NINA Rapport 532

Konfliktar mellom vilt og luftfart

Samling av eksisterande kunnskap i EndNote Web litteraturbase

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Norsk institutt for naturforskning

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Veiberg, V., Nygård, T., Hamre, Ø. & Follestad, A. 2009. Konfliktar mellom vilt og luftfart – samling av eksisterande kunnskap i EndNote Web litteraturbase. NINA Rapport 532. 146 s.

Konfliktar mellom vilt og luftfart er eit aktuelt tema både i samband med flytryggleik og i samband med kva konsekvensar luftfartsaktivitet kan påføre dyre- og fugleliv. På oppdrag frå Miljøavdelinga ved Oslo Lufthavn, er det utarbeidd ein referansebase i EndNote Web over norske, svenske og engelskspråklege arbeid med relevans for dette feltet. EndNote Web er eit gratis og nettbasert referansebaseprogram, som kan nyttast til å bygge opp og vedlikehalde referansebasar som er tilgjengelege for andre brukarar over internett. I dag inneheld den aktuelle basen 632 referansar.

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Abstract

Veiberg, V., Nygård, T., Hamre, Ø. & Follestad, A. 2009. Conflicts between wildlife and aviation – present knowledge gathered in an EndNote Web library. NINA Report 532. 146 pp.

Conflicts between wildlife and aviation are important tasks both in relation to aviation safety and in relation to the effects of aviation on wildlife welfare and area use. On contract from the Department for environment at Oslo Airport, a database containing Norwegian, Swedish and international references relevant to this topic was collected into an EndNote Web library. EndNote Web is a free and internet-based application used to build, maintain and share databases containing literature references. At present, the library contains 632 references.

Vebjørn Veiberg, (vebjorn.veiberg@nina.no), Torgeir Nygård (torgeir.nygard@nina.no), Øyvind Hamre (oyvind.hamre@nina.no) and Arne Follestad (arne.follestad@nina.no), Norwegian institute for nature research, NO-7485 Trondheim, Norway.

Innhald

Forord

Konfliktar mellom luftfart og vilt kan primært delast inn i to hovudtema: i) Utfordringar knytt til flytryggleik og ii) konsekvensar av luftfartsaktivitet for viltet. Begge tema er av internasjonal aktualitet. Samtidig vil konflikten sin art og omfang variere mellom område, og endre seg mellom ulike sesongar/år.

Arbeidet knytt til innsamling og systematisering av relevante referansar omkring desse problemstillingane vart tinga av Miljøavdelinga ved Oslo Lufthavn AS. Formålet har vore å etablere ein referansebase som inneheld det mest relevante av dagens kunnskap knytt til dei aktuelle tema. Denne basen kan enkelt gjerast tilgjengeleg for personar som skal arbeide med relevante problemstillingar, eller som berre ønskjer å få ein rask oversikt over kva som er gjort innan dei ulike felta. Basen kan også enkelt oppdaterast med nye referansar på seinare tidspunkt. Ein slik referansebase er derfor eit meir dynamisk og brukarvennleg verktøy enn ei skriftleg samanstilling utforma på eit gitt tidspunkt.

Vi håpar at basen kjem til nytte for oppdragsgjevar med samarbeidspartar.

Trondheim desember 2009.

Vebjørn Veiberg
Prosjektleiar

1 Innleiing

Konflikten mellom vilt (fuglar og pattedyr) og luftfart er mangfaldig og internasjonal. Det er derfor utfordrande å gi ei dekkande samanstilling av mange relevante problemstillingar. Samtidig har vi erfart at mykje av den aktuelle litteraturen ikkje er tilgjengeleg gjennom dei vanlege litteratursøkekanalane, men føreligg som "grålitteratur". Dette inkluderer artiklar i tidsskrift som ikkje er representert i vitskaplege søkebasar, ulike rapportar, samandrag/presentasjonar/artiklar frå ulike konferansar/seminar/workshops mm. Ei samling av slik relevant informasjon er nødvendig både i samband med samanstillingar av eksisterande kunnskap knytt til konkrete problemstillingar, og for å synleggjere eventuelle kunnskapsmanglar.

Formålet med dette oppdraget har vore å etablere ein referansebase som inneheld den mest relevante litteraturen innan feltet "Konfliktar mellom vilt og luftfart". Alle referansane er samla i ein internettbasert referansebase (EndNote Web). Dette er eit dynamisk søkeverktøy som kan gjerast tilgjengeleg for alle som ønskjer. I tillegg kan basen enkelt oppdaterast når nye relevante referansar dukkar opp.

Dei følgjande kapitla gir ei oppsummeringa av kva kjelder som har blitt nytta til å samle referansane. Det vert også gitt ein kort presentasjon av EndNote Web og bruken av dette verktøyet. Avslutningsvis er referansebasen sitt innhald presentert i form av ei referanseliste med samandrag, der slike har vore tilgjengelege.

2 Søk av litteratur

Referansane som er samla i basen "Aviation – wildlife" viser til bøker, rapportar, artiklar frå vitskaplege tidsskrift eller fagtidsskrift, og artiklar eller samandrag utgitt i samband med konferansar/seminar/workshops om relevante tema. Det inngår også ein del artiklar som berre er publisert som nettartiklar. Basen inneheld per i dag 632 referansar til norske, svenske eller engelskspråklege arbeid.

Referansar til artiklar publisert i vitskaplege tidsskrift er primært søkt opp gjennom bruk av søkeverktøya ISI Web of Knowledge (Thomson Reuters) og Google Scholar. Sistnemnte har også vore nyttig for søking av grålitteratur. BIBSYS, Library of Congress og Google Scholar vart nytta til å søke etter rapportar, proceedings og bøker. I tillegg har følgjande kjelder vore nyttige:

- Gjennomgang av referanselister i ulike review og samanstillingar.
- Gjennomgang av relevante nettsider (f.eks. International Bird Strike Committee, Bird Strike Committee USA og German Bird Strike Committee).
- Personleg kontakt med aktuelle ressurspersonar innan det aktuelle fagfelt.

2.1 Den enkelte referanse

Alle referansar er oppgitt med forfattar, årstal og kjelde. Der samandrag har vore elektronisk tilgjengeleg er dette inkludert saman med referansen. Basen inneheld ikkje fulltekstversjonar av den enkelte artikkel mm. Mange av artikkelreferansane har derimot linkar til dei opphavlege treffa i søkemotoren referansen er blitt henta frå. Gitt at den enkelte brukar har tilgang til desse, kan elektroniske fulltekstversjonar av referansane lastast ned. Alternativt vil eit søk gjennom Google, Google Scholar eller BIBSYS kunne finne fram til fulltekstversjonar. Om dette ikkje lykkast vil eit bibliotek kunne skaffe skriftlege versjonar av den ønska referansen.

3 EndNote Web

EndNote Web (Thomson-Reuters) er eit gratis og nettbasert referansebaseprogram, som kan nyttast til å bygge opp og vedlikehalde referansebasar. Kvar base kan innehalde 10 000 refe-

ransar. EndNote Web kan også nyttast som søkeverktøy mot andre litteraturdatabasar slik som ISI Web of Knowledge, BIOSIS og liknande (gitt at den enkelte brukar har tilgang til desse søkeverktøya). Dette krev at den enkelte brukar/organisasjon har brukarlisens til desse tenestene.

I tillegg til å fungere som ein sentral referanselagringsbase kan EndNote Web også brukast til å lage referanselister i vanlege tekstdokument/rapportar. Referansane i basen kan også eksporterast i ulike format, slik at dei kan inngå i lokale baseverktøy (eks. EndNote, Reference Manager mfl.).

4 Enkel bruk av EndNote Web

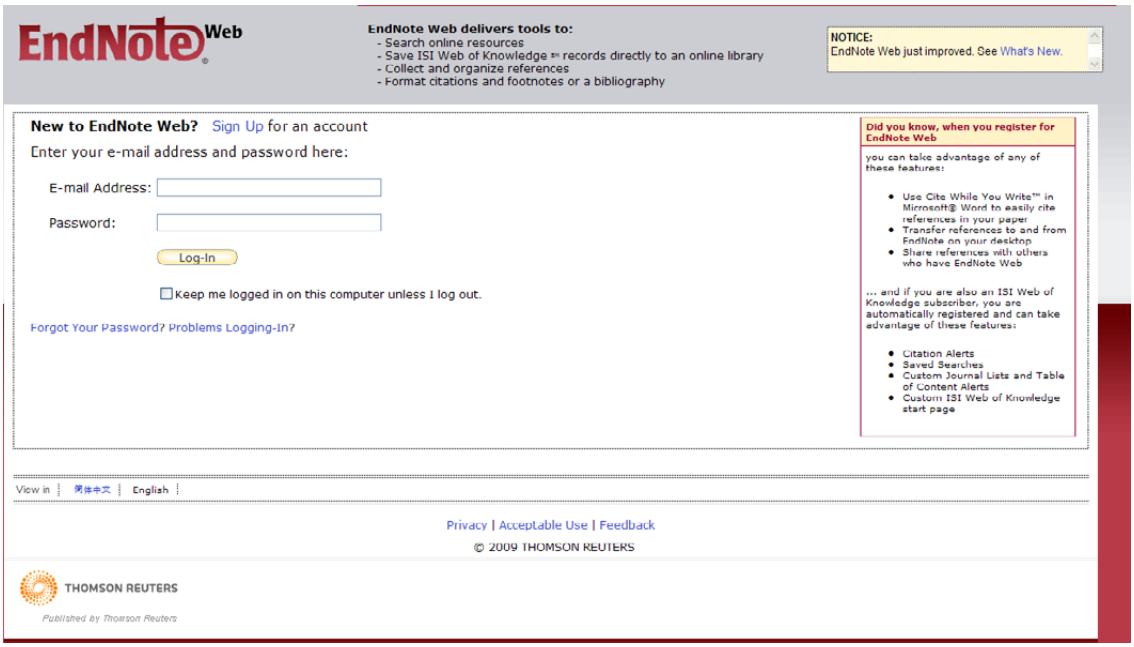
EndNote Web inneheld mange funksjonar til ulike formål. Innføring i alle funksjonane er tilgjengeleg via Help-funksjonen i EndNote Web. Vi har likevel valt å gi ei kort innføring i dei mest relevante funksjonane i samband med tilgang til og søk i den eksisterande referansebasen.

4.1 Tilgang

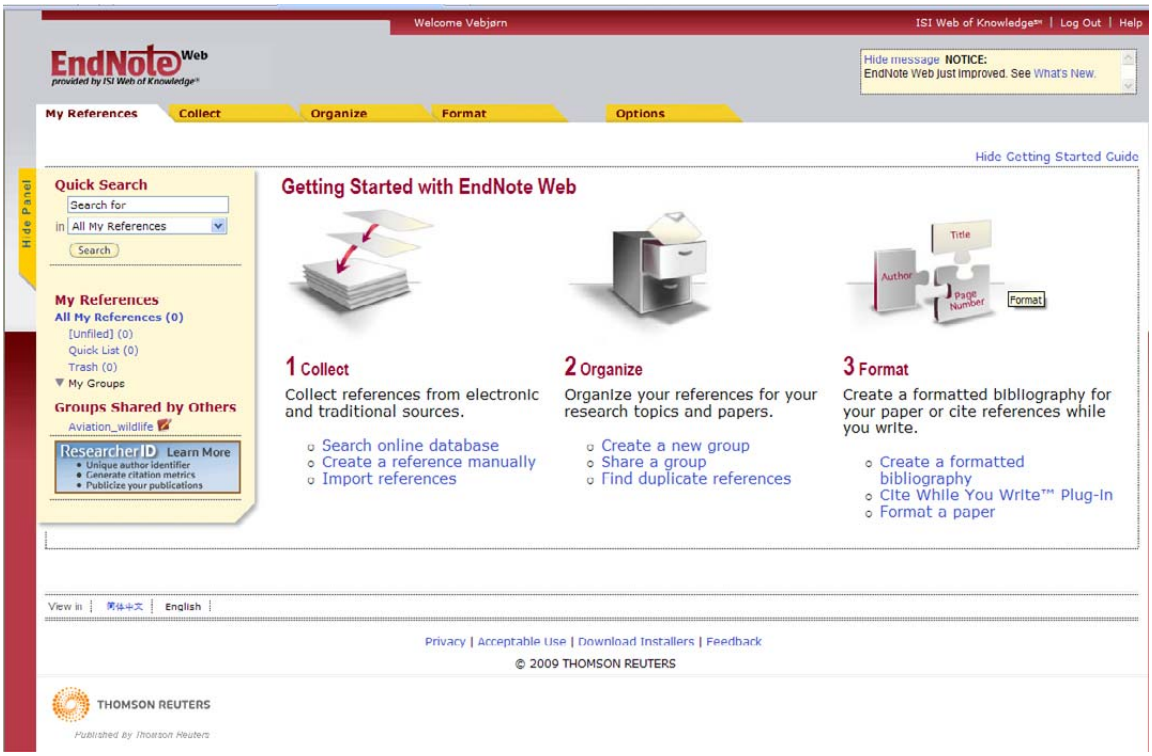
Per no har Torgeir Nygård ved NINA administratorrolla for basen. Det vil seie at han bestemmer kva brukarar som har tilgang til basen og rettar den enkelte brukar har. Om ønskjeleg kan administratorrolla overførast til ein person hos oppdragsgjevar.

For å logge inn på EndNote Web bruk følgjande url-adresse:
http://www.myendnoteweb.com/EndNoteWeb/2.7/release/EndNoteWeb.html

Skriv inn di e-postadresse og det valde passordet. Trykk Log-in.



Etter fullført innlogging vil det framgå av menyen til venstre at ein har tilgang til referansebasen "Aviation – wildlife".



4.2 Søk i eksisterande base

Dersom ein ønskjer ein fullstendig oversikt over alle referansane som finst i basen, klikkar ein berre på namnet til sjølve basen (Aviation – wildlife). Oftast er det derimot ønskjeleg å avgrense søket til meir spesifikke tema. Bruk då Quick Search menyen øvst i venstre hjørnet av sida. Skriv inn ønska søkeord, marker den ønska referansebasen (dersom du har tilgang til fleire) og trykk Search. Treffa kjem fram i vindauget til høgre. Her kan ein også definere kor mange referansar som skal visast per side (her sett til 50). Dersom ein får fleire treff enn det som kan visast på ei side, kan ein bla seg mellom dei ulike sidene.

Ønskjer ein å kombinere søkeord og avgrense søket ytterlegare, kan dette gjerast på følgjande måte:

- **Plussteikn** (+) framfor søkeord vil returnere referansar som inneheld søkeordet.
- **Minusteikn** (-) framfor søkeord brukt i kombinasjon med andre søkeord, vil returnere treff som ikkje inneheld dette ordet. Minusteiknet kan berre brukast saman med andre søketermar som resulterer i treff.
- **Mellomrom** mellom to søkeord, utan bruk av minus- eller plussteikn, returnerer treff som inneheld begge søketermane.
- **Parentes** () kan brukast til å gruppere søkeord.
- **Stjerne** (*) i slutten av ord vil returnere treff der søkeordet anten inngår som eige ord eller som første del av samansette ord.
- **Doble hermeteikn** (” ”) returnerer referansar som inneheld den eksakte frasen som det er referert til i hermeteikn.

