FAA-certified engines will have increased birdstrike capability, older engines will remain in service for an additional three or four decades, and 2) the FAA birdstrike criteria do not always reflect real-world birdstrike situations, and engines will continue to be vulnerable to these new and dynamic situations. The improvements of aircraft engineering does not provide any immediate relief from the birdstrike hazards that currently exists, and does not present a substantial probability of a long-term solution to the birdstrike hazard. JFKIA will continue to support and participate in research and development.

3.4.3.4 Bird Tracking and Warning Devices

Aircraft commonly avoid such natural hazards as hail and extreme turbulence associated with thunderstorms by using both radar and passive lightning detection equipment. The question arises as to whether concentrations of birds could be detected and avoided in an analogous method. Currently, terminal radars can detect large flocks of birds, and such warnings are routinely passed on to flight crews. Enroute radars filter out both weather and bird returns in order to better track aircraft.

Doppler radar shows promise as a means for obtaining "early warning" of birds in an area. By analyzing the ways in which the frequency of the reflected radar pulse has been shifted, it is possible to determine the relative motion of targets. In the case of birds, the regular wingbeats provide a Doppler signature that increases deductibility (Air Force Civil Engineering Center, 1976). Although powerful weather and airport surveillance radars can be used to detect, monitor, and quantify migratory bird movements, they are not designed to observe detailed bird movements within close proximity to the airport and its surface. Marine radars can be tuned and utilized to detect birds flying overhead (Gauthreaux, 1984).

Combined with preferred runway usage guidelines this may aid in the reduction of birdstrike risk. The procedures and application for this technology would need to be developed on a demonstration basis to test its actual efficacy in the field. The operational effectiveness for the gull problem at JFKIA may be limited, but such a program may offer substantial utility for seasonal bird migration monitoring especially at night.

It is likely that such technology is more useful for arriving aircraft which may have more opportunity to respond based upon bird flight movement information in the vicinity of airports or along routes.

The application of real time tracking of bird movements in the vicinity of flight paths offers an opportunity for the air traffic system to respond much as it does to other uncontrollable hazards such as thunderstorms, by avoidance of the most severe hazards. The response time for communicating the hazard and implementing an alternate procedure is probably substantially more constrained than for most weather hazards which can be observed with lead time for response.

- **Technical Implementation Feasibility**

The alternative of the Port Authority continuing to support research of technologies which have the potential to reduce birdstrike is feasible.

- **Effectiveness**

Operational and Ultimate Effectiveness: The effectiveness of any new technologies will be established through the research programs developing them. However, in terms of addressing the immediate urgency of the gull hazard they are ineffective while their long term effectiveness is uncertain.

- **Conclusion**

Given their unpredictable effectiveness and environmental effects, research alternatives are not advanced for environmental analysis. However they are considered potential contributors to solutions to the problem. No environmental impacts can be identified for a research program. Although not advanced for environmental analysis, they are considered part of the range of reasonable alternatives in the long term.

3.4.4 Summary Conclusions for Nonlethal Alternatives

A number of nonlethal alternatives were analyzed for feasibility and effectiveness, but will not be advanced for environmental impact analysis due to limitations in feasibility and effectiveness: planting of Laughing Gull breeding areas with shrubs, filling the marsh, physical obstruction of the marsh (monofilament, cordage or wire barrier), and harassment by means of falconry, dogs, acoustics, and radio-controlled model airplanes.

A number of nonlethal alternatives available for further environmental impact analysis were identified in Sections 3.3 and 3.4: on-airport vegetation management, on-airport water management, on-airport insect control, on-airport sanitation management, operation of the Bird Control Unit, marsh devegetation through mowing, burning, and herbiciding, excavation of the Laughing Gull nest site marshes, harassment of nesting Laughing Gulls with synthetic gull models, reduction of off-airport attractants, aircraft engineering to reduce the number and impact of strikes, and enhancement of JFKIA's Bird Hazard Task Force. Each one of the nonlethal alternatives that will be advanced for environmental impact analysis are considered to have a somewhat limited feasibility and ultimate effectiveness and/or could result in increased hazards from birds other than the target of the activity. As noted in a number of reports (Appendix C.5.5), the majority of the gulls involved in birdstrikes with aircraft at JFKIA are traversing JFKIA airspace among the various habitats found throughout the metropolitan New York City area. Intense activity on the ground, especially on JFKIA, would have only limited effectiveness in reducing gull flyovers. The bird hazard control program that has been conducted at JFKIA since the 1960s has been effective in reducing attractants on the airport, and has controlled birdstrikes to some degree. The increasing number of birdstrikes, primarily caused by those involving gulls, however, indicates the need to evaluate a number of lethal gull hazard reduction approaches to determine their feasibility, effectiveness, and environmental impacts. Due to the merits of the nonlethal alternatives that do exist, many of the nonlethal alternatives are advanced for environmental analysis in Chapter 5.

3.5 Lethal Gull Control

In addition to the formerly described non-lethal measures to reduce the gull hazard at JFKIA, other alternatives were considered which have a lethal component. Some focus directly on removing the Laughing Gull population by lethal measures. Other alternatives focus on harassment and deterrence by lethal measures and in doing so result in limited animal mortality.

It should be noted that none of the alternatives have as primary purpose the elimination of the Laughing Gull population, as it is not the population in itself, but rather its location in Jamaica Bay immediately adjacent to JFKIA runways which results in overflights over JFKIA that create the hazard. Because the overflights occur primarily between the nesting site at the end of runway 4L and off-airport attractants, the purpose of alternatives is to incite the Laughing Gulls to discontinue nesting in the location so close to the airport and in effect to abandon the islands in Jamaica Bay as a nesting colony. Alternatives which focus directly on reducing the numbers of gulls nesting in Jamaica Bay are based on the deterrent effect on other migrant Laughing Gulls that is achieved by very visible lethal measures. They are also based on Laughing Gulls' behavior of returning to their natal area to breed in subsequent years. Certain lethal alternatives seek to reduce the proliferation of the Laughing Gull population in Jamaica Bay.

- **Removal of Adults**

The model assumes that adults can be removed from the population in two ways, by either poisoning breeding adult gulls at nests with DRC-1339 or shooting birds at the airport.

Poisoning: Input values of the effectiveness of DRC-1339 are based on gull control efforts conducted on Ram Island, Massachusetts in 1990. Two applications led to the death of 69% of nesting female Herring Gulls (Cavanagh and Griffin 1990).

Airport Shooting: Although the model randomly varied the number of gulls shot each year between 4,000 and 13,000, the potential to shoot these numbers of gulls was demonstrated by the experimental gull management program conducted by USDA APHIS personnel at JFKIA from 1991-1993 (Dolbeer et al. 1993, R. Dolbeer, pers. comm.). However, this model assumes that these levels of gull shooting can be sustained over the long term. Yet, shooting success (gulls killed/person hour) greatly decreased in the third year of the program (R. Dolbeer, pers. comm.). However, in spite of this declining shooting success, Laughing Gull-aircraft interactions at JFKIA have declined by more than 90% since initiation of the shooting program.

3.5.1 Population Reduction of the Laughing Gull Colony

Rather than attempt to dissuade the Laughing Gulls from utilizing the present colony site by nonlethal means, a more long-term approach might be preferable to attempt to reduce the number of breeding Laughing Gulls (and therefore the number of Laughing Gull strikes at JFKIA) by lethal means. Such means could be directed at reducing either the number or productivity of adults on the colony site. A combination of these methods could also be used.

3.5.1.1 Physical Destruction of Nests and Eggs

The reproductive output of a gull colony can be curtailed by physically destroying (crushing or puncturing) eggs, dispatching chicks that have escaped egg destruction activities, and removing nests (Thomas 1972). In addition to curtailing future recruitment to the colony, this method may in addition cause some Laughing Gull adults to permanently abandon the site, thus reducing the breeding population as well.

- **Technical Implementation Feasibility**

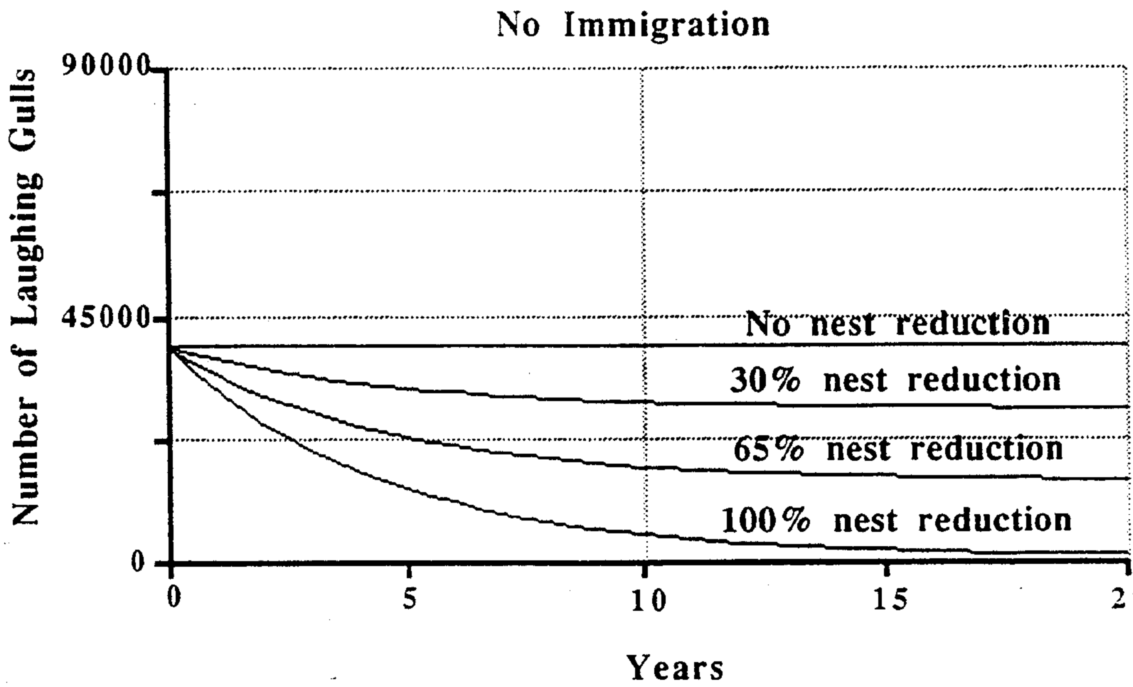
A program of destroying eggs and chicks would be relatively easy to accomplish, given adequate numbers of people to cover this large site. Because of the probable difficulty in finding all nests in the *Spartina*, and the physical obstacles presented by the tidal creeks that dissect the salt marsh, some nests will probably be missed. Even on a sandy beach with unrestricted access and excellent visibility, an egg destruction program at Breezy Point missed an estimated 3% of the nests of the Herring Gull and Great Black-backed Gull (U.S. Department of Agriculture 1993b); the figure for Laughing Gull nests in the Jamaica Bay Wildlife Refuge (JBWR) could be considerably higher. However, owing to the likelihood that birds whose nests are destroyed will attempt to renest (Morris and Siderius 1990), several cycles of egg removal—e.g., every two weeks—will be necessary. Thus eggs missed on one visit may be detected and destroyed on subsequent visits.

