September 2004

Abstracts of Papers from 6th Annual Meeting, Baltimore 2004

Bird Strike Committee-USA/Canada 6th Annual Meeting, 13-16 September 2004, Baltimore, Maryland

ABSTRACTS

(1) LIABILITY OF THE AIRPORT FOR THE BIRD STRIKE DAMAGE

Ante Matijaca, Split Airport Ltd., Legal Department Manager, Kastel Stafilic, Cesta dr. Franje Tudmana 96., POB 2, 21120 Split, Croatia

All around the world, there are a significant number of legal proceedings referring material and non-material damages caused by bird or other animal's strikes. Namely, international court sentences become a highly effective means of application of corresponding preventive methods in the segment of air traffic persons and property protection. Therefore, it is necessary to spread more and more the awareness of possible legal consequences that might emerge in case when, in course of definite proceedings, it is undoubtedly stated that bird and other animals strike safety measures failed to be applied, or that the control of these measures application failed to be conducted. It is also known that interested parties would rather settle an out of court agreement than start long-lasting and expensive legal proceedings. In the Republic of Croatia, the first sentence concerning this matter was pronounced in Pula County Court, on 18th April 2000. Croatia Insurance Co., as the Insurer, sued Pula Airport for damage that had occurred at Pula Airport, on 13th September 1996, as a result of the suction of gulls into the left engine of a Croatia Airlines aircraft B-737, registration 9A-CTB. The aircraft had been in a take-off phase, but it managed to stop on the runway without any consequential damages or human casualties. In this survey, we shall reconsider the domestic legal proceedings in which, after the incident, the damage compensation claim was directed to Pula Airport. Being the first and the only case of the kind, it represents a sort of precedent. In that, the Insurer claims the reimbursement of damage compensation that he paid to the air carrier was because a bird had flown into the aircraft engine on take-off.

(2) MULTI-ENGINE BIRD STRIKES TO TURBINE POWERED AIRCRAFT

Ed Cleary, Federal Aviation Administration, Staff Wildlife Biologist, 800 Independence Ave. SW, Washington, DC 20591 USA

The aviation safety hazard posed by the possibility of multi-engine strikes to turbofan and turbojet powered air carrier aircraft has been the subject of much recent debate and study. An Aviation Rule Advisory Committee (ARAC) convened by the FAA studied the threat posed by large (weight > 1.15 kg.) flocking birds. Early in the process there were questions raised as to the validity of the database used by the ARAC group. The ARAC group recently released their recommendations for ingestion standards of large flocking birds. For engines with an inlet throat area <2.5 m^2 – no large bird ingestion test. For engines with an inlet throat area >2.5 <3.50 m^2 – one 1.85 kg bird. For engines with an inlet throat area >3.5 <3.9 m^2 – one 2.10 kg bird. For engines with an inlet throat area <3.9 m^2 – one 2.5 kg bird. Analysis of bird/turbofan and

turbojet engine strike data (*N* = 5,800; 1990 — 2003) from the FAA National Wildlife Strike Database found 293 instances of multi-engine bird strikes and 74 cases of multi-engine damage. There were 5 reports of all 4 engines on 4-engine aircraft being struck and 4 reports of all 3 engines on 3-engine aircraft being struck. There were 223 (17 corporate aircraft, 206 air carrier aircraft) reports of strikes involving both engines on 2-engine aircraft. Of these, 63 (12 corporate aircraft and 51 air carrier aircraft) strikes damaged both engines. These data indicate that the threat of multi-engine strikes and danger posed by flocking birds is more serious than the ARAC's recommendations would indicate. I recommend that the FAA reject the ARAC group's recommendations in favor of more stringent requirements.

(3) A DISCUSSION OF BIRD STRIKE DESIGN ISSUES FOR ENGINES WITH OBSCURED FANS

Julian M. Reed, Rolls-Royce plc, PO Box 31, Derby, DE24 8BJ, England

In general, the design of rotating structures to withstand bird strike and the associated testing is a difficult process; not least because of the variable nature of bird internal structures and the random manner in which birds present themselves at the inlet to the engine. What increases the difficulty of this process is a case such as a single-engine military aircraft where the fan face may not be visible from the entry to the aircraft intake. In this case, the bird will have significant interaction with the internal structure of the intake during its passage from intake lip to fan. This paper explores the possible interactions that take place in such an installation prior to the bird reaching the fan and makes use of test and analytical evidence to make observations about the effect of such interactions on the bird structure. The implications of these interactions on the behaviour of the fan during the bird ingestion are then explored; again using test and analytical evidence.

(4) APPLYING SCIENCE TO RESOLVING LAND USE ISSUES: PREDICTING THE BIRDSTRIKE RISK FROM WETLANDS NEAR AIRPORTS

John R. Allan, Andrew Robinson, and Richard Walls, Central Science Laboratory, Birdstrike Avoidance Team, Sand Hutton, York YO41 1LZ, UK

The International Civil Aviation Organization's new standard for airport bird control requires that: The appropriate authority shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome unless an appropriate aeronautical study indicates that they are unlikely to create conditions conducive to a bird hazard problem. In the UK, there is a requirement for any new development within 8 miles of an airport to be evaluated in terms of flight safety and for the airport to be given the opportunity to object. Such objections often result in appeals, public inquiries and other legal proceedings. Both sides seek to show that the risk is either unacceptable (in the case of the airport) or negligible (in the case of the applicant). Both sides rely heavily on the opinion of expert witnesses, but there is little good scientific evidence to support the arguments of either side. Wetlands clearly constitute a bird attraction, but the numbers and species attracted, and hence the likely risk, are frequently disputed. This presentation reports on a study, funded by the UK minerals industry, designed to determine how to accurately predict the

numbers and species of birds that will be attracted to wetlands of different designs and to objectively determine how their movements might influence the birdstrike risk at nearby airports. Models have been developed that relate the physical characteristics of a wetland to the numbers and species of birds likely to be present. Measurements of the frequency, length and altitude of bird movements have been made and related to the location of other features such as feeding sites or other water bodies. Results are promising, but a greater range of factors needs to be included in the models. Work is currently on going to gather the necessary data.

(5) FEDEX EXPRESS' APPROACH TO BIRD STRIKE PREVENTION

Nedra Baum, Senior Air Operations Division Specialist, 3131 Democrat Road, Room C273, Memphis, TN 38118 USA

Airlines can help in the prevention of bird strikes. This presentation is an overview of FedEx Express' Bird Strike Prevention Program. FedEx has given a new meaning to bird and wildlife strike reporting by focusing on the type and amount of information Flight Safety receives from the pilots, which is transferred to the FAA's National Wildlife Strike Database. By maintaining specific records and statistics of the bird strikes and their effects on the aircraft, FedEx can share information with the USDA Wildlife Services wildlife biologist at FedEx's biggest hub in Memphis, Tennessee. This enables the biologist and air operations crews to locate nests or roosts of birds on the airfield in order to disperse the indigenous bird population. Flight Safety in turn shares the same information with the governing airports when more than two strikes occur in a month. In addition, FedEx's internal publication of the Straight in Approach communicates information with the FedEx pilots regarding all collected bird strike trends and analysis.

(6) EUROPEAN STARLINGS AND PASSENGER-LOADING BRIDGES: AN AVIATION INDUSTRY-WIDE PROBLEM

Robert L. Johnson, Assistant Airport Operations Manager, Kansas City International Airport, 601 Brasilia Avenue, Kansas City, MO 64195 USA

The European starling population exceeds 800 million throughout the world with one-third of the population residing in North America. Between 1990 and 2002, starlings represented 1.6% of all known aircraft damaging strikes. Of the 36 species groups, starlings were ranked seventh in causing substantial aircraft damage and ranked sixth in causing minor damage. The potential damage to aircraft and economic loss resulting from bird strikes is real. There is another problem; however, associated with aircraft loading bridges which current designs do not address. Starlings, being cavity nesters, are given an endless number of opportunities for nesting sites within loading bridges. Over time, and specifically during summer months, the odor can be overwhelming for passengers unless the airline or airport makes a conscious effort to clean the loading bridges of nesting material several times a year. It has been documented that humans may be prone to serious respiratory diseases by breathing airborne fungal spores that originate in starling fecal matter - putting passengers and employees at risk. Several products, including chicken wire, porcupine wire, mylar tape and electronic control devices have been used in an attempt to address this problem, but with varying degrees of effectiveness

and not without expense. Whether an airport utilizes 10 loading bridges or more than 100, the initial capital expenditures and continued maintenance costs can be significant with no guarantees of performance. The intent of this paper is to energize airport operators, wildlife biologists, and the airline community to work as a team to educate aircraft loading bridge manufacturers industry wide of this problem and provide input for possible solutions. The ultimate goal would be for the redesign of loading bridges and the means of retrofitting existing bridges to exclude starlings from nesting.

(7) CLIMATE CHANGE: IS THERE A SIGNATURE IN THE PATTERN OF BIRD STRIKES?

T. C. Kelly, Department of Zoology, Ecology, and Plant Science, University College, Lee Maltings, Prospect Row, Cork, Ireland; R. Bolger, Aer Rianta, Dublin Airport, Co. Dublin, Ireland; P. D. Bourke, Department of Statistics, University College, Cork, Ireland; M. J. A. O'Callaghan, Department of Applied Mathematics, University College, Cork, Ireland; G. Fennessy and S. Sheehy, Department of Zoology, Ecology, and Plant Science, University College, Lee Maltings, Prospect Row, Cork, Ireland

Several studies, particularly in Britain, have shown that some bird species are now commencing to breed earlier in the year than they did in the past. This marked trend is being associated with climate change. While these changes in phenology may not involve all of the bird species which are hazardous to aviation, the possibility exists that earlier breeding will lead to a change in the monthly pattern of bird strikes-the majority of which appear to involve juveniles (Kelly e*t al* in preparation). This study examines the monthly pattern of bird strikes at Dublin Airport, Ireland from 1970 to 2003. Particular attention has been given to the month in which the peak number of bird strikes occur, and to comparing the patterns in the 1970's, and subsequent decades. The results are discussed in the context of possible climate change effects though the emerging picture is complex and obscured to a certain extent by confounding variables.

(8) COMPARISON OF TWO VEGETATION HEIGHTS FOR WILDLIFE CONTROL ON AIRPORTS

Thomas W. Seamans, Glen E. Bernhardt, and Bradley F. Blackwell, USDA, Wildlife Services, National Wildlife Research Center, Ohio Field Station, 6100 Columbus Avenue, Sandusky, OH 44870 USA; Scott C. Barras, USDA, Wildlife Services, National Wildlife Research Center, Mississippi Field Station, P.O. Drawer 6099, Mississippi State, MS 39762 USA; Jonathon D. Cepek, USDA, Wildlife Services, 6100 Columbus Avenue, Sandusky, OH 44870 USA

Vegetation height management is a potential method to reduce bird numbers on airports. Based on studies in Europe where vegetation management on airfields is generally more intense than in North America, researchers recommended vegetation heights around 15 to 25 cm. However, preliminary studies in the USA produced conflicting results regarding the effect of tall vegetation on bird numbers at airports. From 1999 to 2002, we compared bird and other wildlife use of 4 short- (mean maximum height of 15.6 ± 5.1 SD cm) and 4 tall- (mean maximum height of 29.9 ± 8.4 SD cm) vegetation plots in northern Ohio. We surveyed bird use of the plots 2 to 3 times per week at random starting times from sunrise to sunset. We conducted flush counts once every 2

weeks between May and November. We measured vegetation height and density weekly during the growing season. We conducted surveys of large and medium-sized mammals monthly and conducted small mammal trapping 2 times/year. Vegetation height and density differed between tall-and short-vegetation plots. Dominant vegetation types in both treatments were forbs, grasses, and woody plants. We observed more birds in short- than tall-vegetation plots; however, when hidden birds are accounted for (i.e., via results from flush counts), we detected no difference. Seasonally, bird numbers differed for both observed and hidden birds in the spring, with more birds using the short- than tall-vegetation plots. Small mammal capture rates (per 100 adjusted trap nights) were 0.0 in short plots, 0.3 in tall plots, and 7.4 in control plots. We found no difference in mammals observed in the plots during sunset and spotlight counts. There was slightly more insect biomass in tall- than short-vegetation plots. Mowing affected small mammal use, vegetation characteristics and invertebrate mass of the vegetation plots. Although overall bird use of plots did not differ, we noted species-specific exceptions. The generalization that tall vegetation (> 15 cm) alone reduces bird use of an airport is not supported by the results of our study. Further research on vegetation density and composition in North America is needed to accommodate airfield habitats that are pleasing to the public and repellant to wildlife.