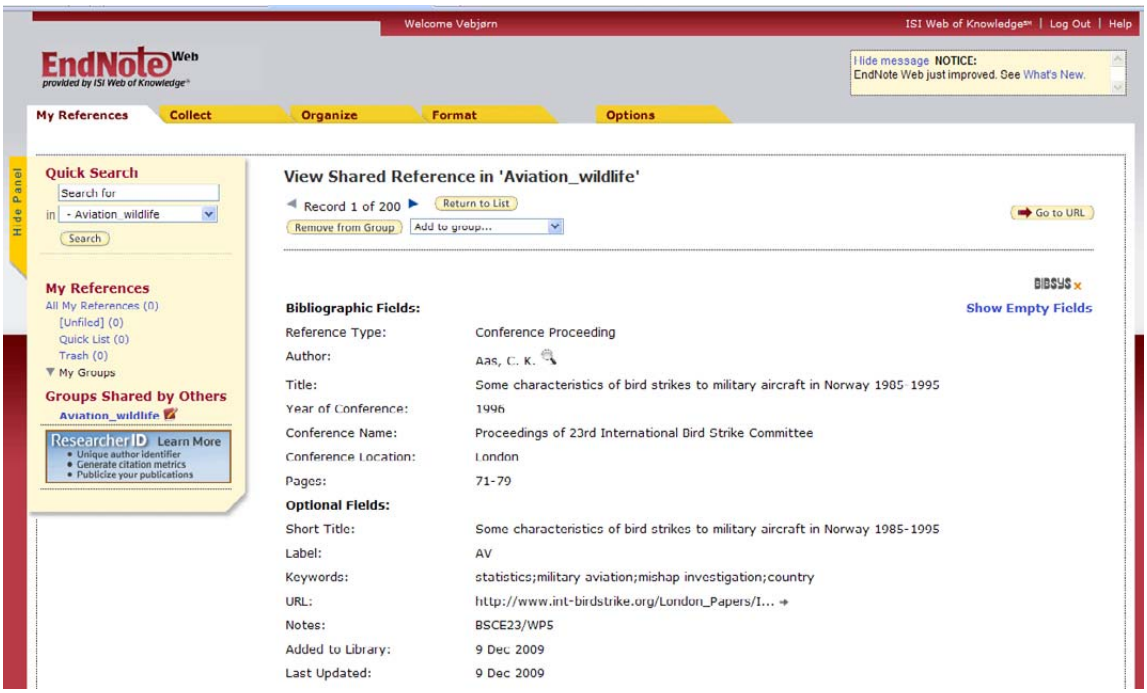
4.2.1 Eksempel

+fugl +fly returnerer treff som inneheld ”fugl” og ”fly”.
+fly -fugl returnerer treff som inneheld ”fly” men ikkje ”fugl”.
støy (+luftfart +hjortedyr) returnerer treff som inneheld referansar om ”støy” eller referansar som inneheld både ”luftfart” og ”hjortedyr”.
luft* returnerer treff som inneheld ordet luft, eller ord som startar med det (luftfart, luftslott).
"airport wildlife" returnerer treff som inneheld den eksakte frasen "airport wildlife".

4.3 Treff og sortering

Standard visninga av trefflista er sortert alfabetisk etter forfattaren sitt etternamn. Om ønskjeleg kan ein gjere om på denne sorteringa ved å klikke på kolonnetitlane Author, Year eller Title. Ein vil då endre sorteringsrekkefølgja for alle referansane i trefflista. I tillegg til namnet på førsteforfattaren og året for publisering, vil tittelen til referansen, kjelda (journalnamn, boktittel mm.) og eventuelle linkar til fulltekstversjonar (Go to URL) framgå. Der referansen er importert etter søk i andre referansesøkeverktøy (eks. ISI Web of Knowledge) vil dette framgå. Her vil visest ein link til det originale søketreffet. Ei oppkopling via denne linken vil krevje at brukar har tilgang til denne tenesta. Her vil det også framgå om det eksisterer elektroniske fulltekstversjonar av den aktuelle referanse.

For å sjå meir utfyllande informasjon for det enkelte treff er det berre å klikke på tittelen. Ein vil då bli vist all informasjon som basen inneheld om den enkelte referanse.



4.4 Vedlikehald

Ein referansebase vil alltid vere avhengig av bruk og vedlikehald for å vere oppdatert. Innlegging av nye eller endring av eksisterande referansar kan berre gjerast av brukarar der desse funksjonane er definert. Per i dag er denne tilgangen styrt av NINA.

5 Referansar i Aviation – wildlife

Avslutningsvis har vi valt å også gi ein skriftleg presentasjon av alle referansane som inngår i basen. Bibliografien er sortert på to nivå. Først etter publiseringsår og dernest alfabetisk etter forfattarnamn. For referansar der samandrag inngår i basen er dette også vist.

2009

[Anon] (2009). "Decision to make bird-strike data public enhances aviation safety." Aircraft Engineering and Aerospace Technology **81**(5): 480-480.

Bataille, A., Cunningham, A.A., et al. (2009). "Evidence for regular ongoing introductions of mosquito disease vectors into the Galapagos Islands." Proceedings of the Royal Society B-Biological Sciences **276**(1674): 3769-3775.

Wildlife on isolated oceanic islands is highly susceptible to the introduction of pathogens. The recent establishment in the Galapagos Islands of the mosquito Culex quinquefasciatus, a vector for diseases such as avian malaria and West Nile fever, is considered a serious risk factor for the archipelago's endemic fauna. Here we present evidence from the monitoring of aeroplanes and genetic analysis that C. quinquefasciatus is regularly introduced via aircraft into the Galapagos Archipelago. Genetic population structure and admixture analysis demonstrates that these mosquitoes breed with, and integrate successfully into, already-established populations of C. quinquefasciatus in the Galapagos, and that there is ongoing movement of mosquitoes between islands. Tourist cruise boats and inter-island boat services are the most likely mechanism for transporting Culex mosquitoes between islands. Such anthropogenic mosquito movements increase the risk of the introduction of mosquito-borne diseases novel to Galapagos and their subsequent widespread dissemination across the archipelago. Failure to implement and maintain measures to prevent the human-assisted transport of mosquitoes to and among the islands could have catastrophic consequences for the endemic wildlife of Galapagos.

Bekessy, S.A., Wintle, B.A., et al. (2009). "Modelling human impacts on the Tasmanian wedge-tailed eagle (Aquila audax fleayi)." Biological Conservation **142**(11): 2438-2448.

The wedge-tailed eagle is Australia's largest bird of prey and one of the largest eagles in the world. Aquila audax fleayi is an endemic Tasmanian subspecies isolated for 10,000 years from the nominate subspecies on the Australian mainland. The Tasmanian wedge-tailed eagle is classified nationally and at a State level as endangered due to its small number of breeding pairs, low breeding success and high rate of mortality from unnatural causes. The subspecies experiences mortality throughout its range from shooting, poisoning, trapping, road accidents, electrocutions and collisions with wind turbines, aircraft, fences and overhead wires, which we term 'un-natural mortality'. A portion of the subspecies' range is managed for timber production, which can lead to disturbance of nest sites and the loss of nest trees. We use a model of the eagle population from the Bass District in northeast Tasmania to explore the relative importance of different sources of mortality and nesting habitat loss, and the potential for mitigating impacts associated with unnatural mortality, disturbance, nesting habitat loss and human access to forests. We create a habitat map including suitable nest sites and link it to a dynamic landscape population model based on life history traits and disturbance responses. Using the program RAMAS-Landscape, we model alternative forest management scenarios, ranging from no timber

harvesting and a natural wildfire regime, to scenarios prescribing native forest harvesting and regeneration and different levels of conversion of native forest to plantation under the same natural wildfire regime. The results indicate that the Tasmanian wedge-tailed eagle is sensitive to unnatural mortality, plantation establishment and native forest harvesting. The predicted decline over the next 160 years (similar to 65%) will most likely be driven largely by loss of current and potential future nest sites associated with harvesting activities, exacerbated by unnatural mortality in the wider landscape. Interventions that minimise unnatural mortality, reduce nest disturbance, and retain breeding habitat and nest sites may improve the prospects for the subspecies in the Bass District. If nest disturbance and unnatural mortality continue at the rates modelled here, the species appears to face a high risk of declining substantially in the region. (C) 2009 Published by Elsevier Ltd.

Bentz, P.-G. (2009). Fiskmåsar på Göteborg Landvetter Airport – Analys av maginnehåll. 7 pp.

Bentz, P.-G. (2009). Fåglarna och framtida dagvattenhantering vid Göteborg – Landvetter flygplats – En bedömning av risken för ökad fågelförekomst i samband med ny dagvattenanläggning. 12 pp.

Blackwell, B.F., DeVault, T.L., et al. (2009). "Wildlife collisions with aircraft: A missing component of and-use planning for airports." Landscape and Urban Planning **93**(1): 1-9.

Projecting risks posed to aviation safety by wildlife populations is often overlooked in airport land-use planning. However, the growing dependency on civil aviation for global ommerce can require increases in capacity at airports which affect land use, wildlife populations, and perspectives on aviation safety. Our objectives were to (1) review legislation that affects airports and surrounding communities relative to managing and reducing wildlife hazards to aviation; (2) identify information gaps and future research needs relative to regulated land uses on and near airports, and the effects on wildlife populations; and (3) demonstrate how information regarding wildlife responses to land-use practices can be incorporated into wildlife-strike risk assessments. We show that guidelines for land-use practices on and near airports with regard to wildlife hazards to aviation can be vague, conflicting, and cientifically ill-supported. We discuss research needs with regard to management of stormwater runoff; wildlife use of agricultural crops and tillage regimens relative to revenue and safety; the role of an airport in the landscape matrix with regard to its effects on wildlife species richness and abundance; and spatial and temporal requirements of wildlife species that use airports, relative to implementing current and novel management techniques. We also encourage the development and maintenance of datasets that will allow realistic assessment of wildlife-strike risk relative to current airport conditions and anticipated changes to capacity. Land uses at airports influence wildlife populations, and understanding and incorporating these effects into planning will reduce risks posed to both aviation safety and wildlife species.species.

Chen, W.S., Ning, H.S., et al. (2009). "Flight path detection of bird targets in radar Images." Chinese Journal of Electronics **18**(1): 192-194.

A sequence of radar images containing bird flock targets was obtained by using a self-development Bird Detection radar system (BDRS) for predicting Bird strike hazard (BSH) applications. We modified standard marine radar to establish the system. Bird flock targets were separated from complicated radar images mainly based on Principal component analysis (PCA) and mathematical morphology. PCA was used to reject the background from the image sequence, and morphology was applied for marginal de-noising. After mass center of bird flock target in every image was calculated, a flight path was detected approximately by data regression algorithm.

Dale, L.A. (2009). "Personal and corporate liability in the aftermath of bird strikes: a costly consideration." Human-Wildlife Conflicts **3**(2): 216-225.

This paper details liability issues inherent in bird-aircraft collisions (bird-strike) incidents at airports and discusses how airport managers and operators must strive to conduct acurate assessments and develop and implement an effective wildlife management plan. Such efforts are mandated by Federal Aviation Administration (FAA) regulations, and failure to follow them may result in loss of human life and property, as well as large financial penalties for managers and operators and adverse media attention and public criticism for the airport authority. collisions (bird-strike) incidents at airports and discusses how airport managers and operators must strive to conduct accurate assessments and develop and implement an effective wildlife management plan. Such efforts are mandated by Federal Aviation Administration (FAA) regulations, and failure to follow them may result in loss of human life and property, as well as large financial penalties for managers and operators and adverse media attention and public criticism for the airport authority.

Dolbeer, R.A. and Wright, S.E. (2009). "Safety management systems: how useful will the FAA National Wildlife Strike Database be?" Human-Wildlife Conflicts **3**(2): 167-178.

The National Wildlife Strike Database for Civil Aviation in the United States became operational in 1995 with the initiation of data entry of all strike reports beginning in 1990. The database contained 82,057 reported strikes from 1990 to 2007. About 9,800 of these strike reports noted damage to the aircraft, of which 2,700 indicated the damage was substantial. The database has proven to be a useful source of objective information on the extent and nature of wildlife strikes for personnel at individual airports and for researchers and regulatory agencies at the national level. With the impending requirement for airports in the United States to manage safety risks through a formal safety management system (SMS) approach, we propose that the database can be a key element for prioritizing wildlife risks and providing objective benchmarks of the effectiveness of wildlife hazard management plans (WHMP). We propose that airports use the number of damaging strikes ranked by causative species over the most recent 5-year interval in combination with species-specific wildlife count data prioritized by likelihood of damage. This would guide species-specific management actions to minimize future risk. We further propose that a benchmark or threshold rate of 0.96 damaging strikes per 100,000 aircraft movements per year be established. Any airport exceeding this damaging strike rate in a given year should reevaluate its WHMP, with a focus on those species posing the greatest risk. To enhance the utility of the database in an SMS, improvements are needed in the level and quality of reporting. In particular, all strikes and the wildlife species involved in them should be reported. During the past 13 years, the National Wildlife Strike Database has provided a scientific foundation for the various efforts underway to reduce the problem of wildlife strikes with aircraft. Improvements in reporting, as outlined above, will make the database even more useful as part of an SMS to enhance safety at airports nationwide. reported strikes from 1990 to 2007. About 9,800 of these strike reports noted damage to the aircraft, of which 2,700 indicated the damage was substantial. The database has proven to be a useful source of objective information on the extent and nature of wildlife strikes for personnel at individual airports and for researchers and regulatory agencies at the national level. With the impending requirement for airports in the United States to manage safety risks through a formal safety management system (SMS) approach, we propose that the database can be a key element for prioritizing wildlife risks and providing objective benchmarks of the effectiveness of wildlife hazard management plans (WHMP). We propose that airports use the number of damaging strikes ranked by causative species over the most recent 5-year interval in combination with species-specific wildlife count data prioritized by likelihood of damage. This would guide species-specific management actions to minimize future risk. We further propose that a benchmark or threshold rate of 0.96 damaging strikes per 100,000 aircraft movements per year be established. Any airport exceeding this damaging strike rate in a given year should reevaluate its WHMP, with a focus on those species posing the greatest risk. To enhance the utility of the database in an SMS, improvements are needed in the level

and quality of reporting. In particular, all strikes and the wildlife species involved in them should be reported. During the past 13 years, the National Wildlife Strike Database has provided a scientific foundation for the various efforts underway to reduce the problem of wildlife strikes with aircraft. Improvements in reporting, as outlined above, will make the database even more useful as part of an SMS to enhance safety at airports nationwide.

Gaber, W., Goetsch, U., et al. (2009). "Screening for Infectious Diseases at International Airports: The Frankfurt Model." Aviation Space and Environmental Medicine **80**(7): 595-600.

Historically, ships brought infectious diseases to the continents of the world, but in this modern em, infectious diseases and pandemics are, primarily spread through aviation as a mode of travel. This is a significant issue in the realm of infection control because of the increased potential for the rapid worldwide transmission and spread of disease. Although the transmission of infectious diseases to airline passengers inside an aircraft is a rare occurrence, it is essential to implement entry and exit screening procedures at airports within the context of the Inter national Health Regulations (IHR) in order to slow clown the spread of infection, especially during the early phases of a pandemic event. Currently, there are no standardized procedures for health screening at airports, thus allowing individual regional authorities to determine what they deem to he appropriate screening measures for implementation. In this paper, we will discuss a new pragmatic approach for entry and exit screening procedures at international airports, propose a new classification system for contacts within the aircraft, and discuss changing the fixed enforcement of standardized community mitigation measures to the implementation of measures that correspond to specific characteristics; of individual pathogenic agents. The proposed catalog of screening measures is aimed at attaining the goals of the IHR, which states that the measures should be reasonable while avoiding inconvenience or harm to passengers and should not be any more disruptive to the smooth handling of passenger traffic than is necessary.

Gehring, J., Kerlinger, P., et al. (2009). "Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions." Ecological Applications **19**(2): 505-514.