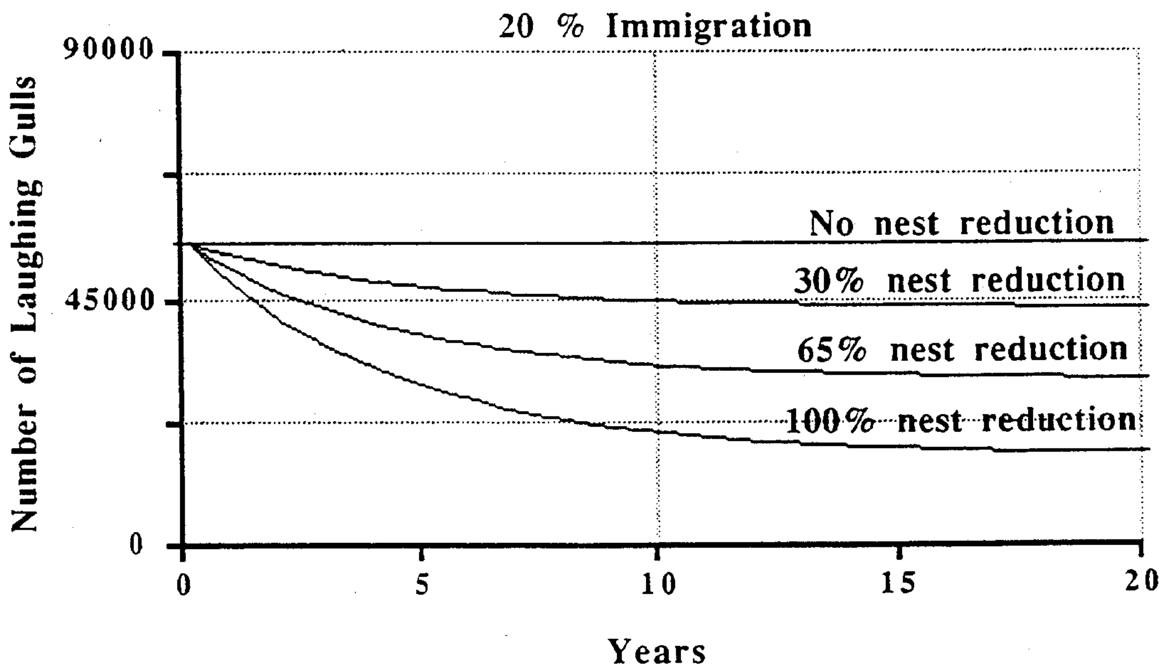
- **Effectiveness**

Destruction of nests and eggs: Although gulls will readily relay after their nest and eggs are destroyed, repeated treatments can significantly reduce the number of young fledged during a breeding season (Blokpoel and Tessier 1987). However, these simulations assume that the adult gulls do not abandon the colony despite repeated annual nest and egg destruction. However, Seubert (1990) reported that potential abandonment of a colony by gulls that have had their nest and eggs repeatedly destroyed is dependent on the species. The Royal Society for the Protection of Birds (RSPB) (1982) reported that Herring (Larus argentatus) and Lesser Black-backed gulls *(Larus fuscus)* in large colonies in Great Britain did not abandon their colonies after repeated nest and egg destruction. In contrast, nest and egg destruction did discourage the breeding of Black-headed Gulls *(Larus ridibundus)* in large colonies. The potential for colony abandonment after repeated nest and egg destruction or oiling for Laughing Gulls at the Jamaica Bay colony is unknown. It is also unknown how the availability of other suitable gull nesting marshes in the area might influence the potential of abandonment of the colony for other suitable marshes.

***Operational Effectiveness* - Population Simulation Results:** Results of population modeling of the overall Jamaica Bay Laughing Gull population (not just the breeding colony) (see Section 3.1.3.3) indicate that, for any type of management designed to reduce the number of nests, the number of gulls remaining in the Jamaica Bay population would vary depending on the level of reduction of nest sites and the amount of immigration into the colony from outside Jamaica Bay. Although the simulation model indicates that annual reduction of nests would reduce the number of gulls in the Jamaica Bay population substantially (especially for the 65% and 100% reduction scenarios) (see Section 3.1.3.3 and Figures 3-13 through 3-15), this management strategy would not completely eliminate the Laughing Gull population unless nest destruction was 100% and immigration was zero. However, based on the apparent high replacement rate of breeders killed by on-airport shooting—the total of 24,000 adult Laughing Gulls shot in 1991-92 represents nearly 160% of the number of nesting individuals present in 1990—there is an abundant pool of nonbreeding birds in Jamaica Bay (Dolbeer et al. 1993). The model calculates the effect on the colony population given its reproductive characteristics. However, it does not account for the behavioral response and colony abandonment as a result of repeated nest failure that may be induced by egg/nest removal or destruction.

***Operational Effectiveness* - Behavioral Response:** Some possible behavioral responses may occur that would increase the effectiveness of this (and other) alternatives at reducing the Jamaica Bay Laughing Gull population but that are difficult to simulate in the model. For example, continued disturbance and reproductive failure may cause breeding birds to desert the Jamaica Bay area and relocate to one or more new colony sites; if the desertion rate exceeds immigration, this would obviously accelerate the rate of population decline. Also, a declining breeding population, may no longer provide the social stimulation needed to attract immigrants as breeders; in a colony of Herring Gulls, the expected rate of decline due to annual culling was doubled when immigration from outside sources was apparently inhibited when the density of breeders declined below the optimum level (Duncan 1978).



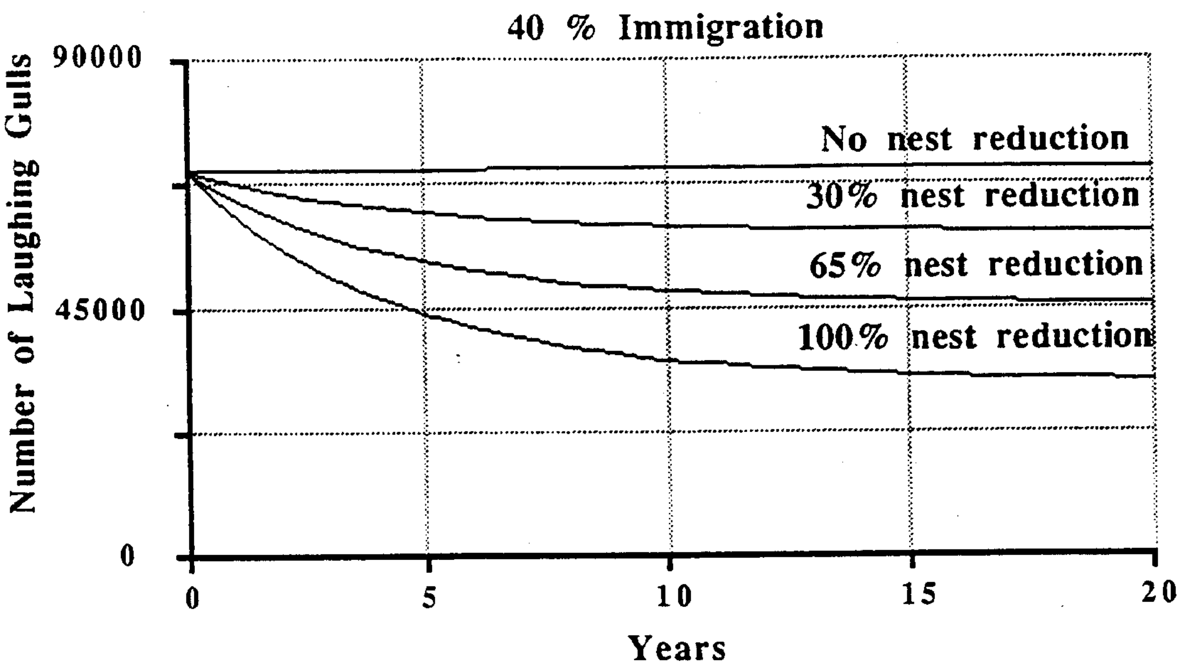


NOTE: Starting population established by simulation and varies depending on assumed level of immigration

NOTE: Graphs show the simulated effect on the Laughing Gull colony population of reduction of nests or eggs by 100%, assuming 0% or 20% immigration of other Laughing Gulls into the nesting colony.

Figure 3-13

Simulated Population Effect of Reduction of Number of Nests by 30%, 65%, and 100% (at immigration 0% - 20%)



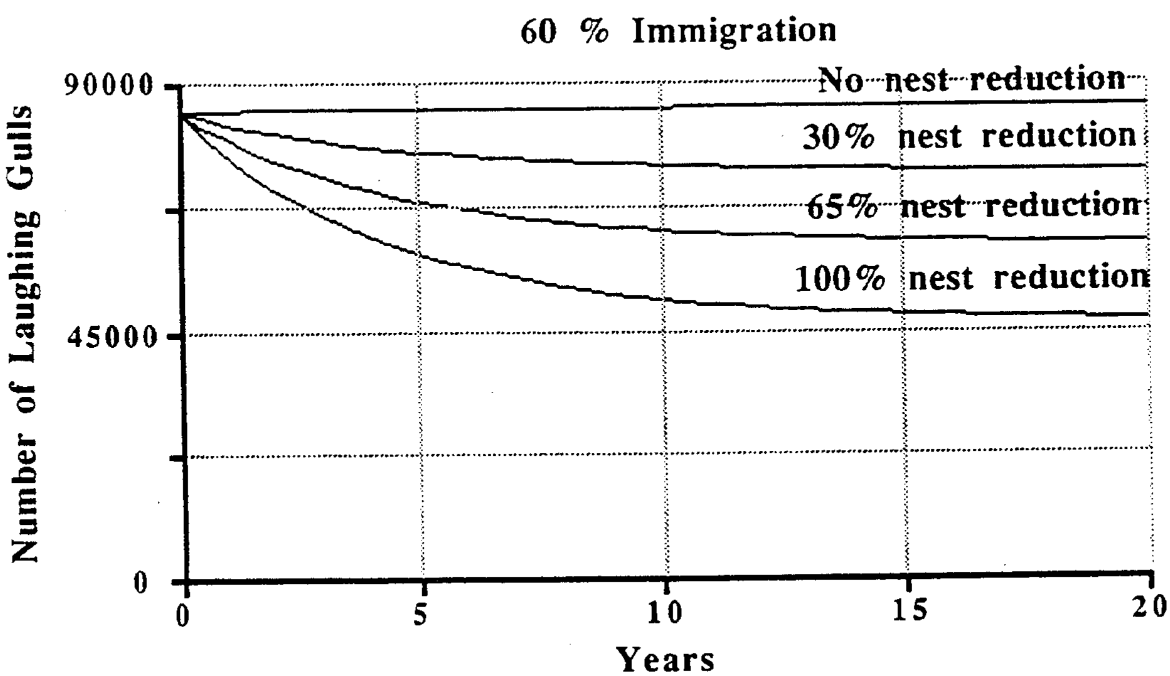


Figure 3-14

Simulated Population Effect of Reduction of Number of Nests by 30%, 65%, and 100% (at immigration 40% - 60%)

NOTE: Starting population established by simulation and varies depending on assumed level of immigration

NOTE: Graphs show the simulated effect on the Laughing Gull colony population of reduction of nests or eggs by 100%, assuming 40% or 60% immigration of other Laughing Gulls into the Colony

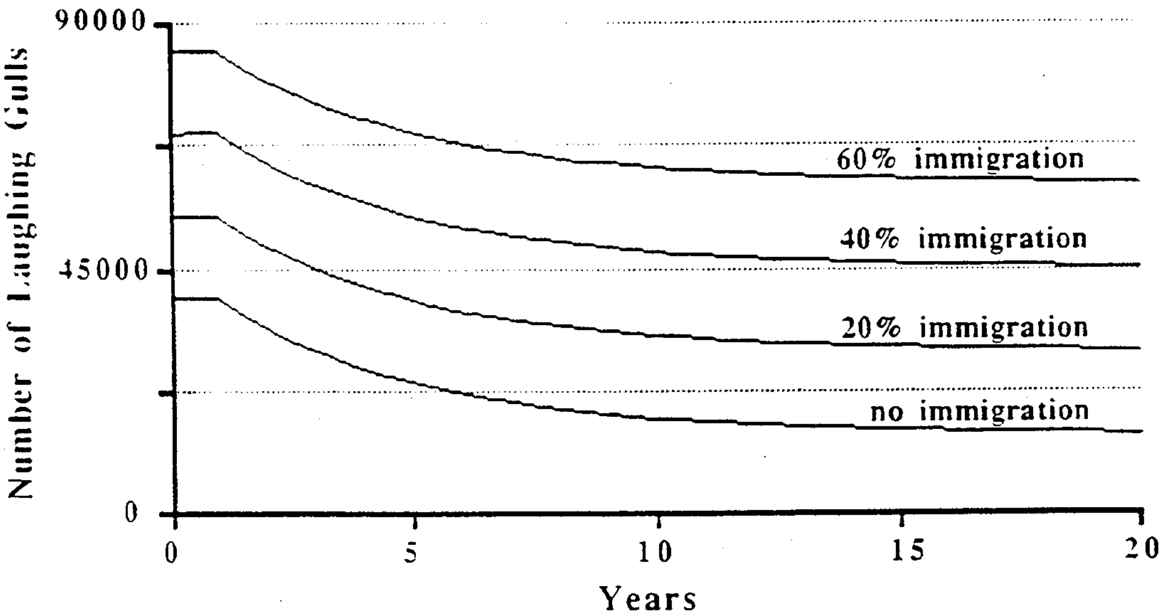


Figure 3-15

Simulated Population Effect of Reduction of Number of Nests by 65% (at immigration 0% - 60%)

Several studies (Blokpoel and Tessier, 1987; the Royal Society for the Protection of Birds, 1982) indicate that egg/nest removal or destruction can contribute substantially to the inducement of nesting colony abandonment. The Royal Society for the Protection of Birds (RSPB 1982) reported that Herring and Lesser Black-backed gulls in large colonies in Great Britain did not abandon their colonies after repeated egg and nest destruction. In contrast, nest and egg destruction did discourage the breeding of Black-headed Gulls in large colonies. Given the similarity between the ecology of Black-headed Gulls and Laughing Gulls it is possible that Laughing Gulls would have a similar response to nest/egg destruction.