(9) STATISTICAL ANALYSIS OF BIRD STRIKE EVENTS AND GRASS MANAGEMENT TO REDUCE BIRD STRIKES IN TAIWAN

Shaopin Yo, Department of Life Science, National Chung Hsing University, 250 Kuo-Kung Road, Taichung 40227 Taiwan; Kuo-Bin Lin, Tao-Yuan Air Force Base, Taiwan

Bird strikes have been a great safety concern in Taiwan. In order to identify patterns in bird strikes, we reviewed a database of bird strike events recorded by the Air Force of the Department of Defense in Taiwan during 1998 to 2003. About 80% of the strike events were due to environmental causes. The number of bird strike events increased significantly since 1999 and reached a peak in 2003. It coincides with the increasing wildlife protection activities on the coastal areas of Taiwan since 1999. Birds are more vulnerable to aircraft activities in summer (July, August and September) due to the population surge of the resident birds after their reproductive seasons in spring. In general, birds are more active and foraging during the dawn and sunset periods. Although the military training of aircraft taking off and landing was purposely excluded these periods, we found a bimodal bird strike pattern around those times. High bird strike risks were found during 08:00 to 10:00 and 15:00 to 16:00. The habitat management activites, such as grass mowing and agricultural activities during the day around the vicinities of the air force bases may contribute to these phenomena. In order to evaluate the impact of habitat manipulation on the bird activities at airfields, we carried out a habitat manipulation experiment and monitored bird activity in short grass and long grass habitats at Tao-Yuan air force base from 2002 to 2003. Bird activities, including bird species number and bird total population counts, were significantly less in the long grass habitat than those of the short grass habitat. Therefore, carefully designed habitat management tactics might greatly effect and reduce bird strike risks at the air force bases of Taiwan.

(10) THE EFFECTIVENESS OF GRASSLAND MANAGEMENT AT TWO SOUTH AFRICAN AIRPORTS

Albert Froneman, Airports Company South Africa – Endangered Wildlife Trust Strategic Partnership, Endangered Wildlife Trust, Private Bag X11, Parkview, 2122, South Africa

It is widely acknowledged that grassland management is an effective pro-active method for controlling bird presence on airports. The unique partnership program between the Airports Company South African and the Endangered Wildlife Trust has overseen vegetation / grassland management programs at several airports in South Africa. Two airports (Johannesburg and Durban International) were considered in a comparative study investigating the effectiveness of overall versus partial grassland management on the airfield. Bird species presence and abundance information over time was used to assess the effectiveness of airfield grassland management in terms of the following: a) Grassland management across the entire airfield at Durban International Airport vs. partial grassland management at Johannesburg International Airport; b) Effects of grass height to minimise the presence of high risk species and improve the effectiveness of other reactive bird control methods; c) Selective herbicide (*Outpace super – Species Switch*) treatment to control grass height. Results indicated that grassland management across the entire airfield is more effective in reducing high risk bird species at Durban International Airport than the partial approach taken at Johannesburg International Airport. The habitat variability created on an airfield using partial grassland management attracts more bird species. The effectiveness of reactive bird control methods are also negatively effected as birds can hide away in the excessively tall grass as was the case with Guineafowl at Johannesburg International Airport. Grass height was found to be a determining factor in the effectiveness of grassland management. Chemical treatment to maintain a specific grass height can reduce grass cutting costs. This study concluded that it is most effective to manage large parts of the airfield grassland habitat at a height of about 25 cm for airports in South Africa.

(11) EFFECTS OF MOWING ON THE PRESENCE OF GRASSLAND RAPTORS

Kerry J. Fitzpatrick, Biological Sciences Program, University of Maryland, 9630 Gudelsky Drive, Rockville, MD 20850 USA

The purpose of this study was to determine how mowing affects use of grasslands by raptors and the underlying mechanisms for those habitat preferences. The goal was to provide management recommendations for either encouraging or discouraging the presence of raptors. The treatments were a factorial of 3 mowing frequencies and 3 heights of cut, plus an un-mowed control. The treatments were each applied to a 72 m diameter circle of grassland and replicated at 5 sites. A pole, with a timer on top, was located at the center of each plot, and was used to record raptor perch use. Perch times were used as measures of habitat preference. Perch times and measures of vegetation height, density and percent cover were recorded monthly for one year. Diurnal and nocturnal use was estimated by recording perch times at sunrise and sunset for three consecutive days. Biomass of insects was measured in June, July and August. Grasshopper flush counts and small mammal trapping surveys were conducted in October. Mowed grass had more raptor use than un-mowed, with maximum use occurring at the 20 cm cut. Grass cut at three or six times per season had more use than grass cut zero or one time per season. Frequency and height of mowing and their interaction, together, were a significant factor in habitat selection for all months of the year. Grass cut at 20 cm between 3 and 6 times per season had more than double

the use of the unmowed grass. Vegetative structure had the largest effect on raptor habitat selection, while prey abundance had a relatively weak effect. Day and night use of study plots was not significantly different. These results suggest that where grassland raptors are a hazard to aviation, raptor presence can be managed by altering the mowing regime.

(12) AN EXPERIMENTAL APPROACH TO REDUCE AVIATION SAFETY HAZARDS ASSOCIATED WITH OSPREY ACTIVITY AT LANGLEY AFB, VIRGINIA

Thomas J. Olexa, USDA, Wildlife Services, 1 FW/SE, Langley AFB, VA 23665 USA

Osprey (*Pandion haliaetus*) are becoming a serious aviation safety concern to both military and civilian aircraft. Since 1985, the United States Air Force (USAF) documented 20 osprey strikes resulting in excess of $1 million dollars in aircraft damage. In 20% of reported osprey strikes to the FA National Wildlife Strike Database, the aircraft was destroyed or sustained substantial damage. Osprey are present at Langley Air Force Base (LAFB) from March through September where over two-dozen nesting pairs have been identified to occur on or immediately adjacent to the airfield annually. The tolerant nesting and breeding behavior of osprey predisposes this species to impacting aircraft arriving or departing LAFB. The apparent strike risk and flight safety concerns associated with nesting osprey resulted in the research and development of an Integrated Osprey Hazard Management Program (IOHMP) at LAFB. As part of the 1st Fighter Wing Bird Aircraft Strike Hazard Plan, the IOHMP incorporated a diverse management approach that included nest surveys and behavior monitoring, exclusionary flagging, nest removals, egg oiling, traditional hazing, lethal reinforcement and nestling translocation. Preliminary analysis of the IOHMP suggests the number of nest sites remain constant (24-31) from year to year, however airfield use declined 83% since the inception of the program. Exclusion flagging, egg oiling, and juvenile translocation are presumed to be the most effective strategies in discouraging nesting while reducing airfield use. Although airfield occurrence has reduced, the relative risks associated with nesting osprey continue to pose a hazardous environment for LAFB flight operations. The IOHMP will continue to integrate new control and monitoring techniques in an effort to determine a specific osprey nest "free-zone" on and surrounding the Langley airfield. The project will ultimately serve as a technical guide for managing osprey-aviation conflicts for professional wildlife damage agencies, aviation safety personnel, and natural resource managers.

(13) MANAGEMENT OF AUSTRALIAN WHITE IBIS IN AUSTRALIA: HOW TARGETED RESEARCH CAN IMPROVE POPULATION MANAGEMENT

N. J. Murray and P. P. Shaw, Ecosure, PO Box 287 Tugun, QLD 4224, Australia.

A dramatic increase in the number of urban Australian White Ibis was recorded between 1989 and 1995 in South-east Queensland. The destruction of a Qantas Airbus engine due to the ingestion of an Australian White Ibis in 1995 triggered the formation of a multi-stakeholder committee to guide the monitoring and management of the regional Australian White Ibis population. The program, which has now been running for seven seasons, is centered on a region-wide program of food reduction, restriction of breeding success and public education. Since first described at Bird Strike '99 (Vancouver, Canada), the program has been improved

through ongoing targeted research aimed at increasing our knowledge of the species and, therefore, enabling modification of the management program to increase efficiency. Results of research into the breeding biology of Australian White Ibis in urban areas enabled us to reduce the visitation rate to managed breeding colonies through knowledge of the incubation period and timing of breeding. The importance of landfills to Australian White Ibis in urban areas was determined through biannual surveys of foraging birds at non-landfill sites and monthly counts of ibis at the regions main landfills (1995-2003). Following the closure of the regions main putrescible waste disposal site, a significant increase in the number of ibis foraging at non-landfill sites was observed. Currently, a research project aimed at investigating urban habitat use through the use of radio-tracking is being undertaken. This paper describes research projects, and demonstrates how targeted research aimed at gaining information into the natural history of a species assists in the formulation of an efficient, and therefore economically sound, management program.

(14) USE OF FENCING TO DETER IGUANAS FROM AIRPORT RUNWAYS AT LUIS MUNOZ MARIN INTERNATIONAL AIRPORT

Pedro F. Quinones, USDA, Wildlife Services, 353 ST QP-19, Country Club, Carolina, Puerto Rico 00982 USA; Richard M. Engeman, USDA, Wildlife Services, National Wildlife Research Center, 4101 LaPorte Ave, Fort Collins, CO 80521 USA

In recent years, the exotic green iguana, a 4- to 6-foot long lizard, has become well established in Puerto Rico. Numbers have become especially high around Luis Munoz Marin International Airport (SJU) where habitat is ideal for iguanas. For most of the year, few iguanas enter the runway area, however during breeding season (January – May), hundreds of iguanas invade the area to breed and lay eggs. During this time, operations on portions of the airfield have to sometimes be halted due to hazards presented by iguana incursions to aircraft traffic areas. Five records of collisions with iguanas are recorded in the FAA wildlife strike database; all of them are from SJU. SJU contracted with the USDA to seek ways to prevent iguanas from getting into the runway areas. Wildlife Services surveyed the runway areas beginning in January to identify areas with most iguana activity. Once this was established, we installed a 1,000-ft. long three strand electric fence with a solar powered charger. The fence ran parallel to one of the runways. The bottom strand was 3 inches from the ground; there was 6 inch spacing between the other two strands. Rather than being repelled by the electrical charges, the iguanas charged straight forward through the wires. We put up a one foot high chicken wire fence 6 inches behind the electric fence. In addition, we extended the chicken wire fence another 1,000 feet and increased the height to 2 feet. The one foot high fence was attached to the electric fence so that it was electrified. Both fences reduced intrusions by iguanas; however, the 2 foot high fence was superior to the one foot high and electrical fence. Additional fence designs are being tried. Iguanas are becoming more problematic as they become introduced into different areas. The problem at airports may become more common in the future.