Estimates suggest that each year millions of birds, predominantly Neotropical migrating songbirds, collide with communication towers. To determine the relative collision risks that different nighttime Federal Aviation Administration (FAA) communication tower obstruction lighting systems pose to night-migrating birds, we compared fatalities at towers with different systems: white strobe lights only; red strobe-like lights only; red, flashing, incandescent lights only; and red, strobe-like lights combined with non-flashing, steady-burning, red lights. Avian fatality data used to compare these tower light systems were collected simultaneously in Michigan on 20 consecutive days during early morning hours during peak songbird migration at 24 towers in May and September 2005 (total 40 days). Twenty-one towers were 116-146 m above ground level (AGL), and three were >= 305 m AGL. During the two 20-day sample periods, we found a mean of 3.7 birds under 116-146 m AGL towers equipped with only red or white flashing obstruction lights, whereas towers with nonflashing/steady-burning lights in addition to the flashing lights were responsible for 13.0 fatalities per season. Kruskal-Wallis test, ANOVA, Student's t test, and multiple comparisons procedures determined that towers lit at night with only flashing lights were involved in significantly fewer avian fatalities than towers lit with systems that included the FAA "status quo" lighting system (i.e., a combination of red,flashing lights and red, non-flashing lights). There were no significant differences in fatality rates among towers lit with red strobes, white strobes, and red, incandescent, flashing lights. Results from related studies at the same towers in May and September 2004 and September 2003 provide ancillary support for these findings. Our results suggest that avian fatalities can be reduced, perhaps by 50-71%,at guyed communication towers by removing non-flashing/steady-burning red lights. Our lighting change proposal can be accomplished at minimal cost on existing towers, and such changes on new or existing towers greatly reduce the cost of tower

operation. Removing non-flashing lights from towers is one of the most effective and economically feasible means of achieving a significant reduction in avian fatalities at existing communication towers.

Lavoie, M.A., Gakwaya, A., et al. (2009). "Bird's substitute tests results and evaluation of available numerical methods." International Journal of Impact Engineering **36**(10-11): 1276-1287.

Recent bird impact tests were conducted using gelatine as a bird substitute. A recipe for the gelatine is suggested in order to use as a reference in further bird test certification procedures. Results from the tests are also given so that they can be used to validate numerical models and promote the use of numerical tools in aircraft design and certification process. Crown Copyright (C) 2009 Published by Elsevier Ltd. All rights reserved.

Marra, P.P., Dove, C.J., et al. (2009). "Migratory Canada geese cause crash of US Airways Flight 1549." Frontiers in Ecology and the Environment **7**(6): 297-301.

In the United States alone, over 7400 bird-aircraft collisions (birdstrikes) were reported in 2007. Most of these strikes occurred during takeoff or landing of the flight, and it is during these flight phases that aircraft experience their highest risk of substantial damage after colliding with birds. Birdstrikes carry enormous potential costs in terms of lives and money. Using feather remains and other tissue samples collected from the engines of US Airways Flight 1549, which crash landed in the Hudson River in New York City on 15 January 2009 after a birdstrike, we apply molecular tools and stable hydrogen isotopes to demonstrate that migratory Canada geese were responsible for the crash. Determining whether the geese involved in this birdstrike event were resident or migratory is essential to the development of management techniques that could reduce the risk of future collisions. Currently, the US civil aviation industry is not required to report birdstrikes, yet information on frequency, timing, and species involved, as well as the geographic origin of the birds, is critical to reducing the number of birdstrikes. Integrating this information with bird migration patterns, bird-detecting radar, and bird dispersal programs at airports can minimize the risk of such collisions in the future.

McCulloch, N. (2009). "Recent decline of the St Helena wirebird Charadrius sanctaehelenae." Bird Conservation International **19**(1): 33-48.

The Wirebird Charadrius sanctaehelenae, a plover, is the only surviving bird species endemic to the South Atlantic island of St Helena. The species is currently dependent on habitats that are wholly anthropogenic or extensively modified by human activity. A census carried out during 2005-2006 showed that the Wirebird has undergone a decline of more than 40% over a five-year period to a total of 235 individuals. The species now qualifies for re-classification as 'Critically Endangered'. Vegetation surveys support the results of a previous study in suggesting that the decline may be associated with degradation of the Wirebird's favoured grassland habitat due to reduction of livestock numbers. Predation by introduced mammals and birds is also likely to be a factor but this remains unquantified. The Wirebird may face additional threats to its habitat in the future unless potential tourism-related development associated with the proposed construction of an airport on the island is closely regulated.

Miyazaki, K., Machida, T., et al. (2009). "Formation mechanisms of latitudinal CO2 gradients in the upper troposphere over the subtropics and tropics." Journal of Geophysical Research-Atmospheres **114**.

Aircraft observations and numerical simulations using an atmospheric transport model exhibit large latitudinal gradients in the carbon dioxide (CO2) mixing ratio around the subtropics and equator throughout the troposphere. The formation mechanisms of the latitudinal CO2 gradients are investigated at aircraft flight altitudes (350-260 hPa) by

considering the influences of atmospheric transport and carbon fluxes at the earth's surface. A meridional transport analysis demonstrates how various transport processes create the latitudinal CO2 gradients in the upper troposphere. The analysis result shows that around the northern subtropics, the suppression of meridional mixing sharpens the CO2 gradient during boreal winter and spring. In other words, extratropical cyclonic activity effectively flattens the mixing ratio along isentropic surfaces at midlatitudes and induces gradients around the subtropics. The southern subtropical CO2 gradient is also induced by the subtropical mixing barrier and convergence of the cross-equatorial eddy flux. Different from the subtropical gradients, a CO2 gradient in the tropical upper troposphere is not created by the suppression of meridional transport but is created by the uplifting of low-level air during boreal winter and spring. The latitudinal CO2 gradient in the tropical upper troposphere decreases due to interhemispheric transport. The seasonal migration of the mean Hadley circulation yields efficient interhemispheric transport and reduces the tropical CO2 gradient.

Parsons, J.G., Blair, D., et al. (2009). "Bat strikes in the Australian aviation industry." Journal of Wildlife Management **73**(4): 526-529.

Bat collisions are a threat to commercial and military aircraft in Australia. We examined bat strike records from Australia during 1996-2006 and found that risk of impact from bats is increasing, is greatest in tropical versus temperate regions, and is more likely during early evening and while an aircraft is landing rather than departing. Temporal patterns of bat strikes differ from those of birds, highlighting the need to employ taxon-specific management strategies to minimize animal impacts on the aviation industry. The use of genetics for identification of strike remains and the implementation of nocturnal survey techniques by wildlife managers at airports will contribute to the mitigation of bat strikes.

Paslawski, J. (2009). "Flexibility in highway noise management." Transport **24**(1): 66-75.

The problem of noise management was taken as a key element of our life comfort. An adequate noise mitigation plan must be elaborated and implemented for a number of potential noise sources. The general idea of FLENOMA2 (FLExibility NOise MAnagement for A2 POZNAN BY-PASS) advisory system was based on flexibility options situated on different management levels. In the recent years, two significant noise sources have been established in Poznan agglomeration: POZNAN BY-PASS A2 as a part of A2 highway (BERLIN-MOSCOW) and the NATO aircraft base in Krzesiny. Both are situated in the urban area of Poznan city. Special emphasis will be placed on flexibility noise mitigation options as an example of operational decision-aid. However, finding a compromise solution based on diffused (using the Internet) information about the noise map (will be present in the near future) is the second goal of this system.

Sastre, P., Ponce, C., et al. (2009). "Disturbances to great bustards (Otis tarda) in central Spain: human activities, bird responses and management implications." European Journal of Wildlife Research **55**(4): 425-432.

We investigated the effects of human activities on the behaviour of great bustards (Otis tarda) in a Special Protection Area in central Spain. We recorded 532 disturbances, at a rate of 0.93 disturbances per hour, a high value compared to other studies. Escape (flight/running) was observed more often than alert. Flight was more frequent than running. Car traffic and walkers were the main sources of disturbance. Motorcyclists, dogs, helicopters and aeroplanes were also harmful in relation to their abundance and time of permanence. Farming and shepherding produced few disturbances and usually did not cause a flight response. These activities are thus considered compatible with the conservation of the great bustards. Hunting caused an increase in the frequency of disturbance on weekends and holidays with respect to working days. We propose access restrictions to car traffic and helicopters/airplanes and hunting limitations in those areas more frequently used by the species.

Seamans, T.W., Clemons, S.E., et al. (2009). "Observations of neck-collared Canada geese near John F. Kennedy International Airport, New York." Human-Wildlife Conflicts **3**(2): 242-250.

Canada geese (Branta canadensis) often cause significant damage when they strike aircraft. They are responsible for a reported minimum of $2.6 million in damage per year to civil aviation in the United States. Knowledge of goose movements in relation to airports would allow wildlife managers to allocate time and funds to manage those populations that pose the greatest threat to aircraft. We placed alpha-numeric neck collars on 300 Canada geese within 8 km of both John F. Kennedy International Airport (JFKIA) and LaGuardia Airport in New York, New York. We conducted weekly observations for 2 years within a 12-km radius of JFKIA at locations used by the geese. At the conclusion of the study, 45% of the collared geese remained within an 8-km radius of JFKIA, and four were killed at JFKIA during wildlife control operations. We observed birds at their original banding sites 75% of the time, and within 5 km of the banding location 95% of the time. Geese that remained in the study area were re-sighted at a mean straight-line distance of 3.6 (plus or minus 3.1) km from their original banding location. We note that 78% of the re-sighting locations used by geese were within 8 km of JFKIA and that movements of these geese could take them over or onto JFKIA. Oiling goose eggs to kill the embryos, rounding up of flightless birds within 8 km of the airport, and bird-control activities at JFKIA and nearby areas all should be continued to reduce the probability of a catastrophic bird strike between aircraft using JFKIA and local Canada geese. they strike aircraft. They are responsible for a reported minimuf $2.6 million in damage per year to civil aviation in the United States. Knowledge of goose movements in relation to airports would allow wildlife managers to allocate time and funds to manage those populations that pose the greatest threat to aircraft. We placed alpha-numeric neck collars on 300 Canada geese within 8 km of both John F. Kennedy International Airport (JFKIA) and LaGuardia Airport in New York, New York. We conducted weekly observations for 2 years within a 12-km radius of JFKIA at locations used by the geese. At the conclusion of the study, 45% of the collared geese remained within an 8-km radius of JFKIA, and four were killed at JFKIA during wildlife control operations. We observed birds at their original banding sites 75% of the time, and within 5 km of the banding location 95% of the time. Geese that remained in the study area were re-sighted at a mean straight-line distance of 3.6 (plus or minus 3.1) km from their original banding location. We note that 78% of the re-sighting locations used by geese were within 8 km of JFKIA and that movements of these geese could take them over or onto JFKIA. Oiling goose eggs to kill the embryos, rounding up of flightless birds within 8 km of the airport, and bird-control activities at JFKIA and nearby areas all should be continued to reduce the probability of a catastrophic bird strike between aircraft using JFKIA and local Canada geese.

Tzovolou, D.N., Benoit, Y., et al. (2009). "Spatial distribution of jet fuel in the vadoze zone of a heterogeneous and fractured soil." Science of the Total Environment **407**(8): 3044-3054.

The goal of the present work is to screen and evaluate all available data before selecting and testing remediation technologies on heterogeneous soils polluted by jet fuel. The migration pathways of nonaqueous phase liquids (NAPLs) in the subsurface relate closely with soil properties. A case study is performed on the vadoze zone of a military airport of north-west Poland contaminated by jet fuel. Soil samples are collected from various depths of two cells, and on-site and off-site chemical analyses of hydrocarbons are conducted by using Pollut Eval (R) apparatus and GC-MS. respectively. The geological conceptual model of the site along with microscopic and hydraulic properties of the porous matrix and fractures enable us to interpret the non-uniform spatial distribution of jet fuel constituents. The total concentration of the jet fuel and its main hydrocarbon families (n-paraffins, major aromatics) over the two cells is governed by the slow preferential flow of NAPL through the porous matrix, the rapid NAPL convective flow through vertical desiccation and sub-horizontal glaciotectonic fractures, and n-paraffin biodegradation in upper layers where the rates of oxygen

transfer is not limited by complexities of the pore structure. The information collected is valuable for the selection, implementation and evaluation of two in situ remediation methods. (C) 2009 Elsevier B.V. All rights reserved.

Vorotkov, M., Sinelschikova, A., et al. (2009). "Optical matrix device : Technical aspects of a new tool for the detection and recording of small nocturnal aerial targets." Journal of Navigation **62**(1): 23-32.

The detection of flying targets in the night sky has provided interest for bird migration research over many years with methods largely dependent on moon watching or the use of radar and infrared camera. These methods lack the versatility of the system described in this paper which detects and automatically records aerial targets in the night sky of a size greater than 5 cm and at a distance of 100 to 1000 metres from the observer. The principle design features are first, an optical device for receiving images of targets on two high-sensitivity CCD matrices when illuminated by white light from searchlight beams and secondly, instantaneous parallactic electronic computation enabling the distance from device to target to be accurately measured, and sequential image:, of each target to be recorded to computer. The device has been tested on targets during the main seasonal nocturnal migration of birds and provides accurate image details of important target flight parameters including: altitude, linear size (wing span and body length), direction of flight (ground track), orientation of the body axis - heading, ground speed, wing-beat frequency, number of wing-beats in each series of beats, duration of the pause between each series of wing-beats, and type of flight trajectory. There are also the potential practical applications for aviation bird-strike at night as well as the remote monitoring of insects, bats and other targets of natural and artificial origin.

Washburn, B. (2009). "Using satellite telemetry to reduce risk of Osprey collisions with military aircraft." Microwave Telemetry Newsletter Archive. from http://www.microwavetelemetry.com/newsletters.php spring09page2.

Wong, D.K.Y., Pitfield, D.E., et al. (2009). "The development of a more risk-sensitive and flexible airport safety area strategy: Part I. The development of an improved accident frequency model." Safety Science **47**(7): 903-912.

This two-part paper presents the development of an improved airport risk assessment methodology aimed at assessing risks related to aircraft accidents at and in the vicinity of airports and managing airport safety areas (ASAs) as a risk mitigation measure. The improved methodology is more quantitative, risk-sensitive, flexible and transparent than standard risk assessment approaches. As such, it contributes to the implementation of Safety Management Systems at airports, as stipulated by the International Civil Aviation Organisation. The first part of the paper presents the methodological advances made in the development of accident frequency models; namely the building of a single comprehensive database of all relevant accident types, the collection and use of normal operations data in quantifying the criticality of a series of risk factors, and modelling accident frequency using multivariate logistic regression. The resulting models have better goodness-of-fit, sensitivity and specificity than standard risk assessment methodologies. (C) 2008 Elsevier Ltd. All rights reserved.

Wong, D.K.Y., Pitfield, D.E., et al. (2009). "The development of a more risk-sensitive and flexible airport safety area strategy: Part II. Accident location analysis and airport risk assessment case studies." Safety Science **47**(7): 913-924.

This two-part paper presents the development of an improved airport risk assessment methodology aimed at assessing risks related to aircraft accidents at and in the vicinity of airports and managing Airport Safety Areas (ASAs) as a risk mitigation measure. The improved methodology is more quantitative, risk-sensitive, flexible and transparent than standard risk assessment approaches. As such, it contributes to the implementation of Safety Management Systems at airports, as stipulated by the

international Civil Aviation Organisation. The second part of the paper presents the analysis of accident locations, including the plotting of Complementary Cumulative Probability Distributions for the relevant accident types. These were then used in conjunction with the improved accident frequency models to produce Complementary Cumulative Frequency Distributions that could be used to assess risks related to specific runways and determine Airport Safety Area (ASA) dimensions necessary to meet a quantitative target level of safety. The approach not only takes into account risk factors previously ignored by standard risk assessments but also considers the operational and traffic characteristics of the runway concerned. The use of the improved risk assessment technique and risk management strategy using ASAs was also demonstrated in two case studies based on New York LaGuardia Airport and Boca Raton Airport in Florida. (C) 2008 Elsevier Ltd. All rights reserved.