Forbes et al. (1993) describe attempts to induce Ring-billed Gulls to abandon their expanding nesting colonies on large gravel rooftops in upstate New York. Nest and egg removal were conducted for three consecutive years and—in combination with other methods—reduced the nesting population by approximately 99 percent at two sites in upstate New York. Alternative nest sites were available in these cases, which may have added to the success of the activities.

Therefore, since 100% nest destruction is probably not achievable owing to the difficulty of the terrain, and since immigration is obviously considerably higher than zero, destruction of nests is likely to be effective at reducing, but probably not eliminating, the Jamaica Bay Laughing Gull population.

Ultimate Effectiveness: Although nest destruction is unlikely to eliminate the local Laughing Gull population, even under the less effective scenarios the population would decline measurably from its starting level; and some of this decline would involve the breeding colony (through attrition of established breeders and curtailment of internal recruitment). Since the number of strikes is highly correlated with the size of the colony (Griffin and Hoopes 1991, Hoopes et al. 1992), the number of strikes by Laughing Gulls would therefore also be likely to decrease. Overall, egg and nest destruction (continued indefinitely) appears to have the potential for producing a small to moderate decrease in the number of birdstrikes at JFKIA.

During conduct of physical destruction of nests and eggs, a short-term and temporary increase in the birdstrike hazard may occur as a result of towering.

- **Conclusion**

Given its effectiveness, egg or nest destruction will be advanced for further environmental analysis.

3.5.1.2 Oiling of Eggs

Another method of reducing reproductive output in Laughing Gulls is to prevent the hatching of eggs by spraying them with oil. Crude oil (Gross 1951), and insecticidal dormant oil (Morris and Siderius 1990) have been used in egg-oiling projects and have been shown to kill through toxicity to the embryo of the aromatic hydrocarbon fraction of the oil (Hoffman 1978, Lewis and Malecki 1984). However, owing to concerns of environmental pollution, a more favored approach is to use pure mineral oil, which is believed to prevent gas exchange through the eggshell and thus asphyxiate the embryo (Blokpoel and Hamilton 1989, Christens and Blokpoel 1991). Recent studies have used Daedol® 50, a chemically inert, nonpoisonous, 100% pure, USP white mineral oil that is colorless, odorless and tasteless (Christens and Blokpoel 1991). This material has the same purity as baby oil (Griffin and Hoopes 1991) and is applied to chicken eggs by commercial egg producers to reduce the decline in quality of eggs shipped to the consumer market (Christens and Blokpoel 1991).

An advantage of oiling over removal or on-site physical destruction of eggs is that the gulls will continue to incubate the oiled eggs well beyond the expected hatch date. By the time that they cease incubation it is too late in the breeding season to successfully initiate a new clutch, thus their productivity for the year is reduced to zero (Thomas 1972). In addition, by extending the hatch date, nesting gulls will spend relatively more time on their nests and less time in JFKIA airspace on foraging flights.

- **Technical Implementation Feasibility**

Oiling gull eggs is relatively easy to accomplish using a backpack garden sprayer (Christens and Blokpoel 1991, Griffin and Hoopes 1991). As the Jamaica Bay colony is very large and occupies a habitat that is physically difficult to traverse (three separate salt marsh islands, all dissected by numerous small tidal creeks), it is probable that some nests will be missed. However, the great majority of nests can undoubtedly be successfully treated by this method. Two treatments between the 14th and 24th days of incubation are recommended (Griffin and Hoopes 1991).

- **Effectiveness**

Operational Effectiveness: Treatment with mineral oil is likely to be highly effective at preventing hatching of Laughing Gull eggs. At two sites in Ontario, Christens and Blokpoel (1991) obtained over 99% hatching failure in eggs of Ring-billed Gulls and 100% failure in Herring Gull eggs sprayed at 10-11-day intervals with Daedol® 50. Even a single spraying early in incubation (17-25 days before expected hatch date) reduced hatching success to less than 10%. The egg-oiling treatment was also effective in that no gulls deserted the sprayed clutches, instead they continued to incubate beyond the expected hatch date. Morris and Siderius (1990) achieved 100% hatching failure for Ring-billed Gull eggs oiled with 97% pure dormant oil.

In Griffin and Hoopes' experimental study in the Jamaica Bay colony in 1990, egg-oiling at nearly half the nests in the colony was 64.5% efficient in preventing hatching in those nests (n=3,675). Since this study was designed to test the efficacy of oiling at different periods of the Laughing Gull nesting cycle—and demonstrated that the most effective time to spray is in the latter half of the incubation period before starring or pipping has occurred—future oiling projects would be implemented in light of this information, and thus would undoubtedly be much more efficient at reducing the hatch rate. Griffin and Hoopes (1991) believed that reproduction in the Jamaica Bay colony could be reduced to near zero if all Laughing Gull nests were sprayed at least twice between days 14 and 24 in incubation.

In terms of efficiency at eliminating the gull colony, Thomas (1972) notes that gull control via any form of egg-sterilization would require continuation for at "at least four years, and probably for seven to nine years. This also assumes that immigration of birds into the population is minimal." According to Seubert in his review of published and unpublished reports on gull management (1990), "if the goal is to eliminate gull colonies because they present unacceptable hazards to aviation, oiling would be a very poor strategy, because no information from worldwide sources indicates that oiling of eggs has ever resulted in gulls completely abandoning a colony.." Similarly, Blokpoel (Wildlife Society Bulletin 19:423-430) reports that oiling has not been shown to cause colony abandonment.

Population Simulation: The population modeling done for this study (Figures 3-2 to 3-4) indicates that no form of reproductive control, including egg-oiling, would eliminate the Laughing Gull population unless efficiency were 100% and the immigration rate were zero. The population would, however, be reduced below the starting level; the amount of reduction would depend on the percentage of nests treated, the reduction in percentage of hatching, and the immigration rate.

Ultimate Effectiveness: Egg-oiling is unlikely to eliminate the Laughing Gull colony entirely. However, the population would decline from its starting level, and some of this decline would involve the breeding colony (through attrition of established breeders and curtailment of internal recruitment). Since the number of strikes is highly correlated with the size of the colony (Griffin and Hoopes 1991, Hoopes et al. 1992), the number of strikes by Laughing Gulls would therefore also be likely to decrease.

During conduct of physical destruction of nests and eggs, a short-term and temporary increase in the birdstrike hazard may occur as a result of towering.

■ **Conclusion**

Overall, egg-oiling, provided that it is implemented indefinitely and is successful in reducing the gull colony population substantially, appears to have the potential for producing a small to moderate decrease in the number of birdstrikes at JFKIA. It will therefore be advanced for environmental analysis.

3.5.2 Population Reduction of Adults

3.5.2.1 Toxicant Application

The value of a toxicant in controlling a given gull population depends on the circumstances surrounding the application of the toxicant, including the extent of prebaiting, date, weather, food available, and population characteristics such as size, age, sex ratio, experience, and foraging routines of the target gull population (Kress 1983). Toxicants have been used to achieve rapid reduction in the size of breeding gull colonies by killing breeding adults. Two possible agents are DRC-1339, a slow-acting toxicant that impairs the circulatory system causing uremic toxicant application and congestion of major organs, and alpha-chloralose, a narcotic that depresses the cortical centers of the brain (Woronecki et al. 1989).

■ **Technical Implementation Feasibility**

According to Dolbeer, et al. (1993), DRC 1339, a toxicant used to control Herring, Great Black-backed, and Ring-billed Gulls, is not registered for use on Laughing Gulls. Obtaining approval for use of DRC-1339 on Laughing Gulls would be required. All approvals are issued by the U.S. Environmental Protection Agency and are subject to the Federal Insecticide, Fungicide, and Rodenticide Act as Amended (FIFRA), which is codified in 40 CFR 158 et seq. To obtain an amendment to the existing label language would require a statement of need, problem hazard, toxicity data, and effect on nontarget species. Concurrence would have to be obtained from the U.S. Fish and Wildlife Service and from the New York State Department of Environmental Conservation. The U.S. Department of Agriculture Animal and Plant Health Inspection Service, Animal Damage Control Program currently uses alpha-chloralose to immobilize and capture nuisance waterfowl, coots, and pigeons (Woronecki and Thomas 1993). Although this chemical can and has been used as a euthanizing agent for gulls (see below), it is not registered for this use in this country. As with DRC-1339, EPA approval would have to be obtained for such a use.

If approval for the use of DRC-1339 or alpha-chloralose can be obtained, either chemical can be administered by placing treated baits ("sandwiches" of bread and margarine mixed with the chemical) in active nests after several days of prebaiting (Woronecki et al. 1989) Additional applications may be necessary depending on the consumption rate and the effectiveness.

- **Effectiveness**

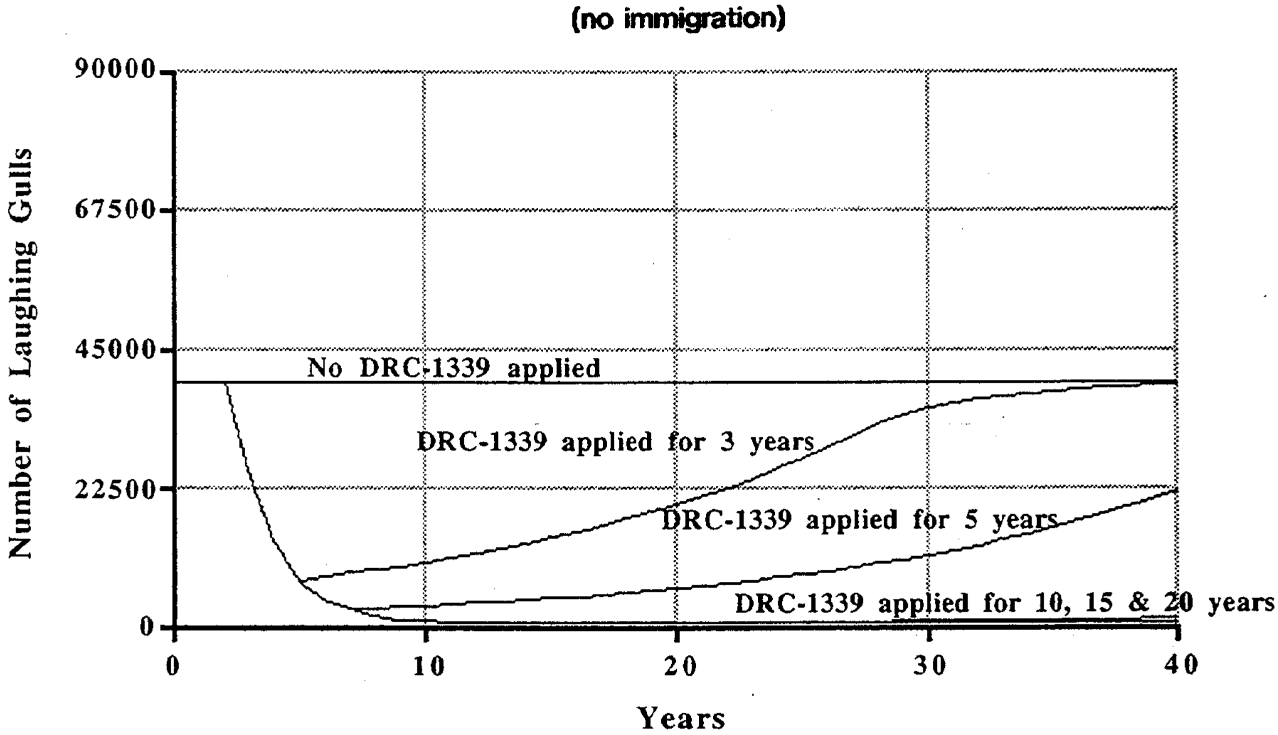
Operational Effectiveness: DRC-1339 has been used extensively in the Northeast since 1969 in attempting to control Herring Gulls (Gramlich 1969, Ladd 1970, Drennan et al. 1986 and 1987). Although the regional population has not been substantially affected, local populations have been successfully controlled, at least in the short term. In 1971, one treatment of DRC-1339 reduced a population of 350 pairs of Herring Gulls on Matinicus Rock, Maine, to 10 pairs (Anon. 1971); although the population did not immediately rebound, as reported by Kress (1983), in 1986 62 pairs attempted to nest and were killed with DRC-1339 (Transue 1989). Blodget and Henze (1992) successfully used DRC-1339 to kill Herring Gulls and Great Black-backed Gulls that had excluded Common and Roseate terns from Ram Island in Massachusetts.