(15) USING SYSTEM SAFETY TO MANAGE WILDLIFE HAZARDS: CANADA GEESE AS A CASE STUDY

Kristi Russell and Bruce MacKinnon, Transport Canada, 330 Sparks Street, Place de Ville,

Tower C, Ottawa, Ontario, Canada K1A ON8; Terry Kelly, SMS Aviation Safety Inc., 275 Slater Street, Suite 900, Ottawa, Ontario, Canada K1P 5H9

The North American Canada Goose population is growing significantly, in large part because of a near-exponential increase in the number of temperate-breeding geese. A study was conducted to assess whether the associated risks to aviation in the Greater Toronto Area (GTA) are being managed appropriately and effectively. The GTA is the location of numerous airports, including Toronto Pearson International Airport, Canada's busiest. It also features habitat that is particularly attractive to temperate-breeding geese. A risk-based framework was developed using avifauna and operational information, that when applied, illustrated that land-use by non-aviation stakeholders, and in particular the municipalities, contributed significantly to the aviation risk associated with Canada Geese. The study concluded that the aviation safety-risks in the GTA are not being managed so as to reduce the aviation risks to levels that are as low as reasonably achievable. The need to significantly modify the individual and collective policies, procedures and practices of numerous aviation and non-aviation stakeholders was highlighted. Two federal government departments, one provincial ministry, numerous municipal governments – including the City of Toronto - four airports and numerous commercial enterprises were implicated. Nevertheless, it was concluded that the aggressive adoption of a system safety approach could reduce the level of aviation risk and yield efficiencies in resource expenditure. Many of the municipalities currently operate goose management plans, but they do so with little or no coordination, and almost universally with no consideration for the related aviation risks. The system safety approach would enable the potential risks to be identified, verified and assessed; mitigating activities planned, coordinated, implemented and evaluated; information shared; and where necessary, activities re-directed. The findings – based on a pressing aviation safety imperative – will challenge GTA aviation and non-aviation stakeholders alike to work together to manage wildlife hazards as never before.

(16) NOT AT OUR AIRPORT: A PLANNER'S APPROACH TO INTEGRATED WILDLIFE MANAGEMENT

Robin Bowie, Maryland Aviation Administration, Division of Environmental Planning, Baltimore/Washington International Airport, P.O. Box 8766, BWI Airport, MD 21240 USA

Approximately nine miles from the Chesapeake Bay and near the Atlantic flyway, BWI Airport has faced its share of wildlife challenges. MAA has learned that although much of the published guidance in FAA advisory circulars and manuals can prove helpful in providing airport operators with advice about the conditions that attract wildlife, the guidance often provides only retrofit solutions or strategies for removing habituated wildlife populations and their habitats. Rarely does it provide solutions for implementing strategies throughout the airport or strategies for preventing the creation of wildlife attractions in the first place. During the past five years, MAA's Environmental Planning Division has developed a proactive, programmatic approach to preventing and eliminating wildlife attractions airport-wide through the cooperation of nearly every airport division and the involvement of its design consultants. In its presentation, MAA's Environmental Planning Manager will discuss how MAA's integrated wildlife management strategies have become an inherent part of the facilities planning process. The presentation will include MAA's efforts to prepare resource management plans to identify potentially hazardous

conditions; educate regulators about potential wildlife hazards associated with an aviation environment and special permitting considerations; educate design consultants through the creation of design guidance and adaptation of technical specifications to address wildlife hazard management during project design; review engineering and construction documents at each design milestone to eliminate potential wildlife attractions; provide environmental oversight to apply wildlife hazard management strategies throughout the construction process; and educate tenants about wildlife attractions through the use of Tenant Directives in leases. The presentation will describe the challenges and successes in developing an interdisciplinary program. It will include the contents and implementation of its technical guidance for design and engineering consultants, and MAA's ongoing efforts to provide strategic hazard management strategies through inter-departmental policies and procedures that apply to nearly every aspect of airport operations.

(17) **MANAGING OFF-SITE WILDLIFE HAZARDS IN YOUR AIRPORT NEIGHBORHOOD (OR MR. ROGERS MEETS THE FAA)**

Lisa Harmon, Senior Environmental Planner, Jones & Stokes Associates, 2600 V Street, Sacramento, CA 95818 USA

FAA Advisory Circular (AC) 150/5200-33, "Hazardous Wildlife Attractants on or Near Airports," states that "Airport operators should be aware of proposed land use changes, or modification of existing land uses, that could create hazardous wildlife attractants within the separations identified in the siting criteria." This responsibility can pose challenges to airport operators for many reasons: site-specific evaluation criteria are not available from FAA; the surrounding area may include jurisdictions in which airport operators have little influence; and sufficient resources may not be available to identify, track, and evaluate proposed development for its potential to create wildlife hazards. The Maryland Aviation Administration (MAA) has seized upon the aggressive development that has occurred in the area surrounding Baltimore/Washington International Airport (BWI), and has addressed this development as an opportunity to pioneer efforts in off-site wildlife management. The presentation will document MAA's multi-faceted approach to develop a streamlined wildlife hazard review process with local planning departments and State permitting agencies. MAA will describe how it reviewed existing federal, state, and local legislation and policies to identify the limitations of its influence on nearby land use, and how it has enhanced its role to actively participate in the design review and permit approval processes performed by local jurisdictions. MAA will present two case studies: one will describe MAA's approach to reviewing and influencing landscaping decisions associated with the development of a new shopping mall; the second will present the special guidance and criteria MAA developed for use by County Planning Officials and permitting agencies when reviewing proposed development within the Airport Zone. The presentation will also disclose the challenges that MAA has faced, such as: outcries from the development community; expenses involved in developing and implementing the wildlife hazard review process; and the need to allocate specific budgets and resources to evaluate plans promptly.

(18) **MARYLAND AVIATION ADMINISTRATION'S APPROACH TO STORMWATER MANAGEMENT**

Eileen K. Straughan, Straughan Environmental Services, Inc., 9135 Guilford Road, Suite 100, Columbia, MD 21046 USA

The Maryland Aviation Administration (MAA) serves as the landlord for the properties that comprise Baltimore/Washington International (BWI) Airport in Anne Arundel County and Martin State (MTN) Airport in Baltimore County, and acts as a steward for the natural systems and resources on its properties. While MAA's fundamental obligation is to provide a safe transportation facility for the traveling public, it is committed to providing the needed facilities in a manner that is environmentally responsible and complies with local, State, and Federal environmental regulations. State regulations regarding stormwater management (SWM) are particularly stringent in part due to the proximity of these aviation facilities to the Chesapeake Bay. In order to meet stormwater management goals and to ensure the safety of the traveling public, MAA has prepared comprehensive stormwater management plans for both BWI and MTN airports and developed guidance for engineers designing SWM facilities at these airports. This presentation will focus on how the comprehensive plans were developed, and how they will be used as guidance in future SWM facility design to avoid the creation of open water that could potentially attract hazardous wildlife.

(19) INTERAGENCY COOPERATION IN THE RIO SALADO RESTORATION PROJECT TO MITIGATE WILDLIFE HAZARDS AT PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Krista M. Wenning, Diane E. Winterboer, Michael A. Pacheco, and David L. Bergman, USDA, Wildlife Services, 8836 North 23rd Avenue, Suite 2, Phoenix, AZ 85021 USA

The Rio Salado Restoration Project (RSRP) is a cooperative effort by the U.S. Army Corps of Engineers (USACE) and the Cities of Phoenix and Tempe to develop and restore native wetland and riparian habitats historically associated with the Salt River in Phoenix, AZ. In addition, this project will provide outdoor recreation and educational opportunities to residents of the Cities of Phoenix and Tempe. However, the much of the restoration efforts for the RSRP fall within 5 miles of Phoenix Sky Harbor International Airport (PHX). Thus, the restoration of these wetland habitats in an otherwise arid environment could attract waterfowl and other birds hazardous to aircraft operations at PHX. This is especially true given that this section of the Salt River is a historic natural flyway for migrating birds. The USDA Wildlife Services Arizona office has been tasked the responsibility of identifying and monitoring wildlife hazards to aviation associated with the RSRP, to conduct Wildlife Hazard Assessments for the projects, and to provide recommendations to minimize wildlife hazards at PHX. In addition, the U.S. Fish and Wildlife Service, Federal Aviation Administration, Arizona Game and Fish Department, and other federal and state agencies have responsibilities related to the project and the associate wildlife. Cooperation and communication among all these agencies and offices, each with differing missions and responsibilities, particularly during the design and development stages of the RSRP have been essential to the success of the RSRP and efforts to mitigate wildlife hazardous to safe aircraft operations at PHX. Examples of interagency cooperative actions to mitigate hazards include limiting wetland habitats within the 10,000 foot critical area of PHX, construction of low-flow channels to minimize pooling of water and selection of native xeric vegetation for restoration efforts.

(20) WASHINGTON DULLES INTERNATIONAL AIRPORT CONSTRUCTION AND ITS IMPLICATIONS ON WILDLIFE DAMAGE MANAGEMENT

David Allaben, USDA, Wildlife Services, Reagan National Airport, Airport Operations (MA 110), Washington, DC 20001 USA

The construction boom, starting in 1999, at Washington Dulles International Airport (IAD) has caused airport management and wildlife managers to re-assess wildlife damage management strategies on a regular basis. IAD is currently developing an Environmental Impact Statement (EIS) for the airport expansion project that will encompass two additional runways with attaching taxiways, two terminal buildings, a subway system, an air traffic control tower, and supporting roads and structures. Since 2000, USDA Wildlife Services (USDA WS) has been involved in the planning and development phase of construction projects to reduce the creation of wildlife attractants. USDA WS has worked with airport management on the construction of seven new detention ponds, educating contractors on the proper installation of temporary fence when the permanent security fence was breeched due to construction, planting of non-palatable ground covers in disturbed areas, and ensuring displaced wildlife from lost habitat would not gain access to the AOA (and have a plan in place to alleviate the problem if this occurred). Increased surveillance of the AOA security fence and maintenance of any breeches, alleviation of airfield attractants (e.g., temporary standing water and wildlife food sources), and removal of all woodland habitats were components of the plan. Increased human activity associated with the construction was both beneficial and detrimental to wildlife management. Benefits included having more eyes on the airfield during working hours to identify hazardous wildlife conditions, whereas detriments were increased vigilance and safety of construction workers and their equipment in the control of wildlife and entrance points left open for easy vehicle access (and potentially wildlife). The construction at IAD has forced construction planners, airport engineers, airport management, and wildlife managers to learn the diverse intricacies of airport construction. Ultimately, this will foster a long-range integrated wildlife damage management plan into all phases of airport construction for the ever-changing airport environment.