Aas, C.K. (2009). Tiltaksplan mot fugler på Rygge flystasjon høsten 2009. Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo. 4 pp.

Airoldi, A. (2008). "Significant properties of aluminium light alloys in the design of energy absorbing aircraft structures." Metallurgia Italiana(3): 5-14.

The paper summarises the fundamental aspects of the design of structure,,; and structural parts in aluminium light alloys in cases when energy absorption performances are required. Particularly, the design of crashworthy helicopter structures and the development of leading edges, for wings or tail empennages, in bird impact conditions are considered. In both cases the structural performance turns out to be strongly influenced by the material properties beyond the elastic range, such as the ultimate strength, the overall toughness, the elongation at failure and file strain rate sensitivity of the plastic response. The design conditions of crashworthy helicopter structures are referred to potentially survivable crash scenarios where file absorption of the impact energy by means of absorbers located in the landing gears, in the subfloor and in the seats call significantly reduce the occupant injuries (Figure 1). The deceleration experienced by the occupants is actually influenced by file response of the whole structure of the helicopter, as it call be outlined by the experimental evidence in all helicopter crash test (Figure 2). As far as the subfloor and the landing gears are concerned, some design solutions developed to integrate energy absorbing elements in their structural lay-outs are presented (Figures 3,4). The Working mechanism of light alloy absorbers is exemplified considering a light alloy crushing tube (Figure 5) and the role that call be played by numerical analyses in the design and verification of the absorbers integrated in the helicopter structure is outlined (Figure 6). Indeed, many helicopter structural parts contribute to transmit the loads thus allowing file absorbers to properly work and for thus parts, strength requirements have to be considered far more important than energy absorbing issues. To identify the A role played by the different parts and the consequent requirements, all hybrid multi-body/finite elements modelling technique is presented With all application to an helicopter subfloor (Figure 7). A general evaluation of the roles played by the strength level, the elongation at failure and the strain rate sensitivity in the design of light alloy absorbers is then carried out, basing oil analytical formulations for the prediction of the absorber performances that are correlated with a data base of experimental results (Figures 8,9). Experiments performed with absorbers made of different light alloy are also discussed (Figures 10,11). Attention is then focused oil the issues relevant to the bird impacts oil aircraft structures, after having pointing out that this occurrence turns out to be, basing oil the current civil aviation regulation, the dimensioning condition for many parts of fixed and rotary Wing aircraft structures. The force levels that call be exerted by a bird strike are evaluated (Figure 12) and file main design philosophies developed to design bird proof leading edges are presented (Figure 13). It is evidenced that, also in this case, the problem call not be reduced to design a structure and select a material for maximum energy absorbing capabilities. In fact, the risk of bird pocketing due to all excessive structural deformation suggests to take into considerations design solutions where the

bird material is actually deflected. In such cases, the strength levels of the chosen light alloy may determine the development Of all adequate bird proof structure, These concepts are illustrated considering the bird impact oil a hybrid light alloy/carbon composite vertical stabilizer (Figure 14). A numercal model of the impact test is also presented discussing the key role performed, in the performed numerical analysis, by a damage law introduced to approximately model the tearing of the structural barrier (Figure 15). The completely different experimental outcomes obtained in two impact conditions are presented, indicating that the adopted simplified material characterisation call indeed evaluate the adequacy of the structural impact strength levels (Figures 76, 17). Globally, all the presented numerical cases highlight the potential role that can be played, in exploiting the full range of properties offered by aluminium alloys, by the execution of numerical analyses, when reliable and complete descriptions of file material behaviour beyond the elastic range are introduced in the models.

2008

Allison, T.D., Jedrey, E., et al. (2008). "Avian issues for-offshore wind development." Marine Technology Society Journal **42**(2): 28-38.

Wind energy is the fastest growing source of electricity in the U. S., and the energy potential in the offshore environment is enormous. Environmental concerns have focused on effects on birds,and in this paper we briefly review these effects in the context of methods for assessing preconstruction risk and postconstruction impact. Federal statutes and legislation, including the National Environmental Policy Act, Federal Energy Act of 2005, the Endangered Species Act, and the Migratory Bird Treaty will require that prospective developers conduct some form of avian risk assessment prior to construction. Such preconstruction studies should utilize a Before-After-Control-Impact (BACI) design. Offshore wind farms pose three primary threats to birds: barrier effects due to flight avoidance, habitat loss (due to displacement), and fatalities resulting from collisions with turbine blades. All have been demonstrated at land-based and coastal wind farms, and flight avoidance and shifts in habitat use have been demonstrated in the offshore environment for a limited number of species in Europe. The additive effect of these impacts to bird populations may be trivial under current levels of development, but could become ecologically significant as offshore installations increase as projected. Interpreting the ecological significance of these effects requires additional research, especially on understanding the importance of winter foraging habitat and population delineation, particularly for waterfowl. Such research and preconstruction studies will be expensive, and we suggest public funding of these efforts and private-public partnerships as is currently underway in some states.

Arnett, E.B., Brown, W.K., et al. (2008). "Patterns of bat fatalities at wind energy facilities in North America." Journal of Wildlife Management **72**(1): 61-78.

Wind has become one of the fastest growing sources of renewable energy worldwide, but widespread and often extensive fatalities of bats have increased concern regarding the impacts of wind energy development on bats and other wildlife. We synthesized available information on patterns of bat fatalities from a review of 21 postconstruction fatality studies conducted at 19 facilities in 5 United States regions and one Canadian province. Dominance of migratory, foliage- and tree-roosting lasiurine species (e.g., hoary bat [Lasiurus cincreus]) killed by turbines was consistent among studies. Bat fatalities, although highly variable and periodic, consistently peaked in late summer and fall, coinciding with migration of lasiurines and other species. A notable exception was documented fatalities of pregnant female Brazilian free-tailed bats (Tadarida brasiliensis) in May and June at a facility in Oklahoma, USA, and female silver-haired bats (Lasionycteris noctivagans) during spring in Tennessee, USA, and Alberta, Canada. Most studies reported that fatalities were distributed randomly across turbines at a site, although the highest number of fatalities was often found near the end Of turbine strings. Two studies conducted simultaneously in the same region documented

similar timing of fatalities between sites, which suggests broader patterns of collisions dictated by weather, prey abundance, or other factors. None of the studies found differences in bat fatalities between turbines equipped with lighting required by the Federal Aviation Administration and turbines that were unlit. All studies that addressed relationships between bat fatalities and weather patterns found that most bats were killed on nights with low wind speed (<6 m/sec) and that fatalities increased immediately before and after passage of storm fronts. Weather patterns may be predictors of bat activity and fatality; thus, mitigation efforts that focus on these high-risk periods could reduce bat fatality substantially. We caution that estimates of bat fatality are conditioned by length of study and search interval and that they are biased in relation to how searcher efficiency, scavenger removal, and habitat differences were or were not accounted for. Our review will assist managers, biologists, and decision-makers with understanding unifying and unique patterns of bat fatality, biases, and limitations of existing efforts, and it will aid in designing future research needed to develop mitigation strategies for minimizing or eliminating bat fatality at wind facilities.

Battistoni, V., Montemaggiori, A., et al. (2008). Beyond falconry between tradition and modernity: a new device for bird strike hazard prevention at airports. 13 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP13.pdf.

Most accredited studies in Italy and all over the world emphasize the problems related to traditional falconry used as a means against bird hazard at airports. Some negative features of using falcons are the impossibility to be employed during some periods of the year and adverse weather conditions, unforeseen animal behaviour, their biological needs, the tight dependency on the falconer and the limited employment over the day. Above all, high costs play a key role due to the value of the animals, to their training, to the number of birds necessary to be effectively operated on a medium/large size airport and finally to the employment features. The attempts to use remote-controlled model aircrafts instead of real falcons proved to be unsuccessful because of the habituation effect it produced on other birds, that are certainly harassed by the device, but do not recognize it as a natural bird of prey, whose hunting area must be avoided. So it is the frightening effect that is missing, upon which also other dispersal methods are based, such as distress calls or predator effigies. The use of full scale bird of prey accurate reproductions, engine powered and fully remote-controlled, seems to have reached the goal to match the natural predator effectiveness with employment flexibility, cost reduction and mass production.

Baxter, A. (2008). The impact of lethal control as a reinforcement echnique when deploying ibsc best practice standards on an aerodrome. 28th IBSC meeting, Brasil. 6 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP04.pdf.

IBSC best practice standard 4 recommends that; “staff should have access to appropriate devices for the removal of birds/wildlife…” This paper discusses how carefully targeted removal of birds significantly increased the effectiveness of non-lethal active bird control on a European aerodrome. Lethal control, in combination with blank shot, was initially tested at two UK landfill sites to remove any risk of increased bird activity in an airfield environment. Deployment under a 7 days a week, daylight hours regime was implemented at one site and deployment under a 5 days a week, operational hours regime was implemented at the other. Measurements of the number of birds removed and overall numbers of birds present were recorded. Daylight hours 7-days a week control minimised both the number of birds shot and the number of birds present. This regime was therefore implemented alongside a suite of nonlethal bird control measures at a European aerodrome. The number of birds shot and number of birds struck by aircraft were then analysed. The integrated system dramatically improved following the inclusion of lethal reinforcement. Lethal control, used sparingly, and as a reinforcement to more traditional techniques, is highly effective at increasing the response rates of birds to deterrence effort.

Bentz, P.-G. (2008). Åtgärder för kvävereduktion vid Skaraborgs flygflottilj F 7, Såtenäs – Utvärdering av åtgärdsförslag avseende risken för ökad fågelförekomst. Sweco Environment, Karlskrona. 11 pp.

Bentz, P.-G. (2008). Planerad utjämnings-/säsongslagringsdamm på Stockholm–Arlanda flygplats – Bedömning av risken för ökad fågelförekomst samt förslag till åtgärder. Inledande rapport. Luftfartsverket-Arlanda. 5 pp.

Bentz, P.-G. and Rosengren, O. (2008). Fågelinventering Stockholm–Arlanda flygplats. 8 pp.

Blackwell, B.F., Schafer, L.M., et al. (2008). "Bird use of stormwater-management ponds: Decreasing avian attractants on airports." Landscape and Urban Planning **86**(2): 162-170.

Characteristics of stormwater-management ponds that contribute to avian hazards to aviation at airports have not been quantified. We selected 30 stormwater-management ponds (average 0.1 ha), approximately 50 km from Seattle-Tacoma International Airport, as surrogates to on-airport facilities. We conducted 46 weeks of avian surveys (between 14 February 2005 and 17 February 2006) and evaluated model fit of 6 a priori models relative to pond use by an avian group via Kullback-Leibler information. Our full model, composed of pond surface area (sa), ratio of area of open water to area of emergent and woody vegetation (ow:ew), perimeter irregularity, and geographic isolation, was among 3 best approximating models for pond use by 9 of 13 groups (within Anatidae, Ardeidae, Charadriidae, Columbidae, Accipitridae, Laridae, and Rallidae) considered. The full model and models lacking sa or ow:ew were indistinguishable in fit for a group composed of avian species considered hazardous to aviation. For models selected, Akaike weights (i.e., relative likelihoods) ranged from 0.869 to 0.994. In contrast, relative likelihood for a mean model (i.e., a model including only an intercept) was <10(-4) for all groups. We suggest that designs of stormwater-management ponds at airports in the Pacific Northwest should minimize the pond perimeter via circular or linear designs. Also, ponds should be located so as to reduce the number and proximity of other water resources within 1 km. For existing stormwater-management ponds at airports, we suggest reducing the availability of open water via covering or drawdown. Published by Elsevier B.V..

Blagojevic, N.Z., Vukasinovic-Pesic, V.L., et al. (2008). "Migration and total concentration of heavy metals in soil samples from the Zeta Valley, Montenegro." Research Journal of Chemistry and Environment **12**(4): 76-81.

The total and the migration concentration of lead (Pb), cadmium (Cd), copper (Cu), zinc (Zn), iron (Fe) and manganese (Mn) in 20 soil samples taken from the surrounding area of Aluminium Factory Podgorica, airports, asphalt plant and highroad in Zeta Valley (Montenegro) were determined. The applied method for preparation of soil samples was the extraction method using CH3COONH4 and CH3COOH for migration concentration, and HCl for total concentration of metals. The concentrations of examined metals were determined by flame atomic absorption spectrometry (FAAS) method. The migration concentration of Pb, Cd and Zn in investigated soil samples ranged within the values allowed by the regulations, the concentrations of migration of Fe and Mn were in accordance to the natural concentration and the migration concentration of Cu in two samples exceeded allowable limits. The total concentration of metals in particular soil samples exceeded the values allowed by the regulations, which is probably the consequence of the influence of aluminium factory, street traffic and usage of plant protection products.

Christensen, T.K. (2008). Risk assessment in relation to restoration of wetlands (lakes and wet meadows) in proximity to airports, a basic model. 28th IBSC meething Brasil**:** 9 pp.

In 1998, the Danish Environmental authorities intended to restore approximately 16.000 ha of low-level areas into functional wetlands, primarily lakes and wet meadows under a national water management plan (VMP2). The primary aim of VMP 2 was to reduce

the outwash of nitrogenous and phosphorous compounds from cultivated farmland areas to lakes, fjords and coastal and offshore areas around Denmark. VMP 2 was also intended to increase biodiversity, and birds were expected to be among the first conspicuous species to colonise restored wetlands. In Denmark, the authorities responsible for airport management are obliged by the National Aviation Authority to take actions to prohibit the establishment of habitats or landscape features within 13 km from airports that potentially attract birds. Hence an obvious conflict of interest exists between the Environmental and Aviation authorities in relation to restoring or establishing wetlands in suitable places near airports. To evaluate the potential bird strike risk from new wetlands close to airports, a general assessment of expected bird occurrence (based on species specific ecology) in relation to various types of wetlands, wetland size and shape and management strategies, was compared to existing bird strike statistics from Denmark 1992-2005. This comparison formed the basis for developing a basic geographical model, which set out guidelines for what habitat changes may be permitted without increasing the risk of bird strikes, as well as proscribing high risk actions in areas close to airports. Basically the model outputs predict that only very minor habitat changes should be made within 6 km of airport runways, whereas larger wetland projects may be considered at distances between 6 and 13 km, pending careful evaluation of potential bird movements across airport areas between the new and existing wetlands. The model can be considered a basic tool in wetland management near airports, but the applicability and usefulness to specific airports will depend somewhat on specific local and regional knowledge of bird occurrence and movements.

Cook, A., Rushton, S., et al. (2008). "An evaluation of techniques to control problem bird species on landfill sites." Environmental Management **41**(6): 834-843.

Birds feeding on landfill sites cause problems in terms of nuisance to neighbors, flight safety, a threat to public health, and affecting the day to day site operation. A number of control measures exist to deter problem species; however, research into their effectiveness across sites and for multiple species has been limited. We use a modeling approach in order to assess the effectiveness of nine techniques - pyrotechnics, hand-held distress calls, static distress calls, blank ammunition, a combination of blank and lethal use of ammunition, the use of falcons, the use of hawks, waiters and helium-filled bird-scaring kites - at deterring three commonly recorded species - the Black-headed Gull (Larus ridibundus), the Herring Gull (Larus argentatus) and the Lesser Black-backed Gull (Larus fuscus) - from six landfill sites across the United Kingdom. The use of distress calls, falconry, and combinations of lethal and nonlethal use of ammunition were the most effective techniques for initially deterring birds from these sites. However, when habituation is considered, there is a clear difference between techniques such as falconry, which have a lethal aspect and may act to reinforce the deterrence, and the use of techniques such as distress calls, which do not. However there are problems related to legislation and public perception when lethal techniques are used.

Coss-Custard, J.D. and Stillman, R.A. (2008). "Individual-based models and the management of shorebird populations." Natural Resource Modeling **21**(1): 3-71.