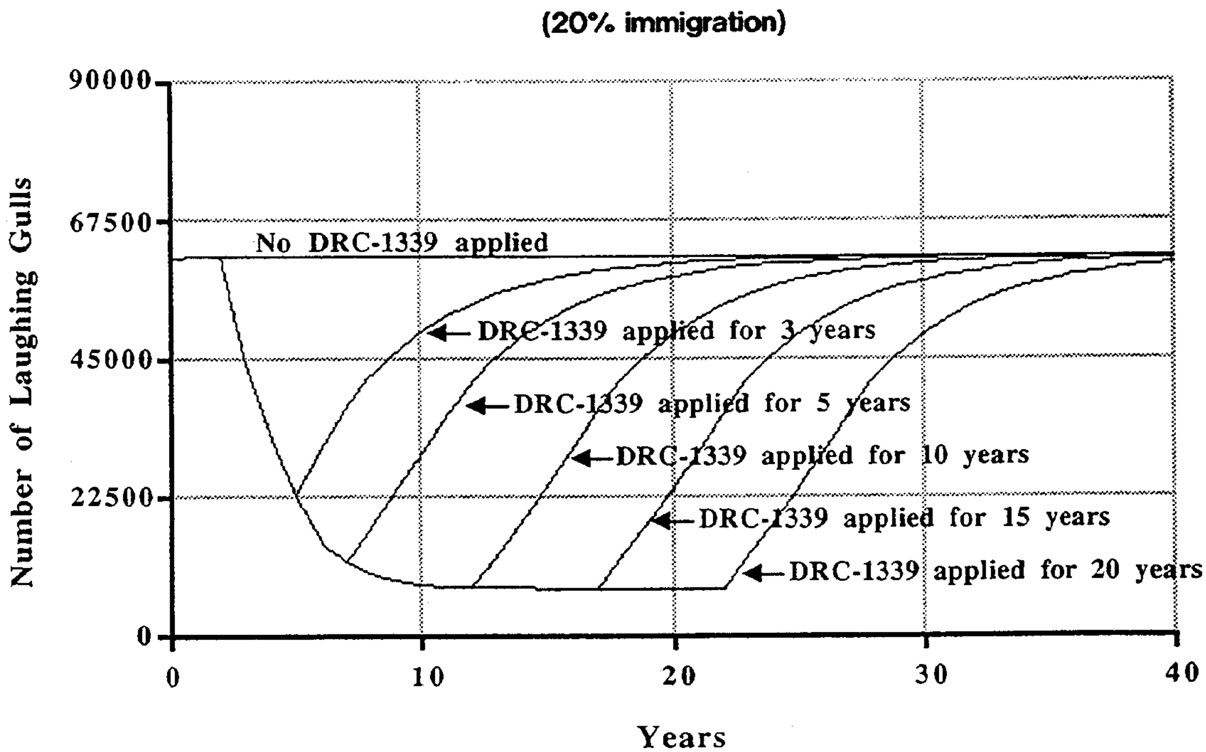
Since Laughing Gulls generally do not utilize scavenging in their feeding behavior to the same extent as Herring and Great Black-backed gulls (Forsythe 1974) they may take fewer of the toxicant baits, therefore the percentage of the adults killed may be lower than is typical for the latter two species.

Results from various toxicant application programs may be quite different: Woronecki, et al. (1989) compared the effectiveness of alpha-chloralose and DRC-1339 at reducing a nesting population of Herring Gulls in Ohio. As only one dead gull was found for every 10 baits consumed of either chemical, researchers suspected the purity of the chemicals used. Also, the toxicity of DRC-1339 may have been different for gulls in this freshwater environment. Furthermore, little population decline was achieved. Dead gulls were apparently quickly replaced from the large nonbreeding population of Herring Gulls in the area, and therefore it appeared that local toxicant application could not achieve long-term population reduction of the subject colony. However, in a Herring Gull colony in England that was subjected to an annual cull by toxicant application to nesting adults, the rate of population decline was almost double what was expected. This apparently was caused by lowered recruitment from other colonies, which may in turn have been a consequence of a reduction in the density of breeding birds in the culled colony below the optimum level (Duncan 1978). In New Zealand, toxicant application for five years apparently eliminated most of a breeding colony of 1250 pairs of Southern Black-backed Gulls (Larus dominicanus) (Caithness 1968). However, when toxicant application stopped, nesting soon resumed; even after 19 years (when all ancestral birds had obviously been removed) new breeders continued to appear. It was concluded that, owing to the "ideal" habitat conditions present, annual toxicant application (or other lethal control) would have to be continued indefinitely to suppress formation of a colony (Caithness 1984).

Population modeling: Population modeling of the overall Jamaica Bay Laughing Gull population (see Section 3.1.3.3, Table 3-3 and Figures 3-16, 3-17, 3-18) similarly indicates that the size of the population could be reduced by toxicant application (through elimination of breeding adults and curtailment of internal recruitment), but that it would begin to rebound immediately upon cessation of annual toxicant application, at a rate determined by the rate of immigration. Population size would return to about half the original level in about 6 to 8 years, and reach nearly the original size in about 20 years. The only scenario that produces a permanent long-term depression of the Jamaica Bay population at a negligible size is 10 years of annual toxicant application with no immigration. Since the immigration rate is probably high this scenario is unlikely to occur.

Ultimate Effectiveness: In 1990, Laughing Gulls constituted 67% of all bird carcasses found at JFKIA during the June-July peak of the breeding season, and 70% of the known-breeding-status Laughing Gull carcasses were breeders (Griffin and Hoopes 1991, Table 13). Most of these birds must have come from the Jamaica Bay colony, since the nearest other colonies are at Barnegat Bay in New Jersey, 113 km (70 mi) south, and at Monomoy Island in Massachusetts to the north.



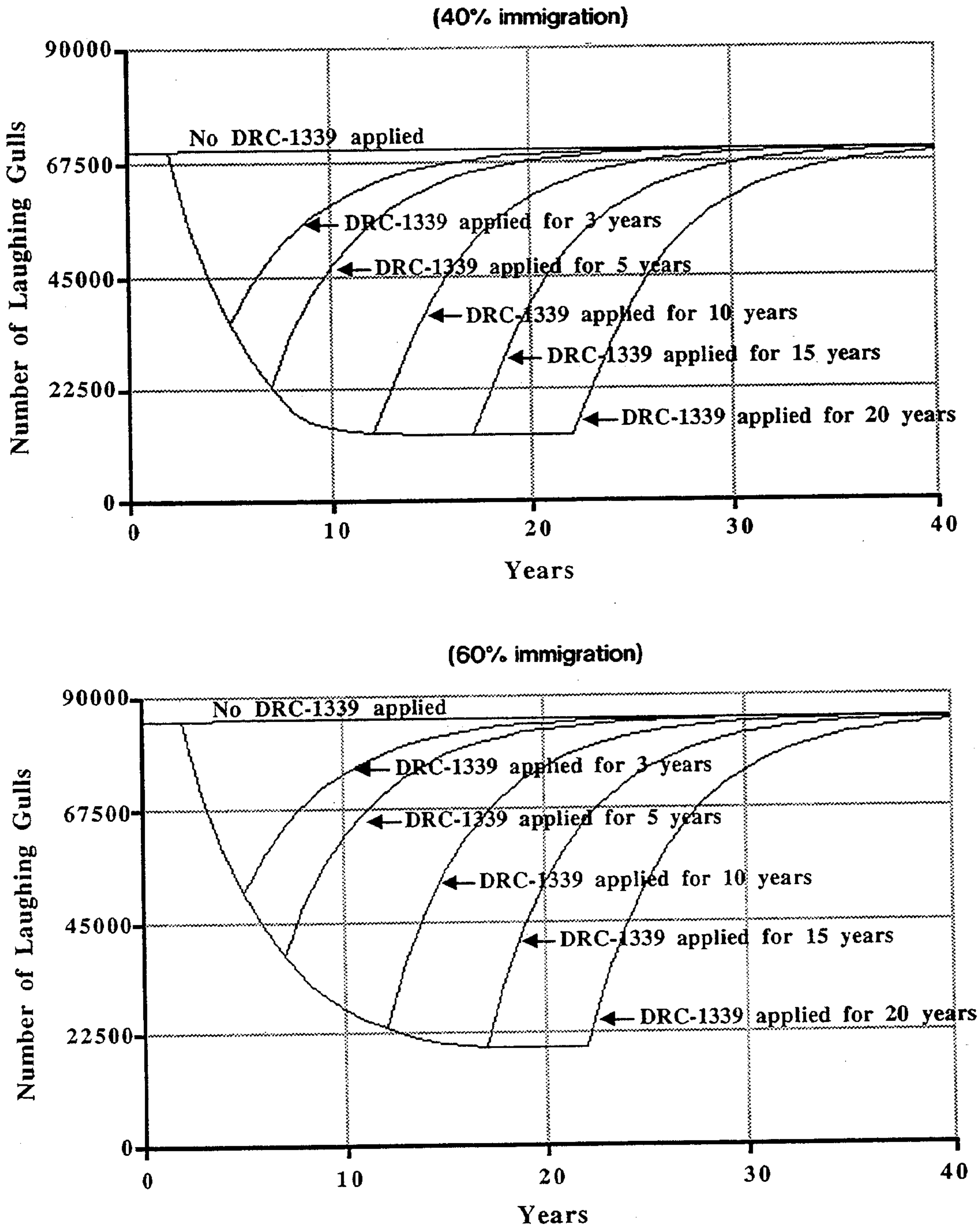


NOTE: Starting population established by simulation and varies depending on assumed level of immigration

NOTE: Graphs show the simulated effect on the Laughing Gull colony population of reduction of adults by means of toxicant for 3, 5, 10, 15 or 20 years, assuming 0% or 20% immigration of other Laughing Gulls into the colony

FIGURE 3-16

Simulated Population Effect of Toxicant Application for 3, 5, 10, 15 and 20 years (immigration at 0% - 20%)

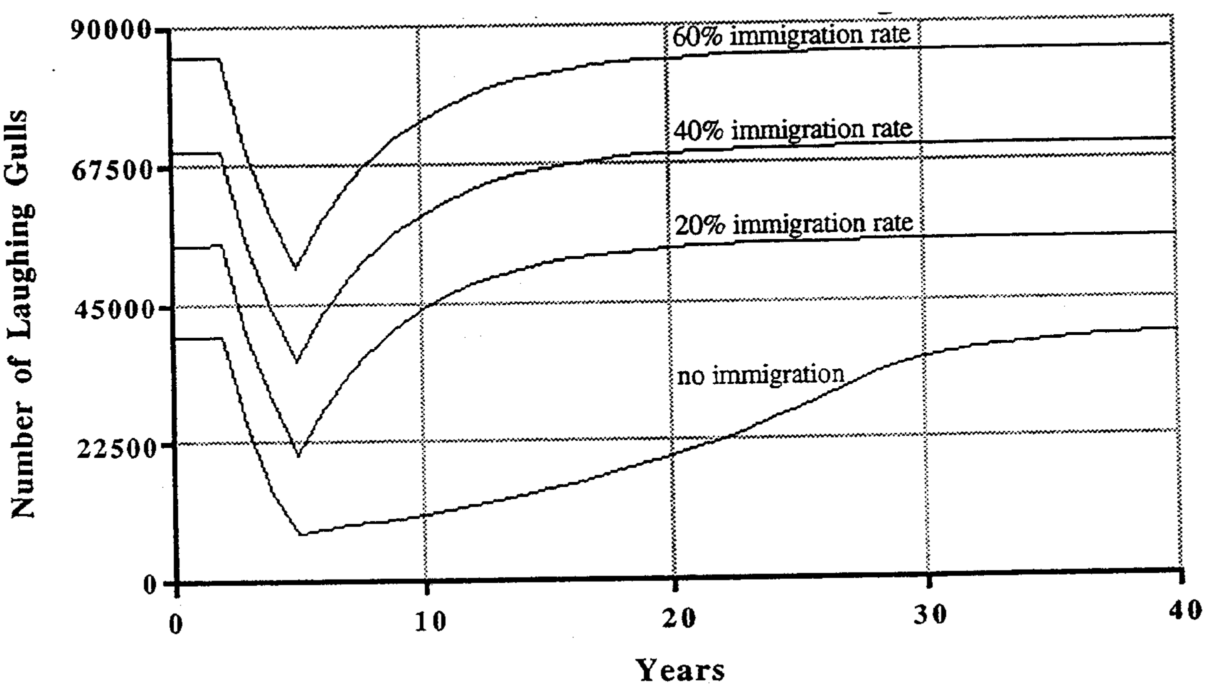


NOTE: Starting population established by simulation and varies depending on assumed level of immigration

NOTE: Graphs show the simulated effect on the Laughing Gull colony population of reduction of adults by means of toxicant for 3, 5, 10, 15 or 20 years, assuming 40% or 60% immigration of other Laughing Gulls into the colony

FIGURE 3-17

Simulated Population Effect of Toxicant Application for 3, 5, 10, 15 and 20 years (immigration at 40% - 60%)



NOTE: Starting population established by simulation and varies depending on assumed level of immigration (see section 3.1)

NOTE: Graphs show simulated effect on the Laughing Gull colony population of reduction of adults by 68% by means of toxicant, for 3 years, assuming 0%, 20%, 40% or 60% immigration of other Laughing Gulls into the colony

Figure 3-18

Simulated Population Effect of Toxicant Application for 3 Years at Immigration Levels of 0%, 20%, 40% and 60%

The immediate reduction in this local breeding population that would be produced by toxicant application would therefore certainly produce an immediate reduction in the number of strikes by Laughing Gulls at JFKIA. Since toxicant application would reduce the number of breeders as long as it was continued (and would continue to have an effect—albeit a declining one—for several years after being discontinued), it would be effective in reducing birdstrikes at JFKIA for that period.