(21) BEHAVIORAL RESPONSE OF GULLS TO A LETHAL CONTROL PROGRAM AT A NEW YORK AIRPORT

Scott C. Barras, USDA, Wildlife Services, National Wildlife Research Center, Mississippi Field Station, P.O. Box 6099, Mississippi State, MS 39762 USA; Richard A. Dolbeer, USDA, Wildlife Services, 6100 Columbus Ave., Sandusky, OH 44870 USA; Richard B. Chipman, USDA, Wildlife Services, Castleton, NY 12033 USA

An airport in southeastern New York reported 80-315 bird-aircraft collisions annually from 1979-1999, causing millions of dollars in damage to aircraft and resulting in 65 aborted take-offs and 60 damaged engines. U. S. Department of Agriculture (USDA) biologists initiated a management program in 1991 to reduce strikes by shooting gulls (*Larus* sp.) attempting to fly over the airport. In 2000 and 2001, we documented behavioral responses of great black-backed gulls (*L. marinus*), herring gulls (*L. argentatus*), laughing gulls (*L. atricilla*) , and ring-billed gulls (*L. delawarensis*) to active shooting stations, simulated shooting stations, and concealed

observers along the south boundary of the airport to determine if gulls exhibited general or species-specific avoidance of shooting stations. We counted gulls within the 150-m radius sampling area around the observation points during 21, 2-hr observation periods per year. Of the gulls included in this study, fewer approached within 50 m of the observation points when shooting occurred than during other treatments. Preliminary analyses indicate that negative behavioral responses were more frequent during the shooting treatment for black-backed gulls, herring gulls, and laughing gulls. These findings suggest that in addition to lethal effects, shooting has a general non-lethal hazing effect on gulls in the airport environment.

(22) URBAN CANADA GOOSE MANAGEMENT IN WESTERN WASHINGTON: USING A UNIFIED POLITICAL APPROACH

Roger A. Woodruff, Laurence M. Schafer, and Michael A. Linnell, USDA, Wildlife Services, 720 O'Leary St., NW, Olympia, WA 98502 USA

Like many other urban areas throughout the United States, western Washington has experienced substantial increases in resident Canada geese, potentially leading to more birdstrikes at the 11 airports located within King, Snohomish, and Thurston counties. Two coalitions were formed in 1989 and 1998 in King/Snohimish County and Thurston County, respectively. These committees were comprised primarily of county and city officials, state and federal wildlife biologists, and park managers. In addition, input was also solicited from hunters, bird conservation groups, and animal rights groups. Following numerous meetings, goose population estimates were developed, problem areas were identified, and management objectives and alternatives were established. An integrated goose control plan was initiated, which included habitat management, public education, egg addling, harassment, and relocation of geese to other locations in the state. It soon became apparent that egg addling and habitat management alone were not sufficient to suppress the population, whereas relocation and harassment simply transferred the problem to someone else. In 1999, the decision was made to use lethal removal to reduce regional populations of urban Canada geese to more acceptable levels. From 2000 to 2003, 10,813 geese were removed from urban areas of western Washington upon request of the individual property owners where geese were causing damage. Reducing goose numbers at problem locations has augmented the effectiveness other methods (e.g., egg addling, harassment, and habitat management). Since the implementation of lethal control, Canada goose complaints are down, park use is up, and city, county, and private residents continue to express their approval of the program's success. Canada goose strikes within the project area declined from 11 strikes between 1995 and 1999 to 4 strikes between 2000 and 2003 (2.2 and 1 per year, respectively). The regional committees continue to implement an integrated goose control program, but the amount of lethal control has been substantially reduced as urban goose populations approach target levels. The selective removal of geese from problem locations has been a successful component of an integrated management program and should continue to be implemented, if and when necessary, to maintain urban goose numbers at levels acceptable to the public.

(23) PROGRESS WITH ENDOPHYTES IN GRASSES FOR THE AVIATION INDUSTRY

Chris G.L. Pennell and M. Philip Rolston, AgResearch Limited, Canterbury Agriculture & Science Centre, P O Box 60, Lincoln, Canterbury, New Zealand

AgResearch in New Zealand is conducting research into the mutualistic association of endophyte fungi and host forage-based grasses, particularly regarding the secondary metabolites produced by this association. We examined the effect of feeding grass-endophyte associations to Canada geese *(Branta canadensis)* and found wide variation in the feeding response based on the endophyte and host plant in ryegrasses. Material that contained high concentrations of the metabolite ergovaline produced a malaise in "naïve" geese that was remembered over time when the "learned" birds were re-exposed. This was not the case with fescue species also containing ergovaline. We are developing a specialist turf-type grass with novel endophytes that has the properties to induce malaise in herbivorous birds. These endophytes contain metabolites that discourage insects and help protect the plant from drought and low nutrient availability. Preliminary demonstration plots of this species sown at Christchruch International Airport in 2000 have yielded encouraging results in reducing insect concentrations; however, specialist grasses that require low maintenance now must be developed. Observations of bird behavior show birds loiter on the bitumen and the grass verge during early mornings and late evenings. The heat sink involved by the proximity of the tarmac surface to the grass verge might provide warmth and a source of food for grazing birds. Also, aircraft movements might distribute wind born insects to the grass verge, increasing the possibility of bird strikes. The major features of grassland cover that effect the invertebrate fauna are the endophyte, botanical composition, sward structure, soil properties, soil moisture and climate. Water run off from runways and taxiways will encourage plant growth and thus increase insect diversity and populations. Future studies involving the collection of insects in relation to the grass verge was started in the autumn of 2004 at Christchurch International Airport.

(24) WATCHING GRASS GROW: EXCITING POSSIBILITIES WITH VEGETATION MANAGEMENT TO REDUCE WILDLIFE HAZARDS AT AIRPORTS

Brian E. Washburn and Thomas W. Seamans, USDA, Wildlife Services, National Wildlife Research Center, Ohio Field Station, 6100 Columbus Avenue, Sandusky, OH 44870 USA; Scott C. Barras, USDA, Wildlife Services, National Wildlife Research Center, Mississippi Field Station, P.O. Box 6099, Mississippi State, MS 39762 USA

Wildlife-aircraft collisions (wildlife strikes) pose a serious risk to aircraft and cost civil aviation in the United States an estimated $490 million annually. Managing habitats within airport environments is the most important long-term component of an integrated approach to reduce the use of airfields by birds and mammals. In contrast to traditional habitat management practices to benefit wildlife, the focus on airfields should be to develop plant communities and habitats that are unattractive to wildlife and that do not provide food and cover. For example, planting and enhancing endophyte-infected tall fescue might be favorable in situations where deterring wildlife from using areas, such as airfields and golf courses, is the desired goal. We conducted a study to determine if Canada geese exhibited a feeding preference between endophyte-infected tall fescue and a perennial ryegrass mixture. The behavioral responses of captive geese to the two vegetation types were observed during the first (2001) and third (2003) growing seasons

following seeding of grasses. During 2001, Canada geese showed no foraging preference between the fescue and ryegrass plots. However, after two additional growing seasons, the tall fescue formed a monoculture in the fescue plots. During 2003, Canada geese fed almost exclusively in the ryegrass plots and avoided foraging the tall fescue plots. Our findings suggest tall fescue might be a favorable species for airfields and other areas where Canada geese are unwanted. For renovations and new seedings on airfields, plants should be carefully selected that are not attractive to wildlife, are adapted to the local climate and soils, and can be maintained (e.g., mowing). Additional research is needed to better define existing and new plants (e.g., grasses, trees) and their management that will readily establish in the various geographic regions in the United States but are undesirable to wildlife.

(25) **THE WILDLIFE HAZARD CONTROL TOUR OF BWI: RESULTS OF FIVE YEARS OF COOPERATIVE EFFORTS BETWEEN MARYLAND AVIATION ADMINISTRATION AND USDA, WILDLIFE SERVICES**

Kendra Cross, USDA, Wildlife Services, 1568 Whitehall Road, Annapolis, MD 21401 USA

USDA entered into a cooperative service agreement with MAA at BWI Airport and Martin State Airport in October 1999 to help alleviate hazards found on/near the airport environment. As an operating condition required by CFR 139, BWI Airport has an FAA approved Wildlife Hazard Management Plan that serves as a guideline to MAA personnel at both airports. USDA and MAA have been working together to develop unique habitat management techniques for new construction and future development, land use planning, effective bird barriers and exclusion devices on MAA property, and to provide continuous education and awareness to airport tenants and vendors. The outdoor field trip at BWI will begin at the newly constructed Consolidated Rental Car Facility. After reviewing many building plans, USDA recommendations, FAA guidance, Maryland's land use regulations to identify wildlife hazard management goals, and the scope of MAA's authority to evaluate public and private development projects within the BWI Airport Zone, the goal of avoiding a possible influx of wildlife populations was accomplished. On the airfield, solutions to problems have included the use of exclusion netting and wire grid systems. The BWI Fire & Rescue building that was infested with Barn Swallows alleviated their problem with the use of exclusion netting. During the Wildlife Hazard Assessment in 2000, the stormwater management pond located adjacent to the fire department was found to attract large flocks of geese throughout the year. BWI successfully installed an overhead wire grid system (10 x 5 ft. spacing) to deter geese. USDA and MAA continue to be proactive and resourceful in their efforts to provide a safe environment for the traveling public and to accommodate BWI's dynamic changing environment.

(26) **TOWARD AN INTEGRATED NORTH AMERICAN BIRD AVOIDANCE SYSTEM: ORGANIZATIONAL AND TECHNOLOGY UPDATE**

Russell P. DeFusco, BASH Incorporated, 5010 Lanagan Street, Colorado Springs, CO 80919 USA

A disproportionate amount of bird strike damage to both civil and military aircraft occurs off versus on airfield property. As bird control efforts or population management can rarely be

accomplished in the off-airfield environment, avoiding birds in flight remains the only viable option. Progress has been made in this area, but much remains to be done. Bird avoidance in time and space is scale dependent. Long range planning can be addressed by such systems as the USAF's Bird Avoidance Model. Near real time, regional advisories are provided by the Avian Hazard Advisory System. Real time and localized advisories are addressed with mobile avian radars, airport surveillance radars, and other systems under research and development. Effort is now underway to integrate all these disparate systems under one overarching umbrella for Canada and the United States. The USAF Academy Institute for Information Technology Applications now hosts a new program to consolidate such efforts. The US BAM and the new Alaska BAM are maintained and updated, new integration of BAM and AHAS internet map server applications, development of small to large scale bird detection radars, and communication networks for control programs and ultimately to be projected into cockpits fall under the new research and development purview. Department of Defense, Federal Aviation Administration, Transport Canada, Canadian Defense Forces, and various contractors are initial participants in the efforts. The ultimate goals are to end competition and incompatibility between systems and to create a unified North American Bird Avoidance System for all users.

(27) CURRENT STATUS OF THE GERMAN REAL TIME BIRD AVOIDANCE SYSTEM

Wilhelm Ruhe, Bundeswehr Geo Information Office, Biology Section, Mont Royal, D-56841 Traben-Trarbach, Germany

Collisions between birds and aircraft are a serious flight safety issue especially in military low-level flight operations. Remote sensing techniques using radars are the most sophisticated and efficient methods available to continuously monitor bird concentrations in a broad spatial coverage. Data from the operational German Air Defense Radar System Network has been made available and a system has been employed to detect bird flocks during migration. This information provides the main data source for the real time Bird Hazard Warning System, a system that became extraordinarily efficient in bird avoidance. Military 3-D air defense radar technology has proven optimal because of its specific design towards individual target recognition and high resolution in all three dimensions. Altitudinal information on bird concentrations is extremely important during migration periods, as enormous bird concentrations have been observed in altitudes even beyond 10,000 ft AGL, an altitude not usually considered as potentially dangerous in respect to bird collisions. Using existing technology and infrastructure whenever possible makes the avoidance system extremely cost effective. Recent developments and the implementation of a widely digitized and automated bird strike warning and expert system for data analysis, the existing air defense radar network, as well as the cooperative use of communications networks provides real time bird strike warning messages (BIRDTAM=Bird Notices to Airmen in analogy to NOTAM) to decision makers and pilots directly into the cockpit. According to German Military Flight Operations Regulations jet aircraft operations are prohibited in valid BIRDTAM regions. Both, reliable BIRDTAM and strict regulations proved to be the best bird strike avoidance strategy in military aviation. In civil aviation BIRDTAM messages are delivered to pilots via air traffic control networks, raising their level of awareness and preparedness. An outline on the technical and organizational structure of the German Forces currently operated real time bird hazard warning system will be presented.