Individual-based models (IBMs) predict how animal populations will be affected by changes in their environment by modeling the responses of fitness-maximizing individuals to environmental change and by calculating how their aggregate responses change the average fitness of individuals and thus the demographic rates, and therefore size of the population. This paper describes how the need to develop a new approach to make such predictions was identified in the mid-1970s following work done to predict the effect of building a freshwater reservoir on part of the intertidal feeding areas of the shorebirds Charadrii that overwhiter on the Wash, a large embayment on the east coast of England. The paper describes how the approach was developed and tested over 20 years (1976-1995) on a population of European oystereatchers

Haematopus ostralegus eating mussels Mytilus edulis on the Exe estuary in Devon, England. The paper goes on to describe how individual-based modeling has been applied over the last 10 years to a wide range of environmental issues and to many species of shorebirds and wildfowl in a number of European countries. Although it took 20 years to develop the approach for I bird species on I estuary, ways have been found by which it can now be applied quite rapidly to a wide range of species, at spatial scales ranging from I estuary to the whole continent of Europe. This can now be done within the time period typically allotted to environmental impact assessments involving coastal bird populations in Europe. The models are being used routinely to predict the impact on the fitness of coastal shorebirds and wildfowl of habitat loss from (i) development, such as building a port over intertidal flats; (ii) disturbance from people, raptors, and aircraft; (iii) harvesting shellfish; and (iv) climate change and any associated rise in sea level. The model has also been used to evaluate the probable effectiveness of mitigation measures aimed at ameliorating the impact of such environmental changes on the birds. The first steps are now being taken to extend the approach to diving sea ducks and farmland birds during the nonbreeding season. The models have been successful in predicting the observed behavior and mortality rates in winter of shorebirds on a number of European estuaries, and some of the most important of these tests are described. These successful tests of model predictions raise confidence that the model can be used to advise policy makers concerned with the management of the coast and its important bird populations.

Dekker, A., van Gasteren, H., et al. (2008). The European Space Agency´s FlySafe project, looking at the bird strike problem from another perspective. 28th IBSC meeting, Brasil. 16 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP16.pdf.

Delingat, J., Bairlein, F., et al. (2008). "Obligatory barrier crossing and adaptive fuel management in migratory birds: the case of the Atlantic crossing in Northern Wheatears (Oenanthe oenanthe)." Behavioral Ecology and Sociobiology **62**(7): 1069-1078.

Behaviour on migration was often suggested to be selected for time-minimising strategies. Current optimality models predict that optimal fuel loads at departure from stopover sites should increase with increasing fuel deposition rates. We modified such models for the special case of the east Atlantic crossing of the Northern Wheatear (Oenanthe oenanthe). From optimality theory, we predict that optimal time-minimising behaviour in front of such a barrier should result in a positive correlation between fuel deposition rates and departure fuel loads only above a certain threshold, which is the minimum fuel load (f(min)) required for the barrier crossing. Using a robust range equation, we calculated the minimum fuel loads for different barrier crossings and predict that time-minimising wheatears should deposit a minimum of 24% fuel in relation to lean body mass (m (0)) for the sea crossing between Iceland and Scotland. Fuel loads of departing birds in autumn in Iceland reached this value only marginally but showed positive correlation between fuel deposition rate (FDR) and departure fuel load (DFL). Birds at Fair Isle (Scotland) in spring, which were heading towards Iceland or Greenland, were significantly heavier and even showed signs of overloading with fuel loads up to 50% of lean body mass. Departure decisions of Icelandic birds correlated significantly with favourable wind situations when assuming a migration direction towards Spain; however, the low departure fuel loads contradict a direct non-stop flight.

DeVault, T.L., Kubel, J.E., et al. (2008). "Mammalian hazards at small airports in Indiana: impact of perimeter fencing." Human-Wildlife Conflicts **2**(2): 240-247.

Fences are used at many airports and small airfields to exclude wildlife from entering critical areas. However, not all fences exclude hazardous mammals reliably, and effective fences can be too expensive for small airports to purchase and maintain. In this study, we evaluated fencing at 10 small airports in Indiana and documented the presence and relative abundance of wildlife within airport boundaries using remote

cameras and spotlight surveys. Only 4 airports were completely fenced, and four were <50% fenced. All airports had openings in their fence lines that would allow hazardous wildlife access to the airfields. We encountered either white-tailed deer (*Odocoileus virginianus*) or coyotes (*Canis latrans*) at nine of the airports with remote cameras and during spotlight surveys. There were fewer coyotes and white-tailed deer encountered during spotlight surveys at completely-fenced airports ˜(= 0.40 individuals/km across 8 surveys; SE = 0.24) than were encountered at airports that were not completely fenced ˜(= 6.15; SE = 2.32; *P* = 0.032). Our study suggests that complete enclosure of airfields and regular fence maintenance is vital for effective wildlifestrike management at small airports.

Diamond, T. (2008). The modern options for record keeping and analysis of airfield bird control. 28th IBSC meeting, Brasil. 8 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP08.pdf.

Airfield Bird Control current “best practice” guides require a high level of record keeping. Detailed logs of bird control protect airports and staff, allowing them to demonstrate “due diligence” in the event of an incident. Incidents are relatively rare, due diligence has to be demonstrated at all times. Handwritten records may raise integrity questions, records can be tampered with after an incident. Recent technological advances, including GPS location reporting, help to eradicate this problem. The benefits of a bird activity database also carry high importance, allowing airfield operations to monitor bird dispersal activities, safety standards, pre-empt influxes of birds and organise control protocol accordingly. What are the options available to Airports? What risks are incurred when airports neglect safety recommendations and dictates?

Dolbeer, R.A. and Wright, S.E. (2008). Wildlife strikes to civil aircraft in the United States 1990-2007. **14**. Report of the associate administrator of airports, office of airport safety and standards, airport safety & certification, Washington, DC
69 pp.

Dove, C.J. and Goodroe, C. (2008). "Marbled godwit collides with aircraft at 3,700 m." Wilson Journal of Ornithology **120**(4): 914-915.

On 25 August, 2007, a Marbled Godwit (Limosa fedoa) was struck by a Southwest Airlines Boeing 737 at 3,700 m. The bird was identified by examination of feather remains recovered from the aircraft and represents an altitude record for this species.

Dove, C.J., Rotzel, N.C., et al. (2008). "Using DNA barcodes to identify bird species involved in birdstrikes." Journal of Wildlife Management **72**(5): 1231-1236.

We determined effectiveness of using mitochondrial DNA barcodes (cytocbrome c oxidase subunit 1 [CO1]) to identify birdaircraft collision (birdstrike) cases that lacked sufficient feather evidence for morphological diagnosis. From September through December 2006, 821 samples from birdstrike events occurring in the United States were submitted for DNA analysis. We successfully amplified a CO1 DNA barcode product from 554 (67.5%) of the samples; 267 (32.5%) did not contain viable DNA and depended on morphological methods (microscopy) for Order or Family level identification. We deemed 19 cases inconclusive either because the DNA barcode recovered from the sample did not meet our 98% match criteria when compared to the Barcode of Life Database (BoLD) or because the DNA barcode matched to a set of >= 2 closely related species with overlapping barcodes, preventing complete species identification. Age of the sample (<= 6 months) did not affect DNA viability, but initial condition of the sample and the collection method was critical to DNA identification success. The DNA barcoding approach has great potential in aiding in identification of birds (and wildlife) for airfield management practices, particularly in regions of the world that lack the vast research collections and individual expertise for morphologic identifications.

Drewitt, A.L. and Langston, R.H.W. (2008). "Collision effects of wind-power generators and other obstacles on birds." Year in Ecology and Conservation Biology 2008 **1134**: 233-266.

There is extensive literature on avian mortality due to collision with man-made structures, including wind turbines, communication masts, tall buildings and windows, power lines, and fences. Many studies describe the consequences of bird-strike rather than address the causes, and there is little data based on long-term, standardized, and systematic assessments. Despite these limitations, it is apparent that bird-strike is a significant cause of mortality. It is therefore important to understand the effects of this mortality on bird populations. The factors which determine avian collision risk are described, including location, structural attributes, such as height and the use of lighting, weather conditions, and bird morphology and behavior. The results of incidental and more systematic observations of bird-strike due to a range of structures are presented and the implications of collision mortality for bird populations, particularly those of scarce and threatened species susceptible to collisions, are discussed. Existing measures for reducing collision mortality are described, both generally and specifically for each type of structure. It is concluded that, in some circumstances, collision mortality can adversely affect bird populations, and that greater effort is needed to derive accurate estimates of mortality levels locally, regionally, and nationally to better assess impacts on avian populations. Priority areas for future work are suggested, including further development of remote technology to monitor collisions, research into the causes of bird-strike, and the design of new, effective mitigation measures.

Efroymson, R.A., Hargrove, W.W., et al. (2008). "The Apache Longbow-hellfire missile test at Yuma proving ground: Ecological risk assessment for helicopter overflight." Human and Ecological Risk Assessment **14**(5): 871-897.

A multi-stressor risk assessment was conducted at Yuma Proving Ground, Arizona, as a demonstration of the Military Ecological Risk Assessment Framework. The focus of the assessment was a testing program at Cibola Range, which involved an Apache Longbow helicopter firing Hellfire missiles at moving targets, that is, M60-A1 tanks. This article focuses on the wildlife risk assessment for the helicopter overflight. The primary stressors were sound and the view of the aircraft. Exposure to desert mule deer (Odocoileus hemionus crooki) was quantified using Air Force sound contour programs NOISEMAP and MR NMAP, which gave very different results. Slant distance from helicopters to deer was also used as a measure of exposure that integrated risk from sound and view of the aircraft. Exposure-response models for the characterization of effects consisted of behavioral thresholds in sound exposure level or maximum sound level units or slant distance. Available sound thresholds were limited for desert mule deer, but a distribution of slant-distance thresholds was available for ungulates. The risk characterization used a weight-of-evidence approach and concluded that risk to mule deer behavior from the Apache overflight is uncertain, but that no risk to mule deer abundance and reproduction is expected.

Fagerstone, K.A., Miller, L.A., et al. (2008). "Registration of wildlife contraceptives in the United States of America, with OvoControl and GonaCon immunocontraceptive vaccines as examples." Wildlife Research **35**(6): 586-592.

Overabundant wildlife populations have the potential to adversely affect wildlife habitats or pose risks to human health and safety through disease transmission and collisions with vehicles and aircraft. Traditional methods for reducing overabundant wildlife, such as hunting and trapping, are often restricted or infeasible in urban and suburban areas. Additional management options are needed. For the past 15 years, scientists with the US Department of Agriculture's (USDA) Wildlife Services' National Wildlife ResearchCenter have been developing and testing contraceptive agents. This research has resulted in the development of several reproductive inhibitors and has forced regulatory bodies to determine where the regulatory authority for wildlife contraceptives

will reside. The regulatory authority for contraceptives for wildlife and feral animals has recently been moved from the US Food and Drug Administration (FDA) to the US Environmental Protection Agency (EPA). The first contraceptive registered by the EPA since this move was OvoControl-G for reducing the hatchability of Canadagoose eggs. OvoControl was registered in 2005 by Innolytics, LLC working in cooperation with the National Wildlife Research Center. A similar product, OvoControl-P, was registered in 2007 as a contraceptive technique for pigeons. Another product developed by the National Wildlife Research Center, GonaCon immunocontraceptive vaccine, is in the registration process for managing white-tailed deer populations. This manuscript will describe the products that have been and are currently undergoing registration as contraceptives in the United States of America, and the data required for those products.

Fleming, P.J.S. and Tracey, J.P. (2008). "Some human, aircraft and animal factors affecting aerial surveys: how to enumerate animals from the air." Wildlife Research **35**(4): 258-267.

Aerial surveys of wildlife involve a noisy platform carrying one or more observers moving over animals in order to quantify their abundance. This simple-sounding system encapsulates limits to human visual acuity and human concentration, visual attention, salience of target objects within the viewed scene, characteristics of survey platforms and facets of animal behaviours that affect the detection of animals by the airborne observers. These facets are too often ignored in aerial surveys, yet are inherent sources of counting error. Here we briefly review factors limiting the ability of observers to detect animals from aerial platforms in a range of sites, including characteristics of the aircraft, observers and target animals. Some of the previously uninvestigated limitations identified in the review were studied in central and western New South Wales, showing that inaccuracies of human memory and enumeration processes are sources of bias in aerial survey estimates. Standard protocols that minimise or account for the reviewed factors in aerial surveys of wildlife are recommended.

Gibb, R.W. and Olson, W. (2008). "Classification of Air force aviation accidents: Mishap trends and prevention." International Journal of Aviation Psychology **18**(4): 305-325.

This article reanalyzed 124 U.S. Air Force aviation mishaps from 1992 through 2005, using the Department of Defense Human Factors Analysis and Classification System. Mishap types included controlled flight into terrain, loss of control, spatial disorientation, and midair collisions. All accidents were linked with supervisory errors related to proficiency and experience factors. Preconditions to unsafe acts were most frequently related to cognitive, psychobehavioral, and coordination, communication, and planning factors. Continued improvements in operational risk assessment and crew resource management are suggested, as well as interventions such as flight operations quality assurance and line-oriented safety audits to specifically focus latent error mitigation strategies.

Gossling, S., Peeters, P., et al. (2008). "Consequences of climate policy for international tourist arrivals in developing countries." Third World Quarterly **29**(5): 873-901.

One of the major implications of climate change for tourism destinations is the potential impact that mitigation policies aimed at reducing greenhouse gas emissions from the rapidly growing aviation sector could have on travel costs and tourist mobility. Such impact is particularly salient for long-haul destinations. Recently tourism organisations such as the unwto have also expressed concern that aviation sector-focused mitigation policies in wealthy nations that are the major international tourism outbound markets will negatively affect tourism development and wealth transfers to tourism-dependent developing nations. This article reviews emerging climate policies in major tourism outbound markets that have direct implications for the aviation sector and examines the potential consequences for travel costs and tourism demand in 10 tourism-dependent less developed island states with diverse geographic and tourism market characteristics. The analysis confirms that aviation mitigation policies would affect

tourism demand to these nations. 'Carbon smart' tourism market restructuring approaches to reduce the emissions intensity of tourism, and market risk to climate policy changes anticipated over the next 10-20 years, are subsequently discussed.

Guan, Y.P., Zhao, Z.H., et al. (2008). "Foreign object damage to fan rotor blades of aeroengine - Part II: Numerical simulation of bird impact." Chinese Journal of Aeronautics **21**(4): 328-334.

Bird impact is one of the most dangerous threats to flight safety. The consequences of bird impact can be severe and, therefore, the aircraft components have to be certified for a proven level of bird impact resistance before being put into service. The fan rotor blades of aeroengine are the components being easily impacted by birds. It is necessary to ensure that the fan rotor blades should have adequate resistance against the bird impact, to reduce the flying accidents caused by bird impacts. Using the contacting-impacting algorithm, the numerical simulation is carried out to simulate bird impact. A three-blade computational model is set up for the fan rotor blade having shrouds. The transient response curves of the points corresponding to measured points in experiments, displacements and equivalent stresses on the blades are obtained during the simulation. From the comparison of the transient response curves obtained from numerical simulation with that obtained from experiments, it can be found that the variations in measured points and the corresponding points of simulation are basically the same. The deforming process, the maximum displacements and the maximum equivalent stresses on blades are analyzed. The numerical simulation verifies and complements the experiment results.

Guida, M., Marulo, F., et al. (2008). "Analysis of bird impact on a composite tailplane leading edge." Applied Composite Materials **15**(4-6): 241-257.