- **Conclusion**

Assuming regulatory approval could be obtained, this alternative would be feasible, while moderately effective. It is therefore advanced for environmental analysis.

3.5.2.2 Shooting on Colony Site

An attempt could be made to reduce the population of adult breeding Laughing Gulls in the Jamaica Bay colony by shooting birds on the colony site itself. Shooting would be conducted by professional wildlife biologists who are specially trained in the safe and effective use of firearms, and who are proficient in field identification of birds, especially gulls, terns, oystercatchers, clapper rails, seaside and sharp-tailed sparrows, willets, black ducks, and other species known to nest in JoCo, East High Meadow, and Silver Hole marshes. Laughing Gulls would be the only species shot in this alternative; shooting would occur during daylight hours from blinds. The use of blinds would reduce scaring effects and would provide for a more focused and safe program. Shooting would be accomplished by placement of 10-12 biologists in blinds that are separated by safe distances, and that are concentrated in the areas of the marshes with the greatest densities of Laughing Gull nests and the lower densities of other, nontarget bird species.

- **Technical Implementation Feasibility**

Trained wildlife biologists would conduct the on-colony shooting project. The mechanics of installing blinds in the marsh would require planning and acquisition of proper materials that could withstand weathering, tidal flux, and salinity.

- **Effectiveness**

Operational Effectiveness: The direct effectiveness of reducing the Laughing Gull colony size by on-colony shooting would probably be low, since gulls would probably be panicked into flight when shooting starts and only a few will be shot (Thomas 1972). Such flights might be avoided by shooting from a blind (Blodgett 1992). Seubert (1968) reports that a colony of 750 pairs of Herring Gulls near Logan Airport was "controlled" by two years of shooting in which 4468 gulls were killed. As shooting is continued, the birds might also become progressively more wary and thus even more difficult to shoot (Thomas 1972). Kress, however, notes that Laughing Gulls in Maine were not alarmed by .22 rifle fire that effectively dispersed Herring Gulls. It might be possible, therefore, to shoot sitting birds with .22s (avoiding the alarm caused by falling dead birds). Shooting was not, however, effective in reducing colonies of Black-headed Gull (ecologically similar to Laughing Gull) in Europe (Thomas 1972). It is possible, however, that if shooting is carried out very early in the season and in such a manner as to induce the most disturbance, Laughing Gulls would simply desert the colony, and reduction of the local population would be achieved indirectly. A similar program would have to be conducted annually to repel persistent former breeders and new immigrants attempting to occupy the site.

Ultimate Effectiveness: Unless shooting is done in a manner that avoids putting the birds to flight (i.e., shooting from blinds), the panicked birds are likely to cause a temporarily increased strike hazard at

JFKIA. However, if substantial numbers of Laughing Gulls are either shot or induced to desert, and if deserting birds do not remain in the vicinity of the airport, a reduction in the number of Laughing Gull strikes could be achieved. The effects of shooting (killing of breeding adults and curtailment of productivity and hence future internal recruitment) mimic those of the toxicant application alternative, therefore the results achieved are likely to be similar to those illustrated by the toxicant application model (Figures 3-16 through 3-18). If shooting does not achieve the assumed efficiency rate for toxicant application (about 68%), the rate of initial population decline would not be as steep. Since shooting would reduce the number of breeders as long as it was continued (and would continue to have an effect—albeit a declining one—for several years after being discontinued), it would be effective in reducing birdstrikes at JFKIA for that period.

- **Conclusion**

Shooting on the colony site is feasible and would be effective in reducing the gull population, if conducted from blinds. It is therefore advanced for environmental analysis.

3.5.2.3 Introduction of Predators

Predators (fox, raccoons, and others) could be used to reduce the Laughing Gull nesting population in the Jamaica Bay marshes. Predators would have to be released into the marsh ecosystem and would predate adult and immature gulls and eggs, and also other bird species and their eggs.

Mammalian predators have been shown to be highly effective in reducing populations of gulls. For example, foxes (Pimlott 1952, Axell 1956, Kadlec 1971, Southern et al.1985) and raccoons (Pimlott 1952, Kadlec 1971) have been shown to cause mortality of both juvenile and adult gulls, and decreased productivity, often eliminating entire colonies.

- **Technical Implementation Feasibility**

While introduction of predators trapped at other locations would be relatively simple, maintaining them on the salt marsh islands would be difficult. Since fresh water and shelter are not available, these would have to be provided. Kadlec (1971) noted the difficulty of ensuring the health and survival of foxes and raccoons introduced to Massachusetts islands for gull control; only 32 of 75 animals released during the 4-year study were known to have survived.

Once the Laughing Gulls leave the colony (either as a result of predation or at the end of the breeding season), the predators' food source would be greatly reduced and they would probably have to be removed. Introduced mammals could drown if severe storms overwash the islands (although the swimming distance to high ground at JFKIA is not far). It is unlikely that such animals could survive the winter on the salt marshes; if not removed earlier, they would certainly have to be trapped and removed before winter. If these animals are released, new ones would have to be obtained in succeeding years. Because of the islands' closeness to the mainland, introduced animals may escape by swimming the narrow channel between JoCo marsh and JFKIA. Animals captured for introduction would have to be maintained in captivity for several months to ensure that they were free of rabies (Kadlec 1971). New York State is a rabies-endemic area, and there are current severe restrictions in place regulating the handling of raccoons and other mammals. Current regulations prohibit the trap and transfer of these species.

■ **Effectiveness**

Operational Effectiveness: Predators kill both adult gulls and chicks, destroy eggs, and cause disturbances that result in the failure of eggs to hatch or reduce chick survival (Southern et al. 1985), thus they can be effective in suppressing both the breeding population and the gulls' reproductive output. Gulls typically lack effective behaviors for deterring or distracting predators, instead relying on the occupation of predator-free colony sites to provide a safe nesting situation (Southern et al. 1985). In a natural predation situation on an island in Lake Michigan, fox predation reduced the breeding population of Ring-billed Gulls by 84% and that of Herring Gulls by 53% over nine years, and almost completely suppressed the production of the young (Southern, et al. 1985). Wildlife Research (1966) reports that breeding populations of Herring Gulls were reduced by 90% on islands where predation was implemented for three years. On islands off the Massachusetts coast, annual introductions of foxes and raccoons for two to four years virtually eliminated reproduction in Herring and Great Black-backed gulls, resulted in some colonies disbanding, and reduced the size of others by a minimum of two-thirds (Kadlec 1971). One of these was Spectacle Island, which supported a large gull colony a few miles from Boston's Logan Airport. After the cessation of the predator project, repopulation of the islands by gulls was relatively slow. Griffin and Hoopes (1991) found that predation by feral dogs reduced reproductive output of Laughing Gulls to zero on three of seven study plots in the Jamaica Bay colony.

Since recruitment can easily replace the elimination of reproduction, displacement of breeding adults can be the most substantial local effect of predators. Given the difficulties of maintaining predators on islands, use of this technique may be most valuable in controlling the distribution of breeding gulls in critical locations, such as Spectacle Island (Kadlec 1971).

The predator introductions discussed above were on upland islands on which predators had unrestricted access to all parts of each island. The Jamaica Bay colony site, however, consists of tidal salt marshes that are interspersed with many small creeks. This kind of terrain may limit access by predators to some gull nesting areas, and thus could lower the animals' impacts on the breeding population.

Ultimate Effectiveness: Since the effects of predation (killing of breeding adults and curtailment of productivity and hence future internal recruitment) mimic those of other adult gull removal alternatives, such as toxicant application and on-colony shooting, the results achieved are likely to be similar. If predation does not achieve the assumed efficiency rate (about 68%), the rate of initial population decline would not be as steep. Predation would reduce the number of breeders as long as it was continued; therefore, it would be effective in reducing birdstrikes at JFKIA for that period.

During conduct of physical destruction of nests and eggs, a short-term and temporary increase in the birdstrike hazard may occur as a result of towering.

It should be noted that the introduction of mammalian predators (i.e. foxes) could also cause hazards on JFKIA.

■ **Conclusion**

The problems associated with maintaining predators on the marsh complex, in combination with the increased strike hazard due to towering, and present restrictions on the trap, transfer, and handling of mammals render this alternative infeasible. It will therefore not be advanced for environmental analysis.

3.6 Lethal Gull Control: On-Airport Alternatives

3.6.1 Shooting

3.6.1.1 Harassment Reinforced with Shooting

Nonlethal harassment, consisting of the use of pyrotechnics (screamer sirens, bangers, and cracker-shells) and playback of taped gull distress calls, could be considered on both the colony site and the airport in attempt to both displace the colony and prevent birds from congregating on or passing over the airport. In both locations, a gull would be shot occasionally to reinforce the scare effect of the nonlethal methods. Section 1.4.4 documents the procedures that are currently used by JFKIA's BCU regarding harassment with pyrotechnics and reinforcement with shooting.

■ **Technical Implementation Feasibility**

The personnel of the JFKIA Bird Control Unit currently perform exactly these activities in dispersing birds on the airport (Helmke and Silliman 1991), and presumably would continue to do so as part of this program. In order to conduct the same program on the colony site, additional trained personnel would be necessary. Shotguns, flare pistols, appropriate live and pyrotechnic ammunition, distress-call tapes for Laughing Gull, and battery-powered audio equipment for broadcasting the calls would be required equipment. Although some harassment and shooting could be done from the boat, some would undoubtedly have to be conducted on the islands in order to reach all the birds. These activities would be conducted during all daylight hours, April - June.

■ **Effectiveness**

Operational Effectiveness: On-airport harassment programs using the methods described are effective at dispersing roosting, loafing, and feeding gulls (Blokpoel 1976). However, they do not deter birds from overflying the airport, as evidenced by the more than 28,000 gulls shot in JFKIA airspace during the interim control program (Dolbeer et al. 1992) while just this type of harassment program was in operation.

Thomas (1972) reported that distress calls failed to disperse a breeding colony of Black-headed Gulls because the birds rapidly habituated to the sound. It is likely that the birds' strong site tenacity and reproductive drive can overcome their ordinary response to distress calls, especially when these are used for a long period with no reinforcement of actual danger. Instructions for the use of distress calls caution against their overuse (Schmidt and Johnson 1983, Helmke and Silliman 1991), due to eventual habituation of the gulls to the stimulus. It is unlikely that habituation can be avoided in this program considering the long period for which birds would have to be subjected to the calls. It is possible, however, that periodically shooting a few birds on the colony might reinforce the distress message, and improve the effectiveness of this method.

One of the few studies involving the use of pyrotechnics to disperse breeding colonies was conducted in 1993 at the Breezy Point Unit of Gateway National Recreation Area (USDA 1993b). In an attempt to protect nesting Piping Plovers from the negative effects of a nearby colony of about 400 pairs of Herring and Great Black-backed gulls, more than 7000 rounds of pyrotechnics were fired in a five-week period to deter gulls from landing on the colony site. For the first few days this method was effective, although the gulls appeared to habituate after 10 days of harassment and it became increasingly difficult to repel them. When the use of pyrotechnics was discontinued in order not to disturb arriving Common and Least terns, both species of gulls subsequently established nests on the site.

If the 6,000 pairs of Laughing Gulls are as persistent as the larger species, the amount of pyrotechnics needed to repel them could be enormous (unless the added effects of distress tapes and occasional shooting reduces the birds' habituation). Also, the difficulties of operating in the salt marsh terrain could make it extremely difficult to effectively cover the large colony site. If harassment must be discontinued to protect the Common and Forster's terns nesting in association with the Laughing Gulls, the gulls may nest anyway, making the entire harassment program fruitless. However, since Laughing Gulls normally spend about 4 weeks on the colony site before initiating nesting (Montevecchi 1978), keeping them off for the month before the terns arrive may disrupt their breeding schedule sufficiently that some birds will desert and others may not breed successfully. If the harassment could be continued through June, after which Laughing Gulls will not attempt to nest, productivity for the year could be virtually eliminated.

Ultimate Effectiveness: If this alternative results in the Laughing Gulls quickly abandoning the colony site and dispersing from the Jamaica Bay area, it would be effective in reducing the number of birdstrikes at JFKIA, despite a possible temporary increase in the hazard during the period of harassment.