(28) **DISTRIBUTING BIRD HAZARD INFORMATION TO AVIATORS FOR RISK MANAGEMENT: THE WIRELESS FUTURE**

T. Adam Kelly, DeTect, Inc, 621 W. Baldwin Road, Panama City, FL 32405 USA

The United States Air Force (USAF) Avian Hazard Advisory System (AHAS) provided the first mechanism for aircraft pilots to obtain information about the number of birds hazardous to aircraft active in the atmosphere. AHAS is a near real time system that can update no more frequently than once every 6-10 minutes due the volume scanning strategies of the NEXRAD (WSR-88D) radar system. Dedicated bird radar systems such as the Merlin radar, can update as frequently as once every 2-3 seconds, essentially a real time warning system. The challenge becomes how to get real time and near real time information to pilots and decision makers so that bird strikes can be avoided. Mechanisms for transmitting data to aircraft both on the ground and in the air will be discussed. These mechanisms have important implications for future bird strike hazard reduction.

(29) **AUTOMATED ACOUSTIC MONITORING OF BIRD STRIKE HAZARDS**

Sebastian M. Pascarelle and John Pinezich, Advanced Acoustic Concepts, Inc., 7100 Columbia Gateway Drive, Columbia, MD 21046 USA; Ronald L. Merritt and T. Adam Kelly, DeTect, Inc., 621 West Baldwin Road, Panama City, FL 32405 USA; Barclay Roman, Applied Hydro-Acoustics Research, Inc., 5885 Trinity Parkway, Suite 230, Centreville, VA 20120 USA; Robert C. Maher, Montana State University, P.O. Box 173780, Bozeman, MT 59717 USA

Bird-aircraft collisions present a significant threat to military and commercial aircraft, and as bird populations and air traffic continue to grow, and airport/airbase operations continue to expand, the problem will steadily get worse. A majority of the efforts to solve this problem focus specifically on bird mitigation via, e.g., wildlife and environmental management. However, the first step in birdstrike mitigation is timely and accurate detection of avian threats in airport and airbase environments. Rapid detection ensures maximum response reaction time, and correct identification of bird threats ensures that resources are not expended in responding to false alerts. We propose a hybrid birdstrike hazard monitoring system consisting of (1) a set of highly sensitive passive acoustic arrays, adapted from state-of-the-art undersea warfare sensor technology, which can provide accurate source detection, location, and tracking, (2) a radar surveillance system built specifically for bird monitoring (currently available as a commercial system from Detect, Inc.), and (3) a steered parabolic dish or horn-loaded microphone providing high gain, low side-lobe acoustic data for accurate source classification. The system will fuse the outputs of the acoustic and radar detectors to generate a more accurate picture of birdstrike threats than either sensor type can produce on its own. Work on this project is being supported by an Air Force Phase 2 STTR (topic AF02T009).

(30) **SECRETS IN THE FREEZER: STOMACH ANALYSIS OF STRUCK BIRDS PROVIDES CLUES TO AVIAN ATTRACTANTS AT AIRPORTS**

Marsha Barden, USDA, Wildlife Services, 59 Chenell Drive, Concord, NH 03301 USA; Glen Berhnardt, USDA, Wildlife Services, National Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870 USA; Dennis Slate, USDA, Wildlife Services, National Rabies Program, 59 Chenell Drive, Concord, NH 03301 USA; Andrew Pomeroy, Pease International Airport, 36 Airline Avenue, Portsmouth, NH 03801 USA

The more specific our knowledge of bird attractants at airports, the better able we are to predict bird behavior and potentially reduce and prevent bird strikes. A largely unexploited source of such knowledge is the carcasses of birds struck by aircraft. Stomach contents of 78 bird carcasses from strikes at Pease International Tradeport in Portsmouth, NH over a 6-year period were examined. The carcasses represented the following species: 9 American kestrels (*Falco sparverius*), 1 bank swallow (*Riparia riparia*), 30 barn swallows (*Hirundo rustica*), 1 chimney swift (*Chaetura pelagica*), 2 common nighthawks (*Chordeiles minor*), 8 Eastern meadowlarks (*Sturnella magna*), 4 killdeer (*Charadrius vociferus*), 7 horned larks (*Eremophila alpestris*), 1 Lapland longspur (*Calcarius lapponicus*), 11 mourning doves (*Zenaida macroura*), 1 red-tailed hawk (*Buteo jamaicensis*) and 3 upland sandpipers (*Bartramia longicauda*). No stomach was found in 14 of the 78 carcasses. Two carcasses had empty stomachs. Stomach contents of 62 birds were identified to order and family and, where possible, to sub-family or species. Up to three food items in order of prevalence were identified for each individual. The most common food item identified, as well as the most varied (9 families), was beetles, found in 69% of stomachs. Next came seeds (40%), followed by ants (27%), flies (15%), caterpillars (8%) and wasps (7%). Dates and locations of strikes were correlated with food use. Trends emerged for some species, providing valuable information for predicting increased bird activity and applying effective and appropriate control strategies. Knowledge of timing and availability of food at a particular airport could prove useful in recommending habitat modification to reduce the food attractant or in planning harassment and repellent activities. Wider and longer-term studies of this type are needed to realize the full potential of this tool in reducing bird strikes.

(31) PREY BASE MONITORING AND CONTROL TO REDUCE PREDATORY BIRD STRIKES AT PORTLAND INTERNATIONAL AIRPORT

Sharon E. Gordon, Port of Portland, 7000 NE Airport Way, Portland, Oregon 97218 USA; Gary Witmer, USDA, Wildlife Services, National Wildlife Research Center, 4101 LaPorte Avenue, Ft. Collins, CO 80521 USA

Portland International Airport (PDX) has a history of strikes with wildlife species that are attracted to the airfield because of abundant prey base. From 1997 to 2003, 201 strikes occurred at PDX with wildlife whose primary food source is small mammals, including red-tailed hawks, American kestrels, various owl species, great blue herons, and coyotes. Necropsies of all of these species have revealed that one of their primary food sources is the grey-tailed vole. Rodenticide baiting with zinc phosphide was done for years at PDX, but with no reduction in strikes. The Port of Portland and the USDA National Wildlife Research Center recently assessed the small mammal situation on the airfield, and planned a strategy to reduce the population at PDX. Components of the strategy include studies to better understand the population dynamics, and development of an integrated pest management plan that includes both habitat and population management. The Port of Portland has implemented many parts of the strategy.

With improved trapping procedures, an effective small mammal monitoring protocol has been implemented that provides data on species composition, abundance, and airfield conditions. An effective rodenticide baiting program has been developed that includes pre-baiting with clean grain before the zinc phosphide-treated grain is applied. Additionally, bait is applied only during dry conditions and before grass is mowed in the spring. This dramatically reduced the observations of predatory birds on the airfield in the fall of 2003, and reduced strikes of predatory birds from 19 in 2002 to 13 in 2003. Hence, it appears that the combination of good monitoring data and effective baiting are making progress in the understanding of how prey base populations translate into wildlife strikes at PDX. Other, long-term components of the strategy have yet to be implemented, such as installing barriers to rodent invasion from outside the airfield, or changing the airfield environment from traditional grass cover to other materials that would less support rodent populations.

(32) AGRICULTURE AS A LAND USE TO PREVENT WILDLIFE HAZARDS AT AIRPORTS

Aaron D. Spencer, USDA, Wildlife Services, Midway International Airport, 5150 W. 63 St., Chicago, IL 60638 USA

When considering land use practices at airports, agriculture is rarely selected as a practice to minimize wildlife hazards to aircraft. Agricultural activities can create both a revenue source and cost savings in maintenance to the airport operator. The Federal Aviation Administration (FAA) recognizes these contributions and has issued guidance in Advisory Circular 1500-33 on separations and management of farming operations. In conducting Wildlife Hazard Assessments (WHA) on twelve Illinois airports (with and without agriculture as a land use) surveys throughout the airport were conducted one to four times per month for a period of one year. Wildlife species, number, cover type, and location were recorded during each survey. In comparison to observed wildlife activity on all cover types on the airports, agriculture has been observed to be used less by wildlife than other land uses on the airport. Airport operators remaining cognizant of issues posed by crop selection and proper wildlife mitigation may be able to take advantage of the financial benefits of farming on site as well as reducing the overall attractiveness of the airport to wildlife activity.

(33) A MODEL FOR ASSESSING RISK CATEGORIES FOR BIRDS AT AIRPORTS USING BIRD SURVEY DATA

Phil P. Shaw and N. J. Murray, Ecosure, PO Box 287 Tugun, QLD 4224, Australia

ICAO has amended Annex 14 of the Chicago Convention requiring signatory states to implement Safety Management Systems in the management and operation of aerodromes. With regard to the management of the risks posed by birds to aircraft, there are very few tools available to the airport operator that would satisfy the protocols of the Safety Management System. Here, we describe a model which objectively measures risks and assists airport operators to efficiently resource areas that will diminish risk to the greatest extent. Precise goals and targets can be set for managing the bird strike risk to acceptable levels. Different bird species pose different levels of risk to aircraft operating at airports. Current models for

evaluating such risk are either highly subjective or rely on incomplete data sets, primarily derived from bird strike reports. Our model relies on bird survey data collected from an airport using scientifically rigorous methods. This data and other information on an individual species is divided into the parameters which affect the probability of a strike (population, ability to avoid aircraft, position on airport, and time spent in the air) and those parameters which affect the consequence of a strike (bird mass, flocking tendency and flock size). A database automatically calculates the relative risk, allowing comparison for different time periods of the day or from season to season or from year to year. Comparisons can also be made between different airports where the method has been applied.

(34) THE ROLE OF LOCAL COMMUNITY PARTICIPATION IN THE CONTROL OF BIRD HAZARDS AT ENTEBBE INTERNATIONAL AIRPORT

Gloria Kirabo Bitebekezi, Civil Aviation Authority, P.O. Box 5536, Kampala, Uganda

The location of Entebbe International Airport within Entebbe peninsula gazetted bird sanctuary and on the flight path of migratory bird species moving to and from Africa, makes it one of the most bird strike prone airports in the world. However, the airport has adopted a number of measures and methods to prevent bird hazards from occurring and indeed great success has been registered. Some of the methods of bird control involve participation of local communities around the airport. This paper illustrates the different ways in which the airport authority works with the community to control bird collisions with aircraft at Entebbe International Airport.

(35) SOURCES OF BIRDS CAUSING STRIKES AT JOMO KENYATTA INTERNATIONAL AIRPORT AND PROPOSED MANAGEMENT INTERVENTIONS

S. Mumo Ngene and Milai F. Matha, Kenya Wildlife Service, Langata Road, P.O. Box 42076, Nairobi, Kenya

This study involved identifying sites where birds causing strikes at Jomo Kenyatta International Airport are abundant through talking to airport staff, Nairobi City Council – environment department, and other county councils within the area (i.e. Mavoko). This was followed by visits to the identified sites and recording the number of birds on each site between April-May 2003. The sites include: airport wastes dumping ground and dumping of foodstuffs by hawkers within the airport; Mulolongo livestock slaughter house; Dandora dumping ground (other domestic solid wastes); Dangoretti livestock slaughter house; and Athi River livestock slaughter house. The average number of birds sighted in each area was: Airport (Marabou stork – 10, cattle egrets – 110, and guinea fowls – 50); Mulolongo slaughter house (Marabou stork – 30, cattle egrets – 218, Hadada ibis – 28, and glossy ibis – 15); Dandora dumping ground (Marabou storks – 360, Hadada ibis – 139, and Sacred ibis – 18); Dangoretti slaughter house (Marabou storks – 170, cattle egrets - 29, Cattle egrets 28 and Hadada ibis – 169); and Athi River slaughter house (Marabou storks – 24, cattle egrets – 12, Hadada ibis – 46). During the survey, it was observed that the slaughterhouses were using an open drainage system and were dumping most of the wastes on the open thus attracting a lot of birds. The study recommended that the use of a closed sewage system and recycling of the bones and intestinal contents. A workshop for all site

managers was also recommended, the objective being to educate them on the dangers of having many birds within the vicinity of the airport and the costs of one bird strike.