One of the main structural requirements of a leading edge of a tailplane is to ensure that any significant damage caused by foreign object (i.e. birdstrike, etc...) would still allow the aircraft to land safely. In particular, leading edge must be certified for a proven level of bird impact resistance. Since the experimental tests are expensive and difficult to perform, numerical simulations can provide significant help in designing high-efficiency bird-proof structures. The aim of this research paper was to evaluate two different leading edge designs by reducing the testing costs by employing state-of-the-art numerical simulations. The material considered was a sandwich structure made up of aluminium skins and flexcore as core. Before each test was carried out, pre-test numerical analyses of birdstrike were performed adopting a lagrangian approach on a tailplane leading edge of a large scale aircraft using the MSC/Dytran solver code. The numerical and experimental correlation have shown good results both in terms of global behaviour of the test article and local evolution of some measurable parameters confirming the validity of the approach and possible guidelines for structural design including the bird impact requirements.

Gurski, K. (2008). Vehicle mounted thermal imager used as an airfield wildlife control tool. 28th IBSC meeting, Brasil. 5 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP12.pdf.

A good wildlife control program is a vital part of any aerodromes' flight safety system, and its' importance cannot be overemphasized. A flock of birds or a single deer can cost time, money and lives. All objects emit a certain amount of black-body radiation as a function of their temperatures. Generally speaking, the higher an object's temperature is, the more infrared radiation as black-body radiation it emits. A special camera can detect this radiation in a way similar to an ordinary camera does visible light. It works even in total darkness because ambient light level does not matter. This makes it useful for rescue operations in smoke-filled buildings, underground and as a Wildlife Control tool. The 4 Wing Wildlife Control (WC) Team now has the capability to detect, recognize, identify, locate, and track potentially hazardous wildlife within the GRA under all conditions of visibility, thanks to a new tool in the form of a Thermal-Eye Vehicle Mounted Thermal Imager (VMTI). The VMTI allows the WC Team to scan the

aerodrome for potentially hazardous wildlife with minimum interference to air traffic. Prior to purchasing the VMTI, the WC Team was using a million candle watt spotlight. The spotlight proved to be inadequate due to light diffusion and ambient light from the runways, taxiways and ramps severely reducing the range of the spotlight. Pilot's lives and expensive equipment were risked based on us being able to see glowing eyes in the beam of a spotlight! The paper will discuss the benefits of the VMTI system and its uses in wildlife control within an aerodrome setting.

Hughes, K.A., Waluda, C.M., et al. (2008). "Short-term responses of king penguins Aptenodytes patagonicus to helicopter disturbance at South Georgia." Polar Biology **31**(12): 1521-1530.

The short-term behavioural effects of helicopter overflights on breeding king penguins Aptenodytes patagonicus at South Georgia were examined. Seventeen helicopter overflights were made at altitudes between 230 and 1,768 m (750-5,800 ft) above ground level. Noise from the aircraft engines and helicopter blades increased sound levels in the colony from a background level of 65-69 dB(A) to a maximum mean peak level of 80 dB(A) during overflights. Penguin behaviour changed significantly during all overflights at all altitudes compared to the pre- and post-flight periods. Pre-overflight behaviour resumed within 15 min of the aircraft passing overhead and no chicks or eggs were observed to be taken by predators during overflights. Non-incubating birds showed an increased response with reduced overflight altitude, but this was not observed in incubating birds. Variability in overflight noise levels did not affect significantly the behaviour of incubating or non-incubating birds. Penguins exhibited a reduced response to overflights as the study progressed (despite later flights generally being flown at lower altitudes) suggesting some degree of habituation to aircraft. To minimise disturbance to king penguins we recommend a precautionary approach such that overflights are undertaken at the maximum altitude that is operationally practical, or preferably are avoided altogether.

Husby, M. (2008). Konsekvenser for fugl ved en forlengelse av flystripa utover fjorden ved Trondheim Lufthavn Værnes. Steinkjer, Høgskolen i Nord-Trøndelag.

Jansson, J. and Gustafsson, F. (2008). "A framework and automotive application of collision avoidance decision making." Automatica **44**(9): 2347-2351.

Collision avoidance (CA) systems are applicable for most transportation systems ranging from autonomous robots and vehicles to aircraft, cars and ships. A probabilistic framework is presented for designing and analyzing existing CA algorithms proposed in literature, enabling on-line computation of the risk for faulty intervention and consequence of different actions. The approach is based on Monte Carlo techniques, where sampling-resampling methods are used to convert sensor readings with stochastic errors to a Bayesian risk. The concepts are evaluated using a real-time implementation of an automotive collision mitigation system, and results from one demonstrator vehicle are presented. (c) 2008 Elsevier Ltd. All rights reserved.

Lengagne, T. (2008). "Traffic noise affects communication behaviour in a breeding anuran, Hyla arborea." Biological Conservation **141**(8): 2023-2031.

Modern human societies generate new patterns of noise that may affect acoustic communication in many animal species. Whilst animals have evolved several mechanisms to cope with natural background noise, the rapid increase of anthropogenic alteration of acoustic environment could challenge the potential for adjustments of communicative systems. Because acoustic communication is involved in crucial behaviours, noise pollution can be particularly detrimental in affecting breeding success or survival. I investigated the impact of traffic noise on acoustic communication in a tree frog by way of an experimental approach using noise playback. Traffic noise triggered a decrease of the males' calling activity, with males being more affected when noise amplitude increased. Additionally the, males' social

situation (calling in chorus versus alone) exerted a strong influence on sensitiveness to noise. Males were only weakly affected by noise pollution when calling in a chorus situation, probably because they were more stimulated and because traffic noise emergence was lower. Moreover results showed that in response to noise playback, males are not able to adjust their temporal or frequency call structures to increase efficiency of the information transfer. Understanding species' ability to adapt their communicative systems to cope with human-made noise constitutes an important contribution to wildlife conservation. (C) 2008 Elsevier Ltd. All rights reserved.

Li, Y.L., Zhang, Y.K., et al. (2008). "Study of similarity law for bird impact on structure." Chinese Journal of Aeronautics **21**(6): 512-517.

With dimensional analysis and similarity theory, the model similarity law of aircraft structures under bird impact load is investigated. Numerical calculations by means of nonlinear dynamic software ANSYS/LS-DYNA are conducted on the finite element models constructed with different scaling factors. The influence of strain rate on the model similarity law is found to be dependent on the strain rate sensitivity of materials and scale factors. Specifically, materials that are not sensitive to strain rate obey the model similarity law in the bird impact process. The conclusions obtained are supposed to provide a theoretical basis for the experimental work of bird impact on aircraft structure.

Liechti, F., Dokter, A., et al. (2008). Combining radar systems to get a 3d - picture of the bird migration. IBSC-Meeting 2008, Brasilia. 8 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP09.pdf.

For military training flights bird strikes en route are still a severe problem. To reduce collisions an international project has been launched by the European Space agency (ESA), aiming 1) for a compilation of information on current bird movements by various sensors, 2) to combine them in a single model, and to finally 3) predict bird strike risks for different spatial and temporal scales. A potential sensor to achieve these aims is the already existing European network of weather radars, but measurement accuracy has to be validated first. We compared data from three different weather radar systems with results from a specialized bird radar operating simultaneously within the range of these systems. The analysis clearly showed that weather radars are well suited for monitoring bird migration over time, and also for providing reliable height distributions of targets. Additionally, we compared these findings with the results from the long-range surveillance radar (ROBIN-system), being operational in the Netherlands and Belgium. Our results suggest that almost real-time information on bird movements can be provided by implementing a bird filter to the existing continent-wide network of weather radar systems. Apart from highly improved bird strike warnings, this network would yield invaluable information for scientific research on bird migration and the influence of the weather regime, climate change, and the dispersal of avian diseases.

Marques, E.A.S. and da Silva, L.F.M. (2008). "Joint strength optimization of adhesively bonded patches." Journal of Adhesion **84**(11): 917-936.

Aircraft face damage from impact with objects or birds or due to ageing that leads to fatigue cracks. The conventional methods of repairing aircraft metallic structures generally include the use of a plate joined by screws or rivets. Although these methods are efficient in the short term, they introduce stress concentrations leading to the initiation of new cracks that are difficult or impossible to detect by non-destructive methods. For these reasons, it is necessary to develop new methods to improve the behaviour of the structure (especially for long term) and its manufacture cost. One of the solutions that have been studied by the aeronautical industry is the use of patches bonded with structural adhesives. However, adhesively bonded patches have problems of stress concentration at the edges where crack initiation is prone to occur. This problem can be reduced by the use of a taper and a spew fillet at the end of the patch and by the use of a mixed adhesive technique where a ductile adhesive is placed at the

edges of the patch. Double strap specimens from 3mm thick 6063-T6 aluminium alloy sheet were analysed. Aluminium and straps (or patches) with an internal taper, an adhesive spew fillet, and dual adhesives were experimentally tested. The results obtained were explained by a finite element analysis. A taper angle is beneficial only for the brittle adhesive. The use of two adhesives is advantageous for the taperless configuration.

Matijaca, A. (2008). Possible exoneration of airport from liability for bird strike damage. 28th IBSC meething, Brasil. 16 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP06.pdf.

Liability of air traffic participants in case of bird strike is very complex matter from different aspects. This kind of liability varies from case to case. From human aspect, in the extreme situation, bird strike accident may cause higher degree consequences i.e. injuries or death of persons (passengers, crew members or, in case of the hardest accidents, third persons on the ground). From financial point of view, there are different direct and indirect costs, profit losses and goodwill loss. Therefore, these circumstances may have great and very significant influence on further market position of air traffic participants, and especially on future reliance of their users. On one side, the first party who may suffer significant material damage in case of bird strike is aircraft operator. Therefore, an owner of aircraft, or an aircraft operator, is entitled to demand reparation for caused damage in out of court negotiation process or by legal proceedings. On the other side, the first party to which damage compensation claim will be put is airport operator. During above mentioned processes, a liability of air traffic participant may be established. However, an airport operator has on its disposal a broad spectrum of different possibilities to escape liability, or at least a part of it. This paper tries to explain how to do that.

Mestre, V. (2008). Effects of aircraft noise: Research update on selected topics. **9**. Transportation Research Board.

Parsons, J.G., Blair, D., et al. (2008). "Flying-fox (Megachiroptera: Pteropodidae) flight altitudes determined via an unusual sampling method: aircraft strikes in Australia." Acta Chiropterologica **10**(2): 377-379.

Ruhe, W. (2008). Bird hazard management in the German armed forces. 28. International Bird Strike Committee (IBSC) Meeting and 4. Seminario Internacional Perigo Aviario e Fauna Brasilia. 7 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP14.pdf.

Bird hazard management in the German Armed Forces is based on distinct regulations given by the German Ministry of Defence, profound experience, intense guiding, continuous exchange of knowledge and training in bird strike prevention. Techniques are developed, Measures instructed and systems are operated by the Biology Branch of the Bundeswehr Geoinformation Office, combining a variety of scientific entities and up-to-date technologies in one organization. A brief overview over the currently operationally used methods and the experiences gained is given.

Shamoun-Baranes, J., Bouten, W., et al. (2008). "Avian information systems: Developing web-based bird avoidance models." Ecology and Society **13**(2).

Collisions between aircraft and birds, so-called "bird strikes," can result in serious damage to aircraft and even in the loss of lives. Information about the distribution of birds in the air and on the ground can be used to reduce the risk of bird strikes and their impact on operations en route and in and around air fields. Although a wealth of bird distribution and density data is collected by numerous organizations, these data are not readily available nor interpretable by aviation. This paper presents two national efforts, one in the Netherlands and one in the United States, to develop bird avoidance nodels for aviation. These models integrate data and expert knowledge on bird distributions and migratory behavior to provide hazard maps in the form of GIS-enabled

Web services. Both models are in operational use for flight planning and flight alteration and for airfield and airfield vicinity management. These models and their presentation on the Internet are examples of the type of service that would be very useful in other fields interested in species distribution and movement information, such as conservation, disease transmission and prevention, or assessment and mitigation of anthropogenic risks to nature. We expect that developments in cyber-technology, a transition toward an open source philosophy, and higher demand for accessible biological data will result in an increase in the number of biological information systems available on the Internet.

Shaw, P. and McKee, J. (2008). Risk assessment: quantifying aircraft and bird usceptibility to strike. 28th IBSC meething, Brasil. 8 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP01.pdf.

Different aircraft types have different susceptibilities to colliding with birds; larger, faster aircraft with jet engines are more likely to be struck than smaller, slower propeller driven aircraft. Similarly, different bird species present different risk levels to aircraft depending on their abundance, mass and flocking tendency. The latter are relatively easy to quantify and can be used as input variables in strike risk models. However bird susceptibility to strike is also dependent on inherent behavior traits that may vary significantly between species and are much harder to parameterize. For example flocking species have a high consequence rating if struck because of their additive biomass and increased chance of hitting critical aircraft parts, although their behavior should give them a greater ability to avoid strike in the first place as they have evolved mechanisms to match velocity and avoid collision while in formation. Here we present two simple methods of quantifying aircraft and bird susceptibility to strike. The former requires access to accurate national strike data and is based on comparing aircraft strike rates with aircraft weight and performance categories. The latter requires standardised surveys over time from several airports in a region and is based on comparing species strike rate with species survey density. The aircraft strike susceptibility index can be included in retrospective strike risk assessments and helps provide a more meaningful comparison of strike rates at airports with different aircraft movement patterns. The species susceptibility to strike index can be combined with a range of biological and spatial parameters to give a prospective and ranked risk indication for either an individual species or a whole airport. Ultimately, this alerts operators to the need for appropriate risk treatments and allows species of greatest risk to be targeted in management programs.

Thorpe, J. (2008). Update on fatalities and destroyed civil aircraft due to bird strikes with appendix for 2006 to 2008. 28th IBSC meeting, Brasil. 7 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP11.pdf.

At the IBSC 26 Meeting in Warsaw Poland, May 2003 an illustrated Working Paper WP WP-SA1 (p.87 of Proceedings) ‘Fatalities and Destroyed Civil Aircraft due to Bird Strikes 1912 to 2002’ provided brief details of all cases during the period. The paper was felt to be useful in drawing attention to the scale of the problem, especially when dealing with those who know little about the subject or who are newly appointed to decisionmaking positions. Since then information has become available on some previously unknown accidents, as well as information on subsequent accidents. Thus, at IBSC 27, Athens May 2005 an update, WP II-3 (p.65 of Proceedings) was presented covering the years 2002 to 2005. This paper provides brief details on further cases between 2006 and 2008 as well as updated statistics covering the period 1912 to 2008. It is now believed that the total number of fatal bird strike accidents has risen to 56 killing 262 people. And destroying 103 aircraft. These additional accidents are briefly detailed in the Paper so that the totals are now: · Airliners and Executive Jets – 15 fatal accidents killing 188 and destroying 41 aircraft. · Aeroplanes 5,700 kg and below – 31 fatal accidents killing 61 and destroying 53 aircraft. · Helicopters – 6 fatal accidents killing 10 people and destroying 8 helicopters. The results are broadly unchanged in

that the major threat (nearly 80% of accidents) to Airliners and Executive jets is engine ingestion, often due to flocks of gulls (Larus sp.). Aircraft of 5,700 kg and below as well as helicopters are most at risk from windshield penetration, mainly the result of collision with birds of prey (Accipitriformes). These groups of aircraft mainly fly at heights where birds are most likely to be encountered. Some accidents are the result of pilots attempting to avoid birds.

van Paepegem, W., Shulev, A., et al. (2008). "Use of projection moire for measuring the instantaneous out-of-plane deflections of composite plates subject to bird strike." Optics and Lasers in Engineering **46**(7): 527-534.