If, however, the response of Laughing Gulls is similar to that of the Herring and Great Black-backed gulls at Breezy Point, in that, although they do not establish territories on the colony site they remain in the general area, the local population would not be reduced and therefore neither would Laughing Gull strikes at JFKIA. The constant harassment may keep so many birds in the air that the birdstrike hazard is actually increased over what it would be if the birds were incubating. The gulls prevented from landing at Breezy Point "towered" over the site, spiraling very high into the air in large numbers (USDA 1993b); this behavior would be extremely hazardous to aircraft safety at on the colony site, which is directly in the path of Runway 4R/22L.

- **Conclusion**

Due to the infeasibility of harassing the gulls in such a large area and the probability of habituation leading to ineffectiveness, this alternative will no longer be considered.

3.6.1.2 Intensive On-Airport Shooting Program

The shooting of gulls that attempt to enter JFKIA airspace and which present a hazard to aviation and passenger safety, could be conducted each year between May and August. The shooting program has been demonstrably effective in reducing the number of gull-aircraft strikes at the airport (Dolbeer et al. 1992). Under this program, 2-5 wildlife biologists and wildlife technicians trained in bird identification and the proper use of firearms would be stationed along the perimeter of the airport. Using only steel shot, biologists would shoot gulls attempting to enter JFKIA airspace. Shot gulls are retrieved and identified to species and age class. Except for a sample delivered to biologists for scientific investigations, all carcasses are buried on JFKIA property.

- **Technical Implementation Feasibility**

Using APHIS/ADC personnel and funded by the Port Authority, this program has been implemented yearly since 1991. Continuation of this program is feasible.

■ **Effectiveness**

The effectiveness of this alternative is determined by two possible effects. Direct effects of the shooting program are related to the elimination of gulls when they enter JFKIA airspace. Indirect effects may result from any colony population reduction achieved by shooting gulls on-airport.

Direct Operational Effectiveness: The program has been very effective in removing gulls from JFKIA airspace, as indicated by the total of 30,000 gulls removed from JFKIA airspace since implementation of this program. Its impact on the breeding population of the Jamaica Bay colony has been somewhat less than might be expected. Despite the killing in 1991 and 1992 of a total of 24,000 breeding adults (Dolbeer et al. 1992)—160% of the 1990 population (7629 pairs), 6000 pairs nested in 1993. The decline in the number of gulls removed from JFKIA airspace in 1993 (assuming similar proficiency of the shooters) does not correspond with a similar decline in nesting Laughing Gull in the Jamaica Bay colony. In fact, the nesting colony remained relatively stable during implementation of the shooting program. This indicates that either (1) the gulls that have not been shot have developed an aversive behavior pattern in response to the shooting, or (2) the new individuals that have replaced the shot birds are not following the same flight lines as their predecessors, perhaps because the "group knowledge" of some attractant that lies beyond the airport has been eliminated along with the shot birds. It is also possible that some major off-airport attractant has been eliminated, although none has been identified to date.

Indirect Operational Effectiveness: Population modeling (Section 3.1.3.3, Table 3-3 and Figure 3-19) indicates that annual on-airport shooting of numbers of Laughing Gulls varying between 4,000 and 13,000 per year will produce a long-term decline in the Jamaica Bay population. Only with an assumption of no immigration, however, is the population reduced to a negligible level.

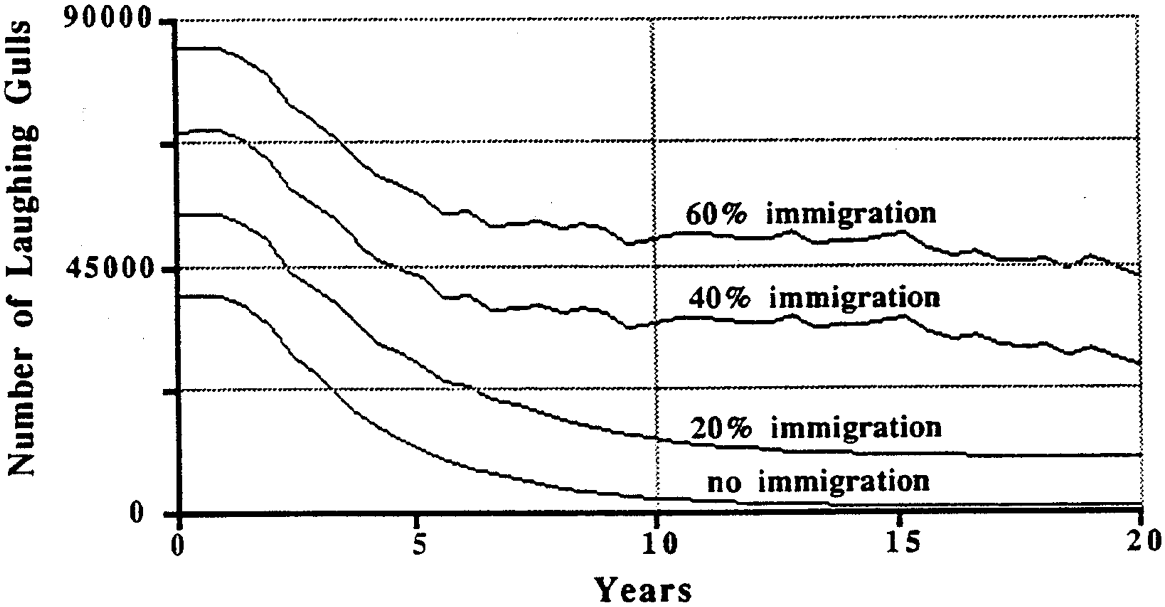
Ultimate Effectiveness: The on-airport shooting program has been highly successful in reducing the number of birdstrikes at JFKIA by targeting those Gulls attempting to overfly the airport specifically rather than attempting to reduce and/or relocate the nesting colony population in general. Strikes by Laughing Gulls during the shooting period were reduced by 66% in 1991, 89% in 1992, and more than 90% in 1993 compared to the mean number for that period for the years 1988-1990 (Figure 1-17). Strikes by other gull species were similarly reduced. Both the effectiveness and the selectivity of the interim shooting program are illustrated by comparing the 1990 birdstrike data (Figure 3-20) with those of 1993 (Figure 3-21), after the shooting program had been in effect. These data indicate that the shooting program resulted in a substantial decrease in the number of gull strikes. As the program was not aimed at non-gull species, the relatively small portion of strikes by birds other than gulls decreased to a lesser degree. However, decrease of non-gull related strikes through the deterrent effect of the program on other birds contributes further to the effectiveness of this method.

■ **Conclusion**

Since substantial birdstrike reduction has been achieved by this method in 1991-93, it is considered to be very effective at reducing the number of gull-aircraft interactions for future years.

3.6.1.3 On-Airport Harassment of Gulls by Avicide Application

Avitrol® (4-Aminopyridine) is a chemical agent that may repel birds from an area by soliciting a fright response. This alternative proposes to strategically place untreated bait at the perimeter of the airport, establishing new feeding locations. After gulls would be trained to feed at the airport site, the untreated bait would be replaced with treated bait. A small portion (1-3%) of the grains would actually contain



NOTE: For the purpose of simulation, Reduction of Laughing Gull mortality as a result of on-airport shooting was assumed to randomly vary between 4,000 and 13,000 birds per year

NOTE: Graphs show simulated effect on the Laughing Gull colony population of reduction of adults by 68%, by means of annual on-airport shooting, assuming 0%, 20%, 40% or 60% immigration of other Laughing Gulls intothe colony

Figure 3-19

Simulated Population Effect of On-Airport Shooting (immigration at 20% - 60%)

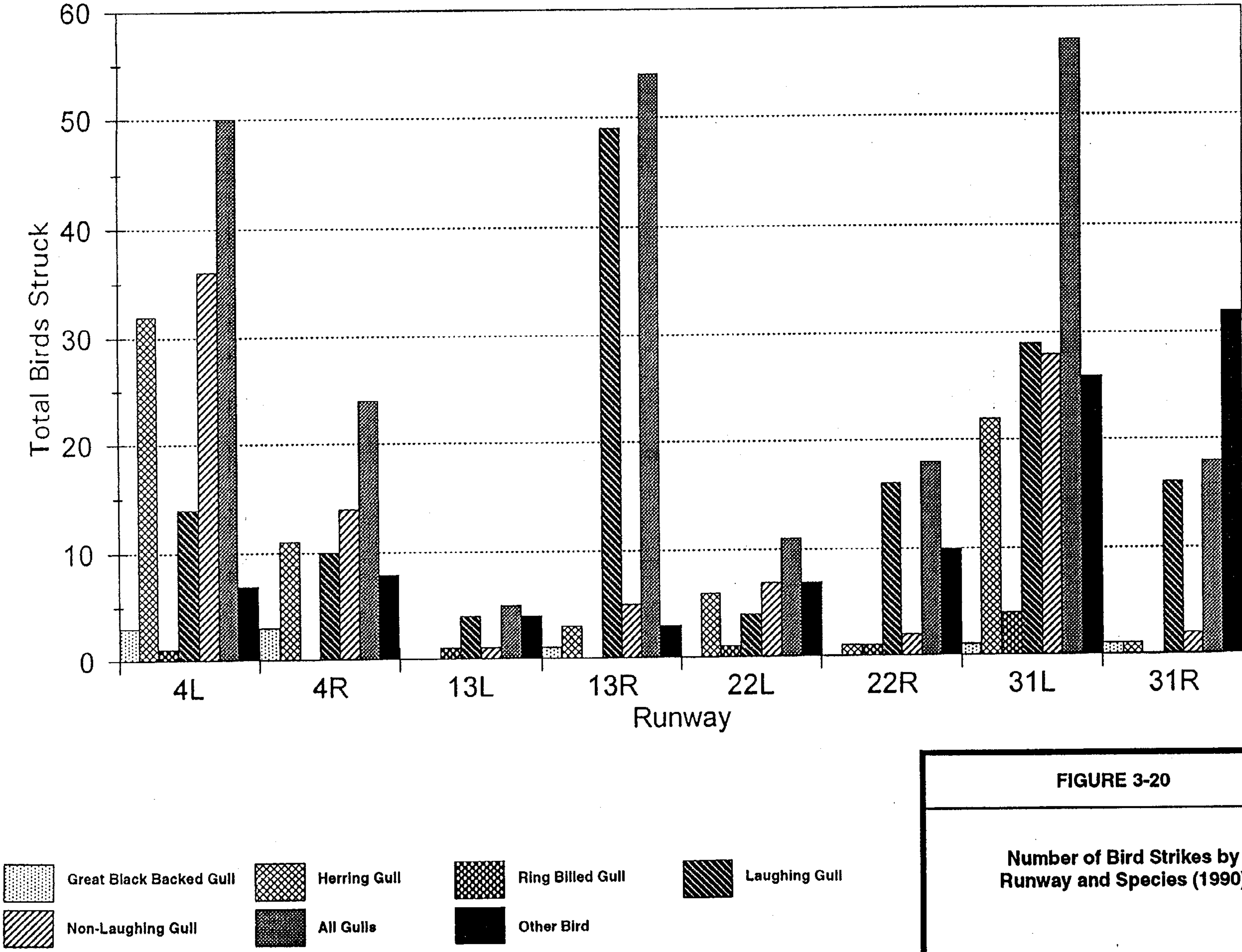


FIGURE 3-20

Number of Bird Strikes by Runway and Species (1990)