(36) **PROBLEMS AND PROGRESS: 15 YEARS OF BIRD HAZARD PREVENTION ACTIVITIES AT DAR ES SALAAM INTERNATIONAL AIRPORT, TANZANIA**

Kim M. Howell and Charles Msuya, Dept. of Zoology & Marine Biology, P.O. Box 35064, University of Dar es Salaam, Dar es Salaam, Tanzania

In 1989, a study was begun to identify the species of birds involved in bird strikes at Dar es Salaam International Airport, Dar es Salaam, Tanzania (DIA). Seventy seven species of birds were recorded from the airport, but only eight of these were involved in strikes. 61% of the strikes involved the Black Kite, *Milvus migrans*. A fruit bat was involved in one strike. In addition to specific factors attracting birds and other wildlife to DIA such as reproductive flights of winged termites, many were of a general nature and included lack of control over human activities within the airport area (farming and livestock keeping) as well as problems directly related to aircraft and airport management, such as waste management and vegetation control. A number of recommendations were made at the end of the study in 1991 but these did not immediately result in actions resulting in reduction of the wildlife hazard. A changing socioeconomic climate involving a more friendly investment policy, privitization of the national airline, an increase in the number of locally owned airlines, regional cooperation, adherence to IMF and World Bank policies as well as tightening security due to terrorist activities (on the recommendation of ICAO) made it possible to introduce a number of changes which greatly improved control over the airport grounds. The most important of these was the construction of a concrete block wall that now completely encloses the airport. These changes, as well as the need for compliance to meet international standards of airport safety, have created an atmosphere in which all parties concerned understand the need for greater security and control generally over activities at DIA, especially those concerned with aircraft and passenger safety. This is evidenced by the well attended FAA Safe Skies for Africa workshop and subsequent training and monitoring activities.

(37) **THE BRAZILIAN COMMITTEE FOR AVIAN HAZARD CONTROL: SUCCESSFUL ACTIONS AND OUTCOMES**

Jandrisson Gurgel do Amaral, Brazilian Air Force, Brazilian Civil Aviation Department – DAC, Air Accident Investigation and Prevention Division – DIPAA, R. Sta. Luzia, 651/1001, CEP 20030-040, Rio de Janeiro – RJ – Brazil

The subject addressed in this paper is the presentation of the main actions recently implemented by the Brazilian Committee for Avian Hazard Control around the country. In order to successfully achieve this intent, the paper will briefly present the Committee, the objectives of it, the methodology being applied, the analysis of the dimension of the hazard, the environmental/educational approaches being focused and the results obtained. In addition, the paper will present a status update of the rates of bird collisions in Brazil, as well as some recent incidents related to this issue.

(38) **FORTY YEARS OF GERMAN BIRD STRIKE COMMITTEE**

Heinrich Weitz, Chairman German Bird Strike Committee, Postfach 1162, D – 56831 Traben-Trarbach, Germany

The German Bird Strike Committee (GBSC) was founded in 1964 as a loose federation following a suggestion given by the German Minister of Traffic. Representatives from different areas of aviation as well as biologists became members of this new organization. On 1st January 1981 the GBSC obtained the legal status as a non-profit organisation, defined by its statute. Since 1st January 1994 the GBSC, (which is guided by an elected executive committee) installed a permanent office in Traben-Trarbach, Germany and recruited an acting director (with scientific background), who is assisted by a second scientist and a clerk. Long-term funding is mainly provided by the German Airports Association, receiving individual advice on current (and general) biological flight safety problems as well as updates on existing ecological expertise about the airports and their surroundings. A close co-operation exists and is vital between the GBSC and the German Bundeswehr, especially on the field of radar based bird observations. The presentation will include an overview on the tasks and the organisation structure of the GBSC. Additional information will be given on programs and funding issues and the way in which the Committee is acting on behalf of the German government.

(39) **BSC-USA AIRPORT WILDLIFE MANAGEMENT TRAINING PROGRAM: A FINAL UPDATE**

John E. Ostrom, Metropolitan Airports Commission, Minneapolis-St. Paul International Airport, 4300 Glumack Drive, Suite 3000, St. Paul, MN 55111 USA

Bird Strike Committee-USA is finalizing the development of a formal multi-level training program for all individuals involved in airport wildlife management. This training program will provide the basic necessary information; tools and resources to those persons interested or involved in wildlife management at airports. These two programs are designed and intended for those individuals who may need to fill the roles of an airport wildlife specialist, airport wildlife manager or airport wildlife biologist. The program's curriculum will cover most if not all of the issues faced by personnel tasked with the often daunting task of airport wildlife management responsibilities. The first class of this multi-level training program will be offered in late spring/early summer of 2005.

POSTERS

(P1) **ANIMAL AMBUSH AT THE AIRPORT: THE EXTENT AND NATURE OF TERRESTRIAL WILDLIFE STRIKES WITH CIVIL AIRCRAFT, USA, 1990-2003**

Sandra E. Wright and Richard A. Dolbeer, USDA, Wildlife Services, 6100 Columbus Avenue, Sandusky, OH 44870 USA

Birds have long been recognized as a serious threat to aviation safety. However, other wildlife (mammals and reptiles) can also have a serious impact on aircraft. From 1990-2003, 1,243 strikes to civil aircraft involving terrestrial vertebrates (reptiles and mammals [excluding bats])

were reported to the Federal Aviation Administration (FAA). Deer (614) and coyotes (150) were the most commonly reported struck terrestrial wildlife. Other terrestrial wildlife reported struck included rabbits/hares (88), foxes (59), woodchucks (50), turtles (50), alligators (12), and iguanas (5). Whereas 13% of bird strikes resulted in aircraft damage and 8% had a negative effect on the flight, 48% of strikes with terrestrial mammals caused damage and 34% had a negative effect on the flight. Although terrestrial wildlife represented only 2.4% of the reported strikes in the FAA national database from 1990-2003, 16 (57%) of the 28 civil aircraft that were destroyed due to wildlife strikes were caused by these non-bird species. We conclude that 1) terrestrial wildlife strikes are an important component of wildlife hazards to aviation in the USA that must be taken seriously by airport personnel, 2) terrestrial wildlife strikes should be reported to the FAA in the same manner as bird and flying mammal (bat) strikes, 3) the International Civil Aviation Organization should broaden their standards and recommended practices regarding the reporting of bird and bat strikes and managing bird and bat hazards at airports to include terrestrial wildlife, and 4) the size limit for reporting terrestrial wildlife strikes should be animals greater than 200 g (the size of a Norway rat or about ½ pound).

(P2) **THE EFFECTS OF *Neotyphodium lolii* ENDOPHYTE ON CANADA GEESE, FINCHES & GULLS**

Chris G.L. Pennell and M. Philip Rolston. AgResearch Limited, Canterbury Agriculture & Science Centre, P.O. Box 60, Lincoln, Canterbury, New Zealand

Habitat modification by sowing turf type grasses inoculated with selected novel endophytes may be the way forward in reducing the problem of bird strikes to the aviation industry. Canada geese *(Branta canadensis)* were offered ryegrass (*Lolium perenne*) seed and herbage infected with endophyte *Neotyphodium lolli* to examine the effects of known endophyte alkaloids on feeding behaviour. In seed feeding trials, the geese did not discriminate on first exposure between endophyte-free and endophyte-infected seed, but on day two developed an 80% rejection of infected seed containing high ergovaline concentrations. Geese removed from the trial and fed endophyte-free material for three months and then returned to the feeding trials showed lasting learnt avoidance behaviour associated with post digestion malaise. Greenfinches *(Carduelis chloris)* were fed endophyte-infected seed in choice and no choice trials to establish evidence of post digestion feedback. In both feeding trials the green finches were able to discriminate on day one between infected and endophyte-free seed, and endophyte presence in the seed decreased consumption 30%. Gulls *(Larus dominicus*) feeding on pig pellets at an open air pig fattening unit were given a choice of pellets containing endophyte infected seed and control. Gulls consumed less of the pellets containing endophyte-infected material right from onset and this rejection grew significantly stronger ($P < 0.001$) over the 15 day feeding period.

(P3) **INFLUENCE OF THE NUMBER OF REPELLENT-TREATED AND UNTREATED FOOD OR WATER CONTAINERS ON INTAKE IN THE EUROPEAN STARLING, *STURNUS VULGARIS***

Arla G. Hile, USDA, Wildlife Services, National Wildlife Research Center, c/o Monell Chemical Senses Center, 3500 Market St., Philadelphia, PA 19104 USA; Michael G. Tordoff, Monell Chemical Senses Center, 3500 Market St., Philadelphia, PA 19104 USA

The availability of multiple sources of foods or drinks has a profound influence on choice behavior of rodents, so that the most abundant types of substance is chosen preferentially. However, it is not known how other taxonomic groups might respond to the same kind of variation in availability. Birds tend to be visual foragers, and are known to adjust their food selection based on relative densities of alternative foods only when the appearance of the foods differs. Here we tested European Starlings (*Sturnus vulgaris*) with various combinations of repellent-treated or unadulterated water (experiment one) or food (experiment two). In experiment one, birds consumed significantly more of the repellent-treated water (R) than plain water (W) there were more R bottles than W bottles available, and vice-versa. Therefore in experiment one, an aversion to the repellent was reversed to an apparent preference. Similarly, birds' avoidance of repellent-treated food disappeared when bowls containing the treated vs. untreated food were relatively abundant. These results suggest that overuse of any single repellent could impact the effectiveness of the repellent. Further testing is needed to determine whether these findings will hold true under field conditions. This finding could have important implications in landscape-scale use of chemical repellents for vertebrate pest control.

(P4) **LAND USE CHANGES TO MANAGE WILDLIFE HAZARDS AT A CENTRAL KANSAS AIRPORT**

Devon V. McBride, USDA, Wildlife Services, Airport Public Safety, 2173 Air Cargo Rd., Wichita, KS 67209 USA

Historically, row-crop agriculture has been an important source of revenue for Mid-continent airport in Wichita, Kansas (ICT). In May of 2002, wildlife hazards associated with species using the crops were reevaluated and determined to outweigh the yearly revenue generated from crop production. During the following fall and spring a variant of Kentucky-31 tall fescue was seeded on ~1,000 acres of airport property that had been in winter wheat production. High populations of Canada geese (*Branta canadensis*) and other waterfowl are in the immediate vicinity of ICT during the fall and winter months due to the abundant winter wheat fields and numerous large bodies of water. Waterfowl sightings have greatly decreased at ICT following the establishment of our tall fescue grass stand. Wildlife survey data also shows a great decrease in other problem avian species using the area, such as mourning doves (*Zenaida macroura*) and Rock doves (*Columba livia*). Species that appear to have been positively affected by the planting of fescue grass include: upland sandpiper (*Bartramia longicauda*), Eastern and Western meadowlark (*Sturnella* spp.) and grackles (*Quiscalus* spp.). Overall, the conversion to grass from row-crop agriculture has created a more aesthetically pleasing environment, a more accessible landscape in case of emergency and a reduction in the number avian species using the area and being struck by aircraft.