For the new generation aircraft families, the use of fibre-reinforced plastics is considered for the leading edge of the wings. However, this leading edge is very prone to bird strike impact. This paper presents the use of the projection moire technique to measure the instantaneous out-of-plane deflections of composite plates subject to bird strike. Very strict constraints with regard to (i) high-speed image acquisition, (ii) vibrations of the impact chamber, and (iii) projection and observation angles, complicated substantially the development of the set-up. Moreover, the high frame rates (12,000 fps) required a very intensive illumination. In the optimized configuration, a specially designed grating with gradually changing period is projected by means of special halide hydride lamps through one of the side windows of the impact chamber onto the composite plate riveted in a steel frame. The digital high-speed camera is mounted on the roof of the impact chamber and records through a mirror the object surface with the projected fringe pattern on it. Numerical routines based on local Fourier transform were developed to process the digital images to extract the phase and the out-of-plane displacements. The phase evaluation is possible due to the carrier frequency nature of the projected moire pattern. This carrier frequency allows separation of the unwanted additive and multiplicative fringe pattern components in the frequency domain via the application of a proper mask. The numerical calculations were calibrated for the bird strike on an aluminum plate, where the plastic deformation could be checked after the test. (C) 2008 Elsevier Ltd. All rights reserved.

Witter, I. (2008). Experience of using bird hazard risk assessments as one component in reducing the risk from birdstrikes at 7 airports in the UK. 28th IBSC- meeting, Brasil. 5 pp. from http://www.int-birdstrike.org/Brasil_Papers/IBSC28%20WP03.pdf.

BAA airports developed a species-specific bird hazard risk assessment methodology in 2000 jointly with Central Science Laboratory, U.K. This methodology has been used on an annual basis since that date at BAA airports, not at a group level but at an individual airport level categorising species into either high, medium or low risk categories. The risk assessment requires annual statistics of the species struck in confirmed birdstrikes at that specific airport in order to categorise the species. This annual process clearly indicates on which species resources should be targetted to have the maximum effect on reducing the risk of serious birdstrikes. This process, combined with the constant availability of bird control staff, their training, logging of bird activity and dispersal, a detailed habitat management programme on airport, a safeguarding process to influence proposed new developments such that they do not introduce new bird attractants around the airport, and off airport monitoring of bird numbers and flight lines in the vicinity of the airport, have all contributed to a reduction in the numbers of birdstrikes involving high and medium risk species over the last 8 years across BAA airports as a whole. This is despite the fact that the number of aircraft transport movements has increased over this time period by 12% across the airports. Such a quantified, prioritised process combined with expert independent inspection provided by CSL alongside our habitat management programme appears to be delivering the results that were hoped for when this began.

Zaugg, S., Saporta, G., et al. (2008). "Automatic identification of bird targets with radar via patterns produced by wing flapping." Journal of the Royal Society Interface **5**(26): 1041-1053.

Bird identification with radar is important for bird migration research, environmental impact assessments (e. g. wind farms), aircraft security and radar meteorology. In a study on bird migration, radar signals from birds, insects and ground clutter were recorded. Signals from birds show a typical pattern due to wing flapping. The data were labelled by experts into the four classes BIRD, INSECT, CLUTTER and UFO (unidentifiable signals). We present a classification algorithm aimed at automatic recognition of bird targets. Variables related to signal intensity and wing flapping pattern were extracted (via continuous wavelet transform). We used support vector classifiers to build predictive models. We estimated classification performance via cross validation on four datasets. When data from the same dataset were used for training and testing the classifier, the classification performance was extremely to moderately high. When data from one dataset were used for training and the three remaining datasets were used as test sets, the performance was lower but still extremely to moderately high. This shows that the method generalizes well across different locations or times. Our method provides a substantial gain of time when birds must be identified in large collections of radar signals and it represents the first substantial step in developing a real time bird identification radar system. We provide some guidelines and ideas for future research.

Aas, C.K. (2008). Fly/fugl-rapport Andøya flystasjon 30.-31. oktober 2008. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo. 4 pp.

Aas, C.K. (2008). Fly/fugl-rapport Bodø hovedflystasjon 21.-22. april 2008. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo. 3 pp.

Aas, C.K. (2008). Fly/fugl-rapport Ørland hovedflystasjon 29.-30. mai 2008. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 3 pp.

Aas, C.K. (2008). Fugl. Årsmøte i flytryggingsorganisasjonen i Luftforsvaret, UiO

Aas, C.K. (2008). Ornitologisk besøk ved Harstad/Narvik lufthavn, Evenes 10. juni 2008. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo. 2 pp.

Aas, C.K. (2008). Ornitologisk besøk ved Sandnessjøen lufthavn 3. juni 2008. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo. 4 pp.

Aas, C.K. (2008). Ornitologisk besøk ved Ålesund lufthavn, Vigra 21. mai 2008 Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 2 pp.

Aas, C.K. (2008). Rapport fra ornitologisk besøk ved Kristiansund lufthavn 21. oktober 2008. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo 3pp.

Aas, C.K. (2008). Rapport fra ornitologisk besøk ved Rørvik lufthavn 23. oktober 2008. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 3 pp.

Aas, C.K. (2008). Rapport fra ornitologisk besøk ved Sandane lufthamn 29. oktober 2008. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo. 3 pp.

Aas, C.K., Olstad, T., et al. (2008). A biological battle against the thousands of Garden Chafers (Phyllopertha horticola) that attract large numbers of gulls (Larus sp.) during the summer season at Rygge Air Station, Norway. 28th International Bird Strike Committee; 2008-11-24 - 2008-11-28, UiO

2007

Baxter, A.T. and Robinson, A.P. (2007). "Monitoring and influencing feral Canada goose (Branta canadensis) behaviour to reduce birdstrike risks to aircraft." International Journal of Pest Management **53**(4): 341-346.

Canada Geese (Branta canadensis) were caught and ringed at 55 moult sites within 13 km of a UK airport between 1999 and 2004. More than 2500 visits were subsequently made to some 300 sites, resulting in over 10000 re-sightings of individual birds. The breeding, moulting and foraging ecology of individuals was used to assist in the development of a management plan to help reduce the birdstrike risk to aircraft operating out of the airport. Canada Geese were struck on 11 occasions by aircraft between 1994 and 2004. Strikes were not randomly distributed throughout the year, with four incidents occurring during the pre-breeding season and seven in the post-moult period. The breeding and moult locations of birds that were known to be involved in transiting either the airfield or its approaches were identified. Management actions including egg oiling, direct deterrence and habitat change were instigated and the effects monitored. A significant reduction in the risk to flight safety was achieved through the use of an integrated strategy based on rigorous research and monitoring protocols. This paper discusses the results of monitoring and their use to drive the management regime.

Baxter, A.T. and Robinson, A.P. (2007). "A comparison of scavenging bird deterrence techniques at UK landfill sites." International Journal of Pest Management **53**(4): 347-356.

Birds that forage at waste management facilities have the potential to cause significant problems to Right safety, agriculture and the local environment. A variety of bird management techniques are available for deterring such birds. This paper examines the use of pyrotechnic bird-scaring rockets, helium-filled bird-scaring kites, hawks, falcons, automated distress calls, hand-held distress calls, automated sound generators, blank firing pistols and live rounds to deter gulls (Laridae) and corvids (Corvidae) from six UK landfill facilities. Forty separate trials were undertaken over a 2-year period. Each trial continued for 12 weeks or until birds stopped responding to deterrence. Scavenging gull and corvid numbers were counted during a 4-week pre-deterrence period and were compared to numbers counted after deterrence was implemented. Individual systems were deployed during weekday site operational hours only, or all week between dawn and dusk. The impact on scavenging gull and corvid numbers was recorded. Birds could not be eliminated but numbers were reduced to different extents by different techniques. The success of techniques also varied significantly in terms of habituation. It is hypothesised that deploying combinations of different techniques would improve results.

Bentz, P.-G. (2007). Översiktlig utredning om riskerna för att antalet kollisioner mellan fåglar och vindkraftverk ökar om verken förses med fasadbelysning. En litteraturstudie. Luftfartsstyrelsen, Norrköping. 6 pp.

Bentz, P.-G. (2007). Vattenmagasin för förorenat dagvatten vid Blekinge flygflottilj F 17, Kallinge – Utvärdering av föreslagna våtmarksalternativ avseende risken för ökad fågelförekomst. Sweco Viak, Karlskrona. 6 pp.

Bitebekezi, G.K. (2007). "The role of community participation in the control of bird hazards at Entebbe International Airport, Uganda." Ostrich **78**(2): 131-133.

The location of Entebbe International Airport within the Entebbe Peninsula, a gazetted animal 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 successfully adopted a number of measures to prevent bird hazards from occurring. One of the most important methods of bird hazard control involves participation of local communities around the airport. This paper illustrates the different ways in which the airport works with the community to control bird collisions with aircraft at Entebbe International Airport.

Brandes, T.S. and Benson, R.H. (2007). "Sound source imaging of low-flying airborne targets with an acoustic camera array." Applied Acoustics **68**(7): 752-765.

Two-dimensional images of sound source distribution from near-ground airborne sounds are created using an array of 32 microphones and time-domain beamforming. The signal processing is described and array configurations spanning a square area with a side length of 3.45 m, approximately five wavelengths for a 500 Hz sound, are examined. Simulations of a 32-element under-populated 1096 X 1096 spaced array are given for sound sources centered over the array at 250 Hz, 500 Hz, and 1000 Hz. Stochastically optimized array geometry with a simulated annealing algorithm is discussed and a 32-element array optimized for a 500 Hz source is given along with a simulated image for direct comparison with the 1096 spaced array. Images from field testing a 32-element under-populated log(6) X log(6) spaced array are provided for a small aircraft flyover. Results show that this type of acoustic camera generates accurate images of sound source location. Suggested uses include monitoring small aircraft flying too low to be detected by radar as well as monitoring ecological events, such as bird migration. (c) 2006 Elsevier Ltd. All rights reserved.

Dolbeer, R.A., Marriot, H., et al. (2007). Airport wildlife strike summary and risk analysis report: a new addition to the FAA's wildlife hazard mitigation website. Proceedings 9th Bird Strike Committee-USA/Canada Meeting, Kingston, Ontario, University of Nebraska - Lincoln. pp 1-11.

Aircraft collisions with birds and other wildlife are an increasing concern for the aviation industry. The U.S. Federal Aviation Administration (FAA), through agreements with the U.S. Department of Agriculture, Wildlife Services and Embry-Riddle Aeronautical University, developed a National Wildlife Strike Database to better define the wildlife strike problem. Annual reports that summarize the data (about 72,500 strike records for civil aircraft in USA, 1990-2006) provide a foundation for FAA national policies and guidance regarding research and management efforts to reduce wildlife strikes. However, these national analyses do not provide specific information regarding strikes at individual airports or for other specific user groups. Our objective was to expand the utility of the database by providing an automatically generated Airport Wildlife Strike Summary and Risk Analysis Report for airports. Each report, updated annually and accessible on-line with a password, provides an airport with total and damaging strike numbers and strike rates per 100,000 aircraft movements for the past year and with mean numbers for the past 5 years. The report then compares these rates with regional and national averages for airports in the same size class. The report also documents the wildlife species that, based on past damaging strike records, need to be emphasized in risk management activities. This information provides airports with an objective baseline to aid in the evaluation of their wildlife risk mitigation programs. Such evaluations are required annually in the USA under 14CFR.139.337. This report presently is available for each of the 434 Part 139- certificated USA airports that have strike records included in the database for the last five years.

Downer, J. (2007). "When the chick hits the fan: Representativeness and reproducibility in technological tests." Social Studies of Science **37**(1): 7-26.

Before a new turbojet engine design is approved, the Federal Aviation Administration (FAA) must assure themselves that, among many other things, the engine can safely ingest birds. They do this by mandating a series of well-defined - if somewhat Pythonesque -'birdstrike tests' through which the manufacturers can demonstrate the integrity of their engines. In principle, the tests are straightforward: engineers run an engine at high speed, launch birds into it, and watch to see if it explodes. In practice, the tests rest on a complex and contentious logic. In this paper I explore the debate that surrounds these tests, using it to illustrate the now-familiar idea that technological tests like scientific experiments - unavoidably contain irreducible ambiguities that require judgments to bridge, and to show that these judgments can have real consequences. Having established this, I then explore how the FAA reconciles the

unavoidable ambiguities with its need to determine, with a high degree of certainty, that the engines will be as safe as Congress requires. I argue that this reconciliation requires a careful balance between the opposing virtues of reproducibility and representativeness - and that this balance differs significantly from that in most scientific experiments, and from the common perception of what it ought to be.

Eriksson, C., Rosenlund, M., et al. (2007). "Aircraft noise and incidence of hypertension." Epidemiology **18**(6): 716-721.

Background: An association between aircraft noise exposure and hypertension prevalence has been suggested but there are no longitudinal studies of this association. Our aim was to investigate the influence of aircraft noise on the incidence of hypertension. Methods: A cohort of 2754 men in 4 municipalities around Stockholm Arlanda airport was followed between 1992-1994 and 2002-2004. The cohort was based on the Stockholm Diabetes Preventive Program; half of the study subjects had a family history of diabetes. Residential aircraft noise exposure (expressed as time-weighted equal energy and maximal noise levels) was assessed by geographical information systems techniques among those living near the airport. Incident cases of hypertension were identified by physical examinations, including blood pressure measurements, and questionnaires in which subjects reported treatment or diagnosis of hypertension and information on cardiovascular risk factors. Analyses were restricted to 2027 subjects who completed the follow-up examination, were not treated for hypertension, and had a blood pressure below 140/90 mm Hg at enrollment. Results: For subjects exposed to energy-averaged levels above 50 dB(A) the adjusted relative risk for hypertension was 1.19 (95% CI = 1.03-1.37). Maximum aircraft noise levels presented similar results, with a relative risk of 1.20 (1.03-1.40) for those exposed above 70 dB(A). Stronger associations were suggested among older subjects, those with a normal glucose tolerance, nonsmokers, and subjects not annoyed by noise from other sources. Conclusion: These findings suggest that long-term aircraft noise exposure may increase the risk for hypertension.

He, W.S., Feagin, R., et al. (2007). "Impacts of introduced Spartina alterniflora along an elevation gradient at the Jiuduansha Shoals in the Yangtze Estuary, suburban Shanghai, China." Ecological Engineering **29**(3): 245-248.

Although much research has focused upon the negative impacts of invasive Spartina alterniflora upon salt marshes dominated by other Spartina spp., little is known about its impacts upon native Scirpus mariqueter marshes. In 1997, S. alterniflora was introduced to the Jiuduansha Shoals, Yangtze Estuary, China, to accelerate the formation of marsh habitat via accretionary processes, with the larger goal of drawing waterfowl away from wetlands near the Pudong International Airport, Shanghai, China. In 2000, a nature reserve was established on the Jiuduansha Shoals, making the impact upon the native S. mariqueter community a high priority for research. our objective was to quantify the impacts of introduced S. alterniflora and Phragmites australis to the native S. mariqueter-dominated community at this site in four elevation zones, as compared with a nearby natural shoal. We found that species diversity was greater in the lower elevations with the engineering, through elimination of the natural dominance of S, mariqueter. We also found that diversity was lessened in the higher elevations, due to rapid growth and exclusion by the planted S. alterniflora in conjunction with the native P. australis. Moreover, we found that the growth of the native S. mariqueter was stimulated when S. alterniflora was planted nearby. It is quite likely that the net effect of these ecological processes will be to accelerate further accretion, leading to an eventual replacement of the S. mariqueter-dominated community in the long-term. Future management approaches should focus upon harvesting, grazing, and perimeter-ditching the S. alterniflora to avoid this situation. (C) 2006 Elsevier B.V. All rights reserved.

Husby, M. (2007). Eventuell fredning av Vikanbukta våtmarksområde i Stjørdal kommune og effekter på antall birdstrikes ved Tr Trondheim lufthavn, Værnes. Steinkjer, Høgskolen i Nord-Trøndelag. 1-39 pp.