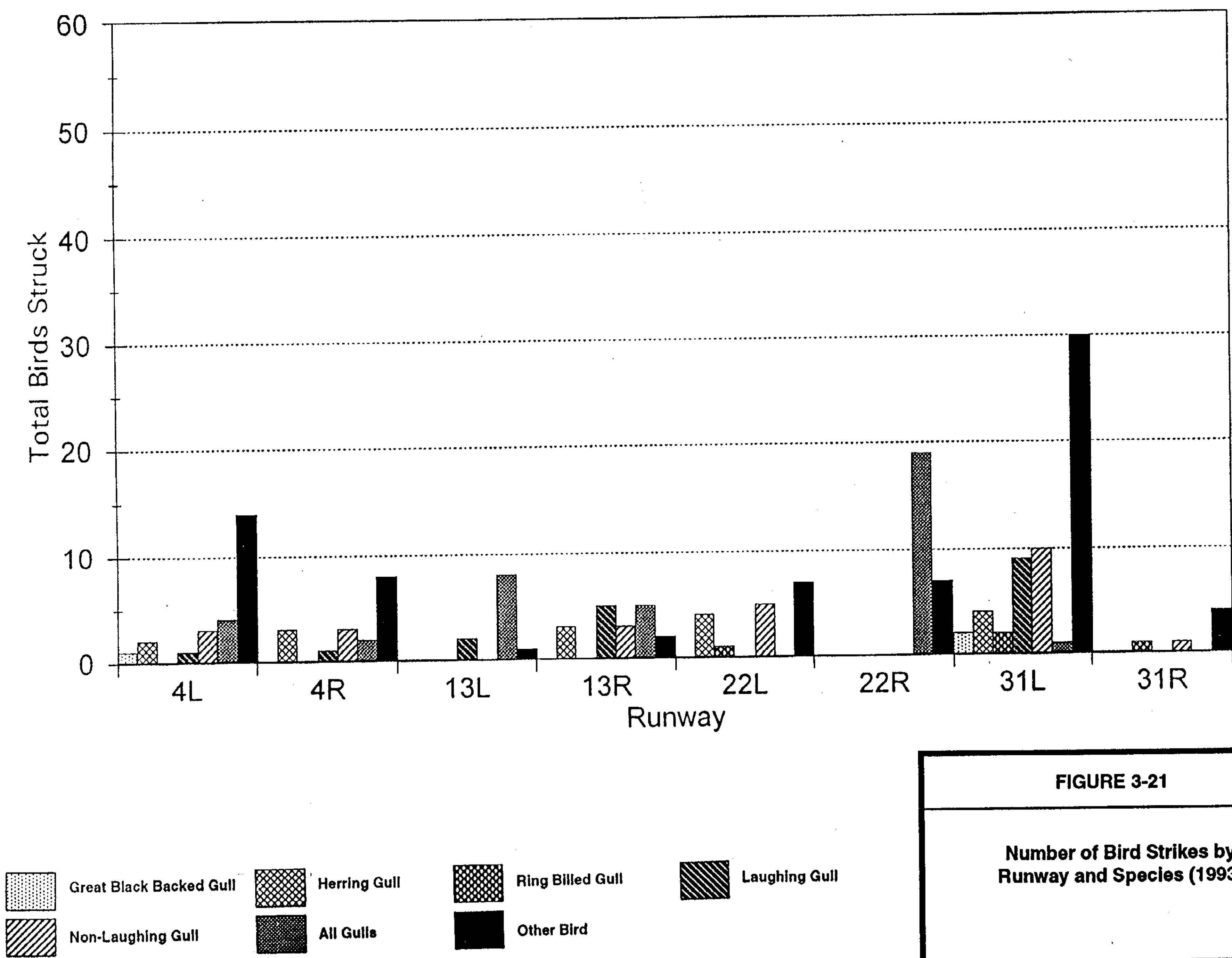


FIGURE 3-21

Number of Bird Strikes by Runway and Species (1993)

the chemical, so only 1-3% of the gulls would due. Prior to death, the gull would fly erratically and emit distress calls, thereby frightening the rest of the gulls away from the area. Applications may be required every other week.

■ **Technical Implementation Feasibility**

Avitrol would have to be pre-baited on the airport or at the colony site for the purpose of attracting birds to the airport and subsequently deterring them. Such application would be feasible.

■ **Effectiveness**

Operational Effectiveness: No literature sources are known that indicate that Avitrol has been proven effective in causing the abandonment of an established gull colony or in reducing gull-aircraft collisions at an airport adjacent to a gull nesting colony.

Much of the literature documents the use of Avitrol on birds other than gulls (primarily blackbirds and pigeons) for the purpose of solving problems in agricultural or urban situations, where the hazard is not related to flight behavior, and where—contrary to the situation at JFKIA—erratic flight situations are not an issue.

This method may be effective in situations where the airport is already an established feeding ground for the target species. However, the gull-aircraft strike hazard at JFKIA is largely related to gulls flying over the airport, rather than to the presence of large congregations of gulls feeding at the airport. The use of Avitrol baits is unlikely to prevent the gulls from flying over the airport to attractants at off-airport destinations, and this method would therefore not be effective. Furthermore, to successfully bait the gulls, the gulls would need to be induced to feed at the airport, which defeats the very purpose that the gull hazard reduction program seeks to achieve. In addition, placing bait at the airport might attract other bird species that could create additional strike hazards at the airport.

Ultimate Effectiveness: The erratic flight of treated birds is unpredictable and could increase the birdstrike hazard. Additionally, pre-baiting would be necessary in order to condition the flock to feed at certain locations. Pre-baiting, either on or near the airport, could serve to attract more birds to the area than otherwise would have been there, as most birds are currently not attracted by food, water or other habitat resources on the airport. Furthermore, it could actually increase the birdstrike hazards at JFKIA by attracting birds to the area. This alternative would in effect increase the hazard to human lives and was not considered effective, either by itself or as part of an integrated program.

■ **Conclusion**

This alternative is not considered effective in reducing the gull-aircraft strike hazard and may actually increase the birdstrike hazard at JFKIA by attracting birds to the area and creating erratic and unpredictable flight behaviors. For the reasons described above, this alternative will not be advanced for further consideration and environmental analysis.

3.6.2 Combinations of On-Airport and Off-Airport Lethal Measures

The preceding sections have discussed lethal gull control measures in terms of on-airport and on-airport implementation, in order to distinguish between the effectiveness of measures that could be implemented without direct physical effects on the Jamaica Bay Wildlife Refuge environment and those that would involve activities within the Jamaica Bay Wildlife Refuge. However, it is conceivable that lethal measures which seek to reduce the Laughing Gull colony in Jamaica Bay would gain in effectiveness if both on-airport and on-colony measures were to be applied simultaneously. Therefore, several combinations of lethal alternatives were analyzed regarding their technical implementation feasibility and anticipated effectiveness.

- **Technical Implementation Feasibility**

The technical implementation feasibility of a combination of lethal elements depends on the feasibility of each individual element.

- **Effectiveness**

Operational Effectiveness: Blodget and Henze (1992) combined egg destruction with toxicant application of breeding adults in attempting to eliminate Herring and Great Black-backed gulls and re-establish a nesting colony of terns on Ram Island, Massachusetts. Prior to the primary toxicant application in mid May, eggs were broken in late April to synchronize nesting and to avoid the possibility that very early clutches might hatch just prior to the first toxicant application treatment. On the dates of treatment, any nests left unbaited with toxicants (owing to insufficient baits) were broken up. All clutches were broken up on the third day after treatment to assure that no pairs that survived would hatch chicks. After secondary toxicant applications in early June, clutches of immigrant or persistent pairs were broken up in late June.

Toxicant application (with DRC-1339), destruction of eggs and chicks, and limited on-colony shooting were combined to reduce a colony of Great Black-backed and Herring gulls in Maine (Kress 1983). The program was successful in reducing fledgling success to near zero. However, even with continued reproductive failure and adult mortality, Great Black-backed Gulls did not show a substantial population decline until four summers after the control program began. Even after the decline, a few pairs would attempt to nest each year, and annual destruction of eggs and chicks was necessary to prevent the population from rebounding quickly.

Computer simulations (Section 3.1.3.3 and Figures 3-22 and 3-23) were conducted for four different combinations, including two types of nest reduction measures (toxicant application and shooting) and reduction of breeding adults of control methods. The effect of the following combinations were simulated:

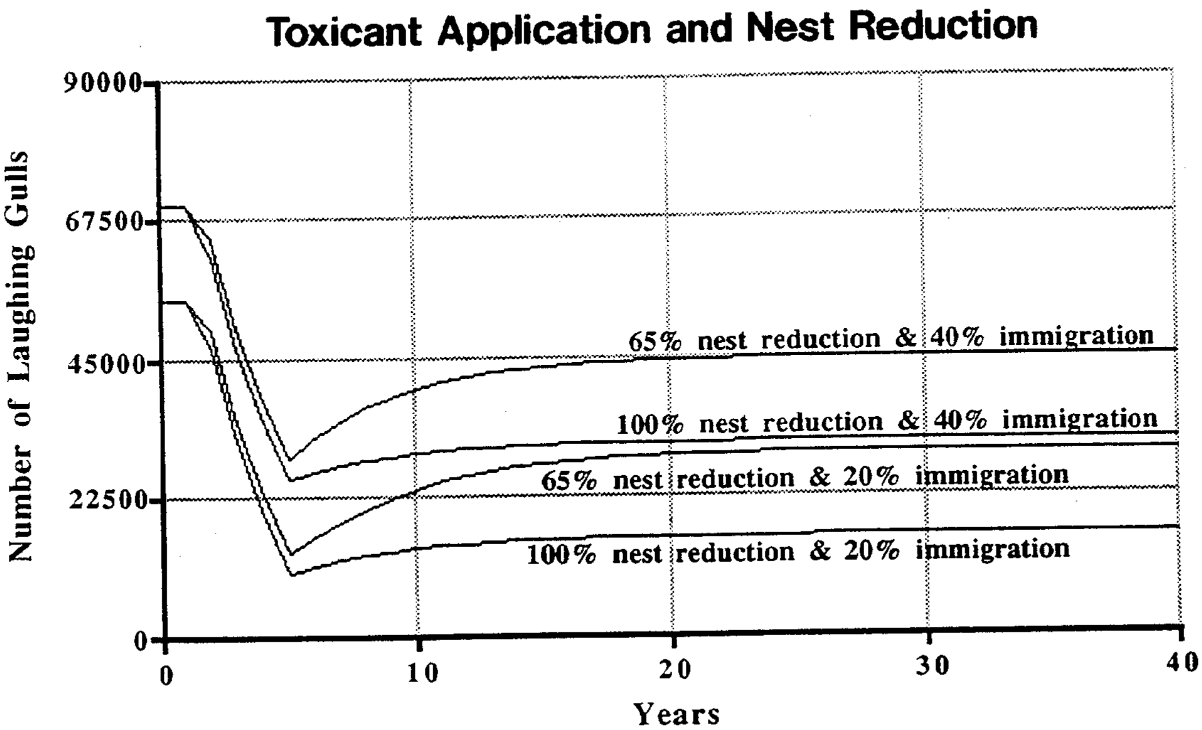
- Twenty years of nest reduction (which could be via habitat modification or lethal methods) plus reduction of breeding adults (through toxicant application)

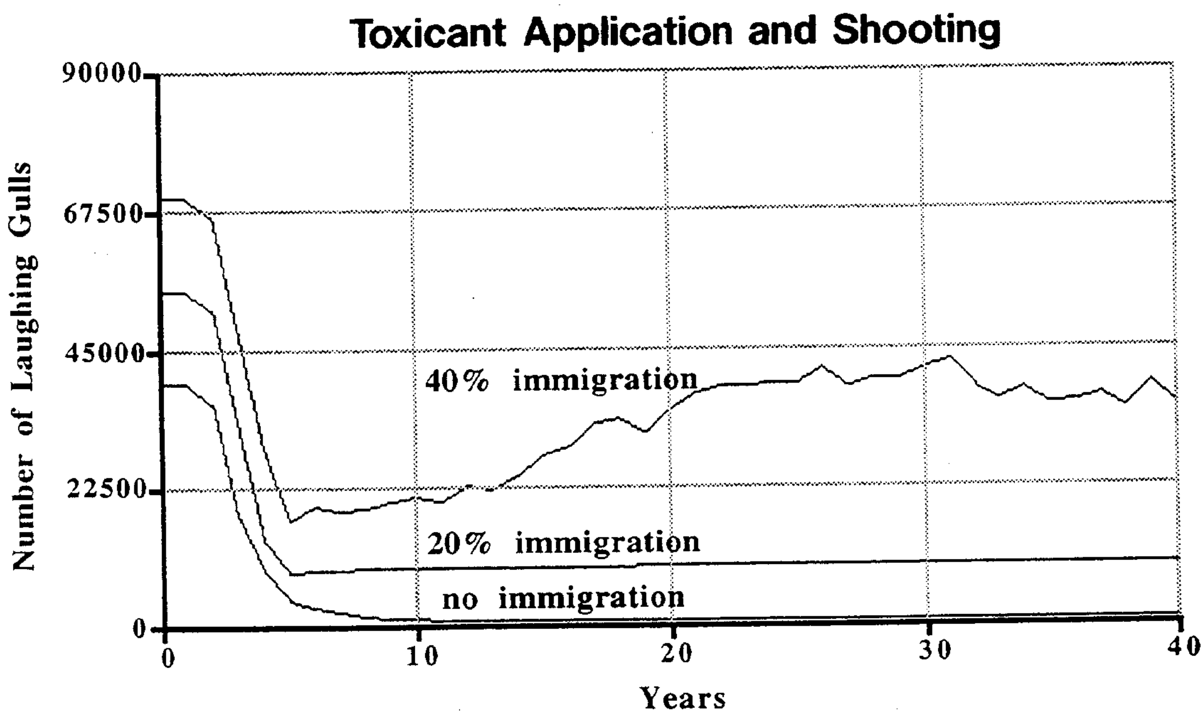
- Three years of on-airport shooting plus reduction of breeding adults (through toxicant application)

- Twenty years of annual shooting plus nest reduction

- Three years of annual reduction of nesting adults by shooting and toxicant application plus nest reduction, followed by the continuation of nest reduction and shooting for another 18 years.