(P5) **HOW DO BIRDS REACT TO APPROACHING AIRCRAFT? OBSERVATIONS FROM THE COCKPIT**

Richard A. Dolbeer, Carol S. M. Washburn, and Sandra E. Wright, USDA, Wildlife Services, 6100 Columbus Avenue, Sandusky, OH 44870 USA

Aircraft collisions with birds are a serious problem worldwide, costing commercial aviation over $1 billion USD each year. Losses to general and military aviation are not as well defined but believed to be substantial. Although considerable effort has been expended to develop technologies to detect birds in aircraft flight paths and to disperse birds from airports, we have surprisingly little understanding of how birds react to approaching aircraft. An improved understanding of bird reactions to aircraft may provide guidance to pilots on avoidance tactics in some situations and provide insights to make aircraft more visible to birds. We developed a database of bird reactions to aircraft by searching the pilot comments section for each of the 56,000 bird strike records in the Federal Aviation Administration National Wildlife Strike Database for Civil Aviation, 1990-2003. We found 633 records in which the pilot noted a response (or lack of response) of the bird or bird flock to the approaching aircraft (in all cases a strike occurred). We classified these responses into 12 categories. Our data analysis indicated that about 80% of the birds encountered attempted some type of reaction to avoid being struck (82% of 367 "bird on ground" cases, 77% of 266 "bird in air" cases). When the aircraft was greater than 500 feet above ground level (AGL), 87% of birds encountered in the air that showed a defined reaction attempted to dive and only 8% attempted to climb. In contrast, below 500 feet AGL only 25% of the birds encountered in the air that showed a defined reaction attempted to dive but 32% attempted to climb. These data suggest that most birds attempt to avoid approaching aircraft, and avoidance maneuvers are governed by height AGL and other factors. Research into systems of lighting, reflective paint or other concepts that would enhance the visibility of aircraft to birds appears to be warranted in an effort to reduce collisions.

(P6) STATUS OF NORTH AMERICAN CANADA GOOSE POPULATIONS IN RELATION TO STRIKES WITH CIVIL AIRCRAFT

John L. Seubert, Wildlife Ecologist-Retired, 1800 Zinnia Road, Golden, CO 80401 USA; Richard A. Dolbeer, USDA, Wildlife Services, 6100 Columbus Avenue, Sandusky, OH 44870 USA

Waterfowl in North America are managed in four administrative flyways – the Atlantic (AF), Mississippi (MF), Central (CF), and Pacific (PF). Canada goose populations in each flyway are subdivided into "migrant-goose" and "large-goose" populations. The "large-goose" populations (AF resident, MF "giant", CF Hi-Line, CF Western Prairie/Great Plains, PF Rocky Mountain), consist primarily of flocks that are non-migratory (hereafter referred to as resident geese). Estimated migrant and resident geese numbers in these flyways are based on mid-winter or breeding period counts. The overall Canada goose population increased 5 fold from 1970 (1.08 million) to 2003 (5.54 million). Most of this overall increase was due to a 16-fold increase in the population of resident geese (from 220,000 to 3.61 million). From 1990-2003, the resident population increased by 2.6 million birds (1.0 million to 3.61 million). In contrast, the migrant population has remained relatively stable since 1990 with the population in 2003 estimated at 1.93 million. Resident geese comprised 65% of the total Canada goose population in 2003 compared to only 36% in 1990 and 20% in 1970. Resident Canada geese are of particular concern to aviation because of their 1) large size (typically 7-10 lbs which exceeds the 4-lb bird certification standard for engines and airframes), 2) flocking behavior which increases the likelihood of multiple bird strikes, 3) attraction to airports for grazing, and 4) year-round presence in urban environments near airports. From 1990-2003, 824 Canada goose strikes and 295 "goose" (unidentified to species but likely Canada geese) strikes with civil aircraft were

reported in the USA of which 433 Canada goose and 166 "goose" strikes caused damage. Damage to an engine was reported in 154 cases. The number of reported Canada goose and "goose" strikes per year increased, in concert with the increase in the population, from 39 in 1990 to 115 in 1998. However, reported strikes declined since 1998 to 96 in 2003 in spite of the continued increase in the overall resident population. This decline is likely due to aggressive Canada goose management programs that have been implemented at many airports. These programs must be continued and expanded to reduce this significant hazard to aviation.

(P7) TECHNIQUES FOR IDENTIFYING BIRD STRIKE REMAINS

Carla Dove, Marcy Heacker, and Greg Concepcion, National Museum of Natural History, Smithsonian Institution, MRC 116, PO Box 37012 Washington, DC 20013-7012 USA

Remains from bird/aircraft strikes are identified using whole-feather characters, microscopic analysis of downy barbules, and by use of DNA sequences. This poster describes the techniques used for identification of fragmented feather remains at the Smithsonian Institution and presents the results of species identifications from civil and military cases sent to the Feather Lab in 2003. Progress on the FAA-sponsored DNA project are discussed.

(P8) INTEGRATION OF AVIAN RISK MANAGEMENT TOOLS TO CHARACTERIZE REGIONAL MIGRATION PATTERNS TO IMPROVE AIRFIELD SAFETY

Gino J.M. Giumarro, Robert D. Roy, and Steven K. Pelletier, Woodlot Alternatives, Inc., 30 Park Drive Topsham, ME 04086 USA

There is a range of avian collision services and systems for use with military, commercial air carrier, and public airport use that focus on engineering, long-term monitoring, and modeling. However, many of these solutions ignore specific bird migration dynamics necessary to conduct a regionally specific analysis of bird-aircraft collision risk. This poster highlights the applicability of using an integrated set of avian risk management tools to assess regionally specific BASH risks at airfields. A multiple methodology approach was used for assessing wind farm and communication tower impacts on birds. Potential impacts of wind farms and communication towers on bird populations were assessed from an integrated set of state-of-the-art avian surveys. The initial step was to conduct a landscape analysis that characterized the relationships between species and ecological communities to determine presence likelihood. Breeding bird field surveys were conducted within the region of influence to document species breeding in the region and to detect species not included in the landscape analysis. Nocturnal bird surveys were conducted to characterize nighttime movements of songbirds through and over the project area during migration periods. These nocturnal surveys used a variety of techniques, including ceilometers, moonwatching, radar surveys, acoustic recording, and NEXRAD weather radar data analysis. The combination of these methods resulted in a robust data set regarding migratory species, timing, volumes, and migration directions within the project area. The final step involves creation of a dynamic three-dimensional model of the region to observe migration data in a real-world setting. The model provides a visual depiction of bird movements with respect to major topographic features in the study area. These topographic features, such as

mountains, rivers, shorelines, and towers, often conflict with or alter bird migration patterns at a localized scale. Changes in these patterns have a direct application on the relative bird-aircraft danger at a particular airport.

(P9) **USDA/APHIS/WILDLIFE SERVICES AT CALIFORNIA AIRPORTS**

Derek Milsaps and Patrick Smith, USDA, Wildlife Services, 3419A Arden Way, Sacramento, CA 95825 USA

USDA/APHIS/Wildlife Services (WS) biologists in California (CA) are working with a variety of airports to reduce wildlife strikes on and around airports and the critical flight paths of aircraft on approach and departure. Waterfowl, wading birds, raptors, small flocking passerines and pelagic sea birds are some of the most common wildlife species at California airports. Along with the diversity of wildlife, California airports are faced with a variety of complex issues such as being inhabited by both state and federally listed threatened and endangered species (T&E) and having a wide array of habitat types (agriculture, wetland, etc.). CA WS has full-time biologists working to minimize wildlife threats to aircraft at several California airports employing methods including: exclusion, dispersal, removal (both lethal and nonlethal), and habitat modification. In addition, CA WS assists airports and the aviation industry with efforts to report and monitor wildlife strikes and provides training to airport personnel to identify potential wildlife hazards on and around airport environments.

(P10) **THE UNITED STATES AIR FORCE (USAF) BASH PROGRAM: USAF'S APPROACH TO RESOLVING WILDLIFE HAZARDS ON AIRFIELDS**

Melanie Presuto, USAF BASH TEAM 9700 Avenue G. SE Bldg. 24499, Kirtland AFB, Albuquerque, NM 87117 USA

The primary goal of the Bird/wildlife Aircraft Strike Hazard (BASH) Team is to preserve the war fighting capability of the USAF through the reduction of wildlife hazards to aircraft operations. However, reducing equipment expenses and crew exposure to risk are very important as well. Since 1985, strikes with birds and other wildlife have resulted in 35 deaths and cost USAF an annual average of $32,352,174. In an effort to accomplish these tasks and reduce this potential risk, the BASH Team practices an integrated pest management approach on their bases worldwide. Although wildlife hazards are not eliminated, they are managed to within acceptable levels using a three-step approach to include: awareness and identification of the risk; dealing with the causes; and, defining safety's role to address problem areas.

(P11) **HABITAT COMPARISON OF AN AIRPORT EXPANSION PROJECT**

Robert C. Alexander, USDA, Wildlife Services, 500 Northwest Plaza, Suite 917, St. Ann, MO, 63074 USA

The Federal Aviation Administration's Advisory Circular 150/5200-33 cites putrescible waste disposal operations as incompatible with safe airport operations, but just how do they compare to

other habitats? As part of a Wildlife Hazard Assessment, five major habitat types were identified from aerial photographs within a 3 statute mile radius of a municipal waste landfill, and within 4.1 statute miles of a major international airport's new runway project. We conducted 12 bird surveys/mo. for one year, sampling morning, midday, and evening hours. The 214 acre landfill was the primary focus of this study, therefore a best fit grid was overlaid on an aerial map and 10 random survey points of 4.5 acres each were selected. The same size grid was then applied to the four other major habitat types including commercial park, river, agriculture, and residential areas. Accessibility did bias the point selection process in the river and agriculture habitats. Number of individuals, activity, cover type, direction of movement, and weather conditions were recorded. Of 120 known bird strikes occurring at this airport documented in the national strike database identified to guild, the greatest number (25.8%) are starlings & blackbirds. This is consistent with the most abundant guild for all habitats surveyed, ranging from 33% of total birds observed in the river habitat to 94% at the landfill (77.5% all habitats). Second in known strikes are waterfowl (22.5%) which account for 7.1% of total birds surveyed in all habitats. Third in known strikes are raptors (21.7%) but only account for 0.14% of all birds surveyed. Pigeons and doves, are 4th in known strikes and abundance with 14.2% and 5.2%, respectively. In this poster we will show comparisons of all habitat types with the four most abundant guilds represented along with a listing of the known strikes by guild.

(P12) **A BIRD AVOIDANCE MODEL FOR NORTHWESTERN EUROPE: PREDICTING THE INFLUENCE OF ENVIRONMENTAL CONDITIONS ON THE SPATIAL AND TEMPORAL DYNAMICS OF BIRD MOVEMENTS**

Judy Shamoun-Baranes, Willem Bouten, and Emiel van Loon, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Netherlands; Jelmer van Belle, Royal Netherlands Air Force; Henk Sierdsema, Sovon, Dutch Centre for Field Ornithology

The Bird Avoidance Model research and development team in the Netherlands is currently developing a model aimed at predicting the 3-D spatial and temporal dynamics of bird densities under changing environmental conditions. By integrating conceptual, statistical, spatial and knowledge based models bird densities are predicted. Submodels complement each other and converge towards a common goal of creating an expert system to facilitate decision-making aimed at reducing the hazard of bird aircraft collisions over northwest Europe. Currently several models within this framework are at different stages of development. Bird migration is modeled with data driven statistical models and with conceptual models to predict nightly changes in nocturnal migration intensity. Nocturnal migrants crossing the Netherlands are influenced by wind, rain and temperature. Results from statistical models are incorporated into the conceptual model based on rules of flight energetics and stopover ecology, simulating bird migration. Innovative to such models will be the on-line inclusion of real data on bird densities from sources such as radar tracking of birds as well as weather data from mesoscale model outputs. Bird distribution maps are being created to assess where birds rest, forage and breed between migratory seasons. Count data, by nature, cannot cover all points in space and time. Various techniques to fill in gaps in the data are being explored and compared in a GIS environment including spatial statistics and regression analysis based on environmental conditions such as landuse, geomorphology and ecoregions. Flight altitudes of birds using soaring and gliding

flight (passive flight) are predicted based on local meteorological conditions. Factors such as temperature, relative humidity and boundary layer height influence flight altitudes either directly reflecting soaring conditions or indirectly by influencing the food sources of aerial foragers. Meteorological conditions have also been found to influence the choice of flight strategies of gulls, which can both soar and glide or use flapping (active) flight. Recently a multidisciplinary network has been established to facilitate the dissemination of knowledge relevant to bird avoidance model and this network is open for new partners.

(P13) DEPARTMENT OF THE NAVY BASH PROGRAM: AN UPDATE

Matthew W. Klope, Naval Facilities Engineering Service Center, Naval Air Station Whidbey Island, 1115 W. Lexington Street, Building 103, Oak Harbor, WA 98278 USA

The U.S. Navy and Marine Corps have a unique bird strike situation it that they strike birds both on land and at sea. During calendar year 2003, the Navy and Marine Corps reported 625 wildlife strikes to the Naval Safety Center, totaling $2,377,204.00 in damages. Topping out the charts for birds were turkey vulture, barn swallows, herring gulls, and cattle egrets. Mammals included deer, bats, and coyotes. Navywide BASH prevention training has been developed through the Navy Civil Engineering Corps Officers School (CECOS), Port Hueneme, California in the form of an interactive BASH Training CD Module. Navy BASH research over the past year has included the testing and evaluation of an aircraft hangar bird deterrent system (ongoing), second phase development of the DoD Legacy BIRDRAD avian radar system, and the inclusion of Naval Safety Center bird strike data into the Navy's PreFlight Planning System (PFPS). In reviewing the Naval Safety Center's bird strike database in has become apparent due to better on-line reporting that a real bird strike threat exists at sea for both jet and helicopter aircraft resulting in the initial steps being taken to incorporate avian radar technology into shipboard weather surveillance radars.

(P14) TEST YOUR ABILITY TO IDENTIFY BIRD STRIKE REMAINS

Matthew W. Klope, Naval Facilities Engineering Service Center, Naval Air Station Whidbey Island, 1115 W. Lexington Street, Building 103, Oak Harbor, WA 98278 USA; Carla J. Dove, National Museum of Natural History, Smithsonian Institution, MRC 116, PO Box 37012 Washington, DC 20013-7012 USA

In order to fully implement a wildlife/bird strike reduction program at any airport, one of the first priorities is to determine what species of wildlife is causing the problem(s). These species can and will vary throughout the year. By knowing what your priority problem species are, limited manpower and funding can be directed where it will have the greatest impact. This poster is provided only as an activity to allow airport and natural resources managers the chance to test your ability to identify actual bird strike victims. It is important that airport and natural resource managers at airport facilities be able to identify wildlife living in and around your facility in order to better manage wildlife populations. Remember that all actual collected bird strike remains must be turned in to the appropriate repositories for positive identification.

(P15) NICARBAZIN AS A REPRODUCTIVE INHIBITOR FOR RESIDENT CANADA GEESE: THE OREGON FIELD STUDY

Kimberly S. Bynum, John D. Eisemann, James R. Wick, Lowell A. Miller, and Kathleen R. Fagerstone, USDA, Wildlife Services, National Wildlife Research Center, 4101 LaPorte Avenue, Fort Collins CO 80521 USA; Gary Weaver, USDA, Wildlife Services, 6135 NE 80th Avenue Suite A8, Portland OR 97218 USA

Ranked by cost, Canada geese were third in the top 50 wildlife strikes listed by the USAF, with an average cost per Canada goose strike of $1,217,992. From 1990 to 2003, Canada geese represented an average of 1.5% of all wildlife strikes reported to the FFA. Expanding populations of "Resident" Canada geese that remain in suburban and urban areas year-round, including areas near airports, may result in increased bird strike risks in the future. Non-lethal and humane means are needed for managing the size of Canada goose flocks residing near or on airports, golf courses, industrial parks, government sites, and city parks. A side effect of nicarbazin, a veterinary drug typically used to treat chickens for coccidiosis disease, is decreased egg production and hatching. Exploiting this "side effect," a field study of the efficacy of nicarbazin for reducing the hatchability of Canada goose eggs was conducted in spring 2004 in Oregon. Study sites were recruited in 2002 and 2003. During the 2003 nesting season, nest locations were recorded using GPS and resulting GIS maps allowed selection of optimal bait sites and more proficient monitoring of nests. The study was initiated in February 2004 at 10 sites in Oregon, with 2 control and 3 treated sites on each side of the Cascades. Following acclimation, bait was fed to resident Canada geese for 42 consecutive days. Nests were located and monitored until hatching or for at least 5 days beyond the expected hatching date to determine hatchability. Data collection was completed in May 2004. Reduction in the percent hatchability of eggs laid at treated study sites is being analyzed and submitted to support EPA registration of nicarbazin as a reproductive inhibitor for use in Canada geese.

(P16) MEMORANDUM OF AGREEMENT: INTERAGENCY COMMITMENT TO REDUCING WILDLIFE STRIKES TO AIRCRAFT

Michael J. Begier, USDA, Wildlife Services, 6213-E Angus Drive, Raleigh, NC 27617 USA; Brian E. Washburn, USDA, Wildlife Services, National Wildlife Research Center, Ohio Field Station, 6100 Columbus Avenue, Sandusky OH 44870 USA

Aircraft-wildlife strikes are the second leading causes of aviation-related fatalities. Globally, these strikes have killed over 400 people and destroyed more than 420 aircraft. While these extreme events are rare the potential for a catastrophic loss of human life resulting from one incident is substantial. In the United States, the Federal Aviation Administration in cooperation with the U.S. Department of Agriculture Wildlife Services Program maintains an aircraft-wildlife strike database. The overwhelming majority of wildlife-aircraft strikes involve various bird species. The majority of these birds are subject to federal oversight via the Migratory Bird Treaty Act. As a result several federal agencies are either directly or indirectly involved with regulatory and management decisions involving bird species that reside on or use habitat present at airports. In 2003, the Federal Aviation Administration, parts of the Department of Defense, the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service and the U.S.

Department of Agriculture signed a memorandum of agreement (MOA) to address aircraft-wildlife strikes issues. The MOA acknowledges each signatory agency's respective mission. Specifically, the MOA assists the agencies by establishing the procedures necessary to coordinate their missions to more effectively address existing and future environmental conditions that contribute to aircraft-wildlife strikes throughout the United States. It is essential that personnel engaged in wildlife-safety issues at airports become familiar with the MOA in order to help minimize wildlife risks to aviation and human safety, while protecting the nation's valuable environmental resources.

(P17) **NWRC'S OHIO FIELD STATION: RESEARCH TO ALLEVIATE WILDLIFE-AVIATION CONFLICTS**

USDA, Wildlife Services, National Wildlife Research Center, Ohio Field Station, 6100 Columbus Avenue, Sandusky OH 44870 USA

Wildlife-aircraft collisions (wildlife strikes) pose a serious risk to aircraft and cost civil aviation in the United States an estimated $490 million annually. The Ohio Field Station of the USDA, Wildlife Services, National Wildlife Research Center (NWRC's OFS), located in Sandusky, Ohio, works with a variety of stakeholders, including the FAA, USDA, Wildlife Services, academic institutions, and private industry to develop science-based recommendations, policies, and procedures to control hazardous wildlife on airports and other locations where they present a hazard to aviation safety. Research conducted by NWRC's OFS covers a spectrum of high priority topics important to both the FAA and USDA, Wildlife Services related to understanding the nature of wildlife hazards at airports and developing management tools to reduce those hazards. Current research being conducted by NWRC's OFS can be divided into three broad categories: (1) wildlife habitat management and other land-use studies, (2) wildlife control methods for airports, and (3) avian sensory perception studies to develop new wildlife deterrents.

(P18) **USDA WILDLIFE SERVICES ASSISTANCE TO NORTH CAROLINA AIRPORTS**

USDA, Wildlife Services, North Carolina Airport Safety Section, 6213-E Angus Drive, Raleigh, NC 27617 USA

North Carolina stretches from the Atlantic Ocean to the Appalachian Mountains. Three distinct geographic regions (i.e., the mountains, Piedmont, and coastal plain) of the state support a wide array of wildlife populations. Increasing populations of white-tailed deer, Canada geese, gulls and vultures contribute to wildlife hazards at airports within the state. North Carolina Wildlife Services (NC WS) personnel have assisted airports since the late 1970's with the potential and realized hazards posed by these populations in each region. Increasing national trends in overall flights and passenger use is mirrored by work requests. The state Division of Aviation recently requested services to assist all general aviation airports with initial consultations, wildlife hazards recognition training and technical or operational management activities. Also reflected is an increase in requests for professional comments on wetland mitigation and storm water drainage projects related to aviation-wildlife safety concerns. The cornerstone of the program remains the variety of work provided to the Department of Defense. NC WS currently maintains

full-time staff at three military sites where comprehensive services are provided. Programs at U.S. Air Force and Marine Corps airbases are recognized nationally within their respective service branches as model programs both by WS and military personnel. As part of these programs, personnel provide services to military air bases in foreign countries. The program also continues to work with the USDA, Wildlife Services, National Wildlife Research Center and Smithsonian Institute Bird Identification Laboratory on new research initiatives and DNA data collection.

(P19) **WILDLIFE HAZARD MANAGEMENT AT ARIZONA AIRPORTS**

USDA, Wildlife Services, Arizona Airport Safety Program, 8836 N. 23rd Avenue, Suite 2, Phoenix, Arizona 85201 USA

Under Congressional mandate, Wildlife Biologists and Specialists with the USDA/APHIS/Wildlife Services (WS) program in Arizona (AZ) work with numerous airports throughout the state of Arizona to reduce hazards associated with wildlife strikes to aircraft. Hazard reduction efforts focus on the airfield and in several critical zones surrounding the airfield requiring the cooperation of many federal, state, and private entities. A diversity of wildlife can be found in the Arizona airport environment. Commonly found birds include doves, pigeons, blackbirds, birds of prey, corvids, and wading birds. Additionally, mammals such as prairie dogs, ground squirrels, coyotes, cats, rabbits, and bats are commonly observed at Arizona airports. AZ WS has full and part-time personnel specifically trained to manage wildlife hazards in airport environments using a variety of techniques including: exclusion, dispersal, lethal and nonlethal removal, and habitat modification. WS personnel also provide assistance in the form of recommendations and guidance and assistance is provided to airports and the aviation industry to increase wildlife strike reporting. AZ WS personnel are also equipped with the knowledge and experience to train airport personnel to identify potentially hazardous wildlife in and around the airport.