Fylkesmannen i Nord-Trøndelag har i utkast til verneplan for sjøfuglområder i Nord-Trøndelag tatt med Vikanbukta i Stjørdal kommune, og området er foreslått som fuglefredningsområde av Direktoratet for Naturforvaltning. Luftfartsverket (nå Avinor) gikk i mot en slik fredning fordi dette kunne gå ut over sikkerheten for luftfarten ved Trondheim lufthavn, Værnes. I dette arbeidet med å finne ut hvor viktig Vikanbukta er for flysikkerheten i forhold til birdstrikes på Værnes, er det gjennomført 57 totaltellinger av fugl i Vikanbukta i perioden juni 2006 – juli 2007, og det er gjennom dette året sett på fuglenes naturlige bevegelsesmønstre og deres atferd ved eksperimentell forstyrrelse. Det er også undersøkt i hvor stor grad menneskelig forstyrrelse reduserer antall fugler som bruker området i dag, og om en økning i antall fugler kan forventes om området blir fredet. For å ha et best mulig grunnlag for feltarbeidet, ble alle birdstrikes ved Værnes i perioden 1986 – 2005 analysert. Antall birdstrikes var lavest om vinteren, og det var hyppigere kollisjoner på/ved selve flyplassen enn i luftrommet vest (over sjøen), eller øst for flyplassen. Måker var den fuglegruppa som dominerte med over 50% av alle birdstrikes der fugleart/gruppe var kjent. Det var ikke noen tydelig sammenheng mellom antall måker i våtmarksområdene Sandfærhus og Halsøen helt inntil flystripa, og birdstrikes med måker på Værnes. En liten topp i antall birdstrikes i april sammenlignet med andre flyplasser i Norge, indikerer at det store antall fugl som er i Stjørdalsfjorden på den tida øker faren for birdstrikes. Ingen fly eller helikopter til eller fra Værnes hadde noen innvirkning på fuglenes atferd i Vikanbukta, og bare unntaksvis på fugl helt inntil flystripa. Antall fugler i Vikanbukta gjennom året var for de fleste arter/artsgrupper atskillig lavere enn i for eksempel Halsøen som ligger helt inntil flystripa. Dette skyldes ikke vanlig menneskelig ferdsel, ettersom bare 40 av 244 skremte fugler forlot området og resten hadde intern forflytning. Signifikant flere fugler forlot området ved sterkere skremming som skyting og båttrafikk. Bare en av de skremte fuglene krysset flystripa eller dens forlengelse, men da i en slik høyde at det ikke var kollisjonsfare med fly. Normal flukt ble fulgt for 285 fugler som forlot Vikanbukta utover sjøen, og bare 10 av disse krysset flystripa eller dens forlengelse i en slik høyde at kollisjon med fly var mulig. Jakt og motorisert båttrafikk innenfor planlagt verneområde er svært sjeldent, og bidrar ikke til at antall fugler er lavt i Vikanbukta. Det er påvist svært få hekkende par i løpet av de to hekkesesongene prosjektet har vart. Et eventuelt vern av Vikanbukta vil ikke føre til flere fugler i området enn det er i dag. Om Vikanbukta ikke skulle bli vernet, sier Stjørdal kommune at området ikke vil bli nedbygd på kort sikt. Det er flere utfordringer i forhold til mulige birdstrikes ved Værnes i dag. Spesielt nevnes et stadig økende antall gjess som raster i våtmarksområdene på begge sider av flystripa og flyr på næringssøk oppover Stjørdalen. Dessuten nevnes alle de måkene som raster på yttersida av Langøra, og som kan bli skremt innover flystripa i langt større grad enn i dag hvis dette området åpnes og tilrettes for alminnelig ferdsel. Også trekk av ærfugl og kråker er nevnt.

Iqbal, M.Z., Malik, S.A., et al. (2007). "Birds of Lahore cantonment." Pakistan Journal of Zoology **39**(4): 203-214.

Lahore Cantonment (LC) is one of the oldest establishments in Lahore. Located about 28 km Northeast of Lahore, it covers about 8950 hectares. Khairy distributor), Fed by (BRB) canal passes through the area. This area has many marsh areas along the route from Burki upto BRB canal besides resident birds. A variety of birds visit the Lahore Cantonment during summer and winter seasons. The habitat and the avian fauna were regularly surveyed at different times of the day from 5:00 am to 6:00 pm. The survey of LC was conducted from September 6, 1996 to September 30, 1997. Binocular 12x50 was used to Spot and study the birds and Yashica Camera (Electro-35) was used to photograph birds, their nests and different habitats. After the year long survey species diversity and the dominant bird species were recorded. 74 different species belonging to 55 genera, 38 families and 13 orders were recorded. Of these, 44 species are

resident, 17 species are winter visitors and 13 species are summer visitors. Amongst the species adapted to diverse habitats in LC black drongo, little green bee-eater, blue checked bee-cater, red wattled lapwing. paddy bird, rufous backed shrike. common myna. hoopoe. red vented bulbul and white breasted kingfisher are prominent. Factors causing detrimental effect on birds like poaching and netting have resulted in almost complete extinction of alexandrine parakeet from the area. Shooting done by caretakers at Lahore Airport results in a great loss of avian life. Besides this grazing by livestock in graveyards and other naturally vegetated areas. disturbance of habitat by noise, water and air pollution are probably the factors detrimental to the avian species of LC.

Langvatn, R. (2007). Jagerfly og villrein. NINA, Trondheim. 13 pp.

Mao, R.H., Meguid, S.A., et al. (2007). "Finite element modeling of a bird striking an engine fan blade." Journal of Aircraft **44**(2): 583-596.

Bird strike is a serious problem that affects both commercial and military aircrafts. Systematic modeling and simulation of bird strikes are severely lacking, especially for cases involving engine, fan blades, and casings. In the present investigation, explicit 3-D finite element analysis using LS-DYNA is carried out to study the nonlinear transient response of a bird striking a fan system. The bird strike is simulated using Lagrangian blade-bird formulations. The bird is modeled as a fluid jet with a homogenized fluidic constitutive relation, using the Brockman hydrodynamic model, which was found to be the most appropriate. The present simulations are validated using a benchmark test of a bird striking a rigid target that is reported in the literature. Following this validation, a reference case of a bird striking a flexible fan blade was set up and used as the reference case in a series of parametric studies. The effect of bird velocity and its size are examined and attention is given to strikes involving larger birds so as to address the lack of data in this area.

Merriman, J.W., Boal, C.W., et al. (2007). "Abundance of diurnal raptors in relation to prairie dog colonies: Implications for bird-aircraft strike hazard." Journal of Wildlife Management **71**(3): 811-815.

Some diurnal raptors are frequently observed at prairie dog (Cynomys sp.) colonies. As a result, some military installations have conducted prairie dog control activities to reduce the bird-aircraft strike hazard (BASH) potential of low-flying aircraft. To evaluate the validity of this management strategy, we assessed raptor associations with prairie dog colonies at 2 short-grass prairie study areas: southern Lubbock County, Texas, USA, and Melrose Bombing and Gunnery Range in cast-central New Mexico, USA. We quantified diurnal raptors (i.e., Falconiformes) at plots occupied (colony plots) and unoccupied (noncolony plots) by black-tailed prairie dogs (Cynomys ludovicianus) at both sites throughout 2002. We compared the number of individual birds of a given species at colony and noncolony plots within each study area by season. Ferruginous hawks (Buteo regalis) and northern harriers (Circus cyaneus) were more abundant at colony plots, whereas Swainson's hawks (B. swainsoni) and American kestrels (Falco sparverius) were more abundant at noncolony plots. Red-tailed hawk (B. jamaicensis) abundance did not differ between the 2 plot types. Our results suggest prairie dog control as a method of reducing BASH potential may be effective at some sites but may be ineffective or even increase the BASH potential at others. Thus, bird-avoidance models assessing the BASH potential should be conducted on a site-specific basis using information on relative and seasonal abundances of individual raptor species and the relative strike risks they pose to aircraft.

Pyykonen, T., Juntunen, J., et al. (2007). "Aviation noise does not impair the reproductive success of farmed blue foxes." Animal Reproduction Science **97**(1-2): 128-136.

The aim of our study was to assess the effects of aviation noise on reproduction and cub mortality in farmed blue foxes. Eighty artificially inseminated blue fox vixens (45

primiparous and 35 multiparous) were exposed to aviation noise on 5 days when they were pregnant or had cubs. The noise during the exposures varied from 85 to 121 dB (L-AFmax). Vixens (45 primiparous and 34 multiparous) on a farm without flight action acted as controls. Cubs were counted 1, 3, 7, 14 and 49 days postpartum and at the beginning of July. Litter size (cubs per whelped vixen), reproductive performance (cubs per mated vixen) and cub losses (lost cubs per whelped vixen) were analyzed from both experimental farms (A and Q. The flight action had no effect on reproductive success. Reproductive performance in primiparous vixens was 4.2 +/- 3.8 and 4.3 +/- 3.6 cubs (ns, Mann-Whitney U-test) in the control and aviation group, respectively, while in multiparous vixens the corresponding figures were 7.1 +/- 4.4 and 7.3 +/- 3.8 cubs (ns). In general, litter size declined from birth to weaning (in primiparous vixens from 8.1 +/- 3.8 to 5.4 +/- 3.2 cubs, and in multiparous from 9.7 +/- 3.8 to 7.2 +/- 3.8 cubs, $P < 0.001$, GLM for repeated measures). The decline was greater in primiparous than in multiparous vixens ($P < 0.01$). There were no differences in total cub losses between the experimental groups (ns). Accordingly, the present results show that exposure to severe and repeated aviation noise does not impair the reproductive success of farmed blue foxes. (c) 2006 Elsevier B.V. All rights reserved.

Reese, R.J. (2007). Biophysical and risk assessment of the Springbank Airport.

The Springbank Airport (YBW), located 10 kilometres west of the City of Calgary, is the satellite airport for the Calgary International Airport (YYC). The airport functions primarily as a commercial pilot training centre, but also hosts a variety of privately owned and operated aircraft. The growing economic demand on the YYC has directly increased development pressures on the YBW. In 2002, the Calgary Airport Authority presented a ten-year framework plan for the YBW including the extension of the north-south Runway 16-34 from its previous length of 3000 feet to 5000 feet. The construction and operation activities had the potential to negatively impact the environment surrounding the YBW. To this date, there has never been a formal documentation of the flora and fauna species that inhabit and/or visit the YBW. One of the primary requirements of this project was to identify and document these species. At the end of the 13-month study, 206 vascular plants, 7 mosses, 19 fungi, 10 mammalian, 3 amphibian and 102 avian species were identified. Field inventory information was used to determined valued ecosystem components and evaluate the level of construction and operation impacts on these components. Mitigation techniques, residual and cumulative impacts were discussed. Potential risks to aviation safety were identified and discussed; wildlife strikes were selected as the most probable risk to aviation safety. The purpose of this document was to provide the YBW and the Calgary Airport Authority with a comprehensive understanding of the biological processes that occur within airport boundaries. Keywords. Springbank Airport, Calgary Airport Authority, Calgary International Airport, Runway 16-34, environmental assessment, risk assessment, valued ecosystem components. Airport (YYC). The airport functions primarily as a commercial pilot training centre, but also hosts a variety of privately owned and operated aircraft. The growing economic demand on the YYC has directly increased development pressures on the YBW. In 2002, the Calgary Airport Authority presented a ten-year framework plan for the YBW including the extension of the north-south Runway 16-34 from its previous length of 3000 feet to 5000 feet. The construction and operation activities had the potential to negatively impact the environment surrounding the YBW. To this date, there has never been a formal documentation of the flora and fauna species that inhabit and/or visit the YBW. One of the primary requirements of this project was to identify and document these species. At the end of the 13-month study, 206 vascular plants, 7 mosses, 19 fungi, 10 mammalian, 3 amphibian and 102 avian species were identified. Field inventory information was used to determined valued ecosystem components and evaluate the level of construction and operation impacts on these components. Mitigation techniques, residual and cumulative impacts were discussed. Potential risks to aviation safety were identified and discussed; wildlife strikes were selected as the most

probable risk to aviation safety. The purpose of this document was to provide the YBW and the Calgary Airport Authority with a comprehensive understanding of the biological processes that occur within airport boundaries. Keywords. Springbank Airport, Calgary Airport Authority, Calgary International Airport, Runway 16-34, environmental assessment, risk assessment, valued ecosystem components.

Seamans, T.W., Barras, S.C., et al. (2007). "Evaluation of two perch deterrents for starlings, blackbirds and pigeons." International Journal of Pest Management **53**(1): 45-51.

Bird-aircraft collisions are costly and potentially deadly to people and wildlife. From 1990 through 2004, 57 702 bird collisions with aircraft were reported within the USA to the US Federal Aviation Administration. Approximately 82% of the strikes occur below 305 m height above ground level; therefore bird deterrents on airfields that reduce the quality of the birds' habitat are critical to safe airport operation. One management approach is to reduce perching sites within the airport premises. We tested two anti-perching devices (Birdwire (TM) and BirdBlox (TM)) in an aviary setting. As an ancillary test, we determined which wire in a standard three-strand security array was preferred by blackbirds and starlings. Red-winged blackbirds (Agelaius phoeniceus), brown-headed cowbirds (Molothrus ater), and European starlings (Sturnus vulgaris) were deterred from sitting on a perch when anti-perching wire was installed 5 cm above the perch. These same species preferred the top wire of the three-wire security array. Red-winged blackbirds, common grackles (Quiscalus quiscula), brown-headed cowbirds, European starlings, and rock pigeons (Columba livia) were deterred from perches protected by BirdBlox (TM). Because our tests were conducted in a captive situation, we recommend field testing the products to determine if bird use of airport structures may be reduced in an operational setting.

Seamans, T.W., Barras, S.C., et al. (2007). "Comparison of 2 vegetation-height management practices for wildlife control at airports." Human-Wildlife Conflicts **1**(1): 97-105.

Tracey, J.P. and Fleming, P.J.S. (2007). "Behavioural responses of feral goats (Capra hircus) to helicopters." Applied Animal Behaviour Science **108**(1-2): 114-128.

Helicopters are commonly used for managing wildlife populations, but their effect on wildlife behaviour is poorly understood and often ignored by managers. Changes in behaviour can adversely affect wildlife, compromise assumptions of survey methods, and reduce the effectiveness of management operations. In this study, we investigated the behavioural responses of free-ranging feral goats to helicopters and the main determinants of alert behaviour in response to helicopters. Ground-based reporters made 784 observations of feral goat groups during 34 standardised helicopter surveys used to estimate abundance. Feral goats were often alert (44% of observations) and, in 31% of observations, moved (up to 1.5 km) in response to helicopter over-flights but no feral goats were observed to be injured nor did any post-partum females desert their young in response to over-flights. Regression analyses indicated that the distance from the helicopter and prior activity were the most important factors influencing the extent of alert behaviour and the distance moved in response to helicopter disturbance. The responses of herds of goats in different home ranges were variable, and cumulative survey time, type of helicopter and the density of herds also influenced behavioural responses. Results indicated that, while long-term effects of helicopter disturbance on feral goat behavioural ecology are minimal, short-term changes in behaviour frequently occur and should be considered when using helicopters to manage feral goats.

van Belle, J., Shamoun-Baranes, J., et al. (2007). "An operational model predicting autumn bird migration intensities for flight safety." Journal of Applied Ecology **44**(4): 864-874.

1. Forecasting migration intensity can improve flight safety and reduce the operational costs of collisions between aircraft and migrating birds. This is particularly true for military training flights, which can be rescheduled if necessary and often take place at

low altitudes and during the night. Migration intensity depends strongly on weather conditions but reported effects of weather differ among studies. It is therefore unclear to what extent existing predictive models can be extrapolated to new situations. 2. We used radar measurements of bird densities in the Netherlands to analyse the relationship between weather and nocturnal migration. Using our data, we tested the performance of three regression models