All simulations were run at two different levels of immigration, and those involving nest reduction were run at two different levels of reduction. Of the above scenarios, shooting in combination with nest reduction (egg/nest oiling, destruction or removal) and shooting in combination with nest reduction and toxicant application were relatively more effective in the long term at reducing the overall population of





NOTE: Top graph shows effect on the Laughing Gull colony population of reduction of eggs or nests in combination with reduction of adults by toxicant application or on-colony shooting for 3 years, assuming various levels of yearly immigration of other Laughing Gulls into the colony.

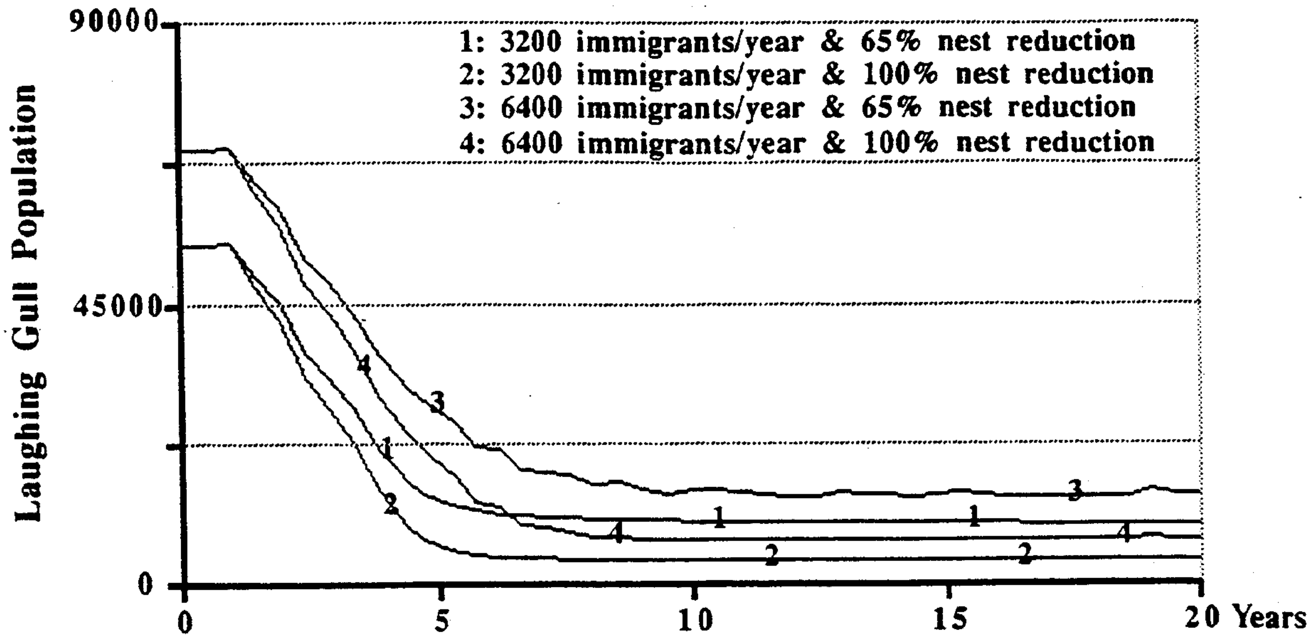
The bottom graph shows ther effect of reduction of adults by means of on-airport shooting in combination with toxicant application or on-colony shooting for 3 years, assuming various levels of immigration.

FIGURE 3-22

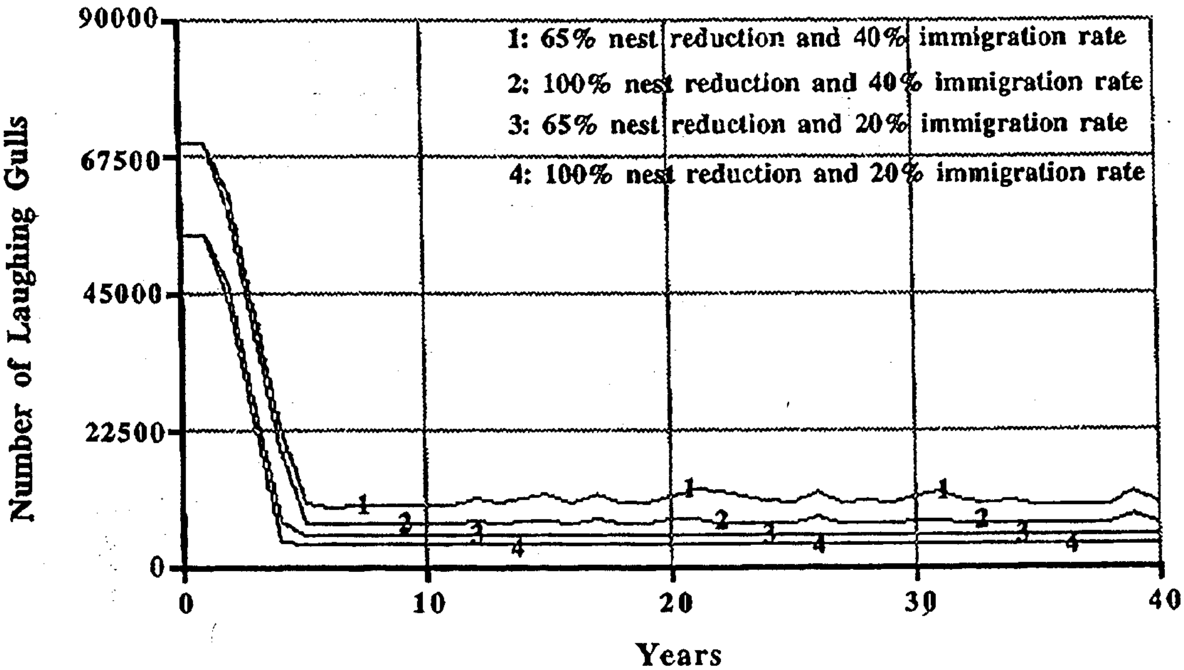
Simulated Population Effect of Combined Alternatives (at immigration levels of 20% - 40%):

- **A. Toxicant (3 years) and Nest Reduction (annually)**
- **B. Toxicant (3 years) and On-Airport Shooting (annually)**

Shooting + Nest Reduction



Shooting + Nest Reduction + Toxicant at Two Levels of Immigration



NOTE: Top graph shows the simulated effect on the Laughing Gull colony population of reduction of eggs or nests in combination with reduction of adults by means of on-airport shooting, assuming various levels of immigration of Laughing Gulls into the colony every year.

The bottom graph shows the effect on the population of reduction of nests or eggs in combination with reduction of adults by means of on-airport shooting and toxicant application, assuming various levels of immigration.

FIGURE 3-23

Simulated Population Effect of Combined Alternatives (at immigration levels of 20% - 40%):

C. On-Airport shooting (annually) and Nest Reduction (annually)

D. On-Airport Shooting (annually), Nest Reduction (annually) and Toxicant (3-year)

Laughing Gulls in Jamaica Bay. The fourth scenario (involving reduction of adults by shooting and toxicant in combination with nest reduction as three simultaneous control methods) produced the most rapid decline in population, to about one-third of its original level in five years. However, simulations also indicate that in the short-term on-airport shooting (or shooting from blinds at the colony site) provides the most immediate reduction in population. Simulations further indicate that in the long term, toxicant application provides only a marginal further reduction of the population. The results of the simulation are presented in Figures 3-22 and 3-23.

Ultimate Effectiveness: The ultimate effectiveness of a combination of lethal elements is expected to be substantial as the Laughing Gull population is likely to be reduced substantially, and could result in a substantial immediate reduction in Laughing Gull-aircraft strikes at JFKIA.

- **Conclusion**

Combinations of lethal alternatives may be more effective than lethal alternatives by themselves. They will be further advanced for analysis of environmental impacts, both separately and as part of a combined alternative.

3.7 Integrated Management Program

In the previous sections, several alternatives, both lethal and nonlethal, were described that by themselves were feasible and/or effective to a varying degree. It appears from the previous sections that not one alternative by itself or combinations of one type of alternative alone (i.e. combination of only nonlethal or only lethal alternatives) could substantially and permanently reduce the gull hazard in both the short and long term. For example, Seubert (1990) notes that, where a particular gull species does not respond to egg destruction by simply abandoning the site (for example, Black-headed Gull does abandon, whereas Herring Gull does not), harassment may also have to be employed to force the birds to relocate.

An integrated approach which contains the most effective elements from different approaches and uses them in such a way that they are likely to reinforce each other's effectiveness was therefore considered to be the best approach. Such a management approach has been successfully applied to the removal and relocation of Ring-billed Gull nesting colonies from gravel rooftops in New York State (Forbes 1993).

Based upon the effectiveness and feasibility of the previously discussed alternatives, the most effective integrated management approach would be to improve all off-colony controls to the greatest extent possible while simultaneously implementing an escalating series of deterrents on the colony, including non-lethal methods as well as lethal means as necessary. They would include on-airport shooting - to guarantee public safety on an immediate basis, as well as reduction of attractants, reduction of the productivity of the colony and discouraging of nesting activities to reduce the birdstrike hazard in both the short and long term. The Port Authority would pursue all possible means of reducing the attractants that result in gull overflights of JFKIA. Such improvements would probably also reduce the number of strikes by other bird species.

To guarantee public safety not only in the future but also on an immediate basis, the on-airport shooting element of the IMP would need to be implemented from the start and remain in effect until other actions effectively reduce the hazard. To the extent that other elements of the IMP (both lethal and non-lethal) prove to be effective in reducing the number of gulls entering JFKIA airspace and consequently are effective in reducing the strike hazard, both the need for on-airport shooting and the extent of its lethal effects would be reduced.

The final determination of the specific elements of the IMP would be made after analysis of the environmental impacts of different measures determined to be feasible and effective in this section. Measures that have the lowest environmental impact would preferably be included in the IMP.

The IMP that could ultimately be employed at JFKIA beginning in 1994 would include all feasible and effective alternatives that do not have substantial environmental impacts, and that are selected by the relevant authorizing agency. It is noted that each component of the IMP would be subject to review, authorization, and permitting by the managing and permitting agencies with jurisdiction. All alternatives involving lethal control would require DEC and FWS permits. Alternatives with proposed activities on the Laughing Gull colony site at GNRA would require the authorization and support of the NPS. Alternatives involving off-airport properties such as the Jamaica Bay Sewage Treatment Plant and the Aqueduct Racetrack would similarly require authorization and support of the managing agency. Once the IMP components are identified, and if the IMP is selected by decision-makers, authorizations and permits would have to be requested. The final IMP that is conducted would consist of as many components as are permitted and authorized from among the originally proposed IMP.

- **Technical Implementation Feasibility**

The feasibility of all possible feasible and effective alternatives have been discussed under their respective sections preceding this section. By definition, all elements would be feasible for implementation, as this is one of the criteria for including them in the IMP.

- **Effectiveness**

Operational Effectiveness: During the past years, integrated management approaches have been demonstrated to have the potential to be more effective than the application of singular measures, either lethal or nonlethal. The 99 percent colony reduction achieved by Forbes et al. (1992) after three years indicates the potential effectiveness of integrated management in reducing the size of the Laughing Gull colony in Jamaica Bay. Blokpoel and Tessier (1987) discuss a number of projects in which colonies of Ring-billed Gulls were dispersed by a combination of methods, including egg collection/harassment; gull exclosure (by wires or otherwise)/egg collection; harassment involving tethered and flying raptors, distress calls, and pyrotechnics; and habitat alteration/harassment

As discussed above, the IMP could contain lethal and nonlethal components which would be applied in combination to increase the program's overall effectiveness. A discussion of the effectiveness of combinations of lethal components is provided in Section 3.6.2. Although the IMP would not necessarily consist of the same identical combinations as discussed in this section, the findings of this section do provide a general indication of the increased effectiveness when lethal measures are applied in combination.

Ultimate Effectiveness: The effectiveness of the different potential alternatives that could be included in the IMP is discussed in the preceding sections under each individual alternative. The effectiveness of the combination of different gull hazard reduction elements within the IMP is likely to result in an effectiveness greater than the sum of its parts. This is because of logistical advantages and the possibility to sequence the different elements within the breeding season when they are most effective. One of the important aspects besides the need for long-term, permanent reduction of the strike hazard effectiveness, which would be achieved by long-term colony relocation as sought to be induced by several alternatives, is the ability of any alternative to result in an <u>immediate</u> reduction of the strike hazard and as such address the urgency of the public safety issue. The immediate effectiveness of the IMP is established by the fact that on-airport shooting, which has contributed greatly to a dramatic reduction in gull strikes since its implementation at JFKIA, has a proven immediate effectiveness, and could be one component of the IMP.

Conclusion (IMP)

Due to the probable effectiveness, minimization of adverse environmental impacts, and feasibility, an integrated management program will be advanced for environmental impact analysis in Chapter 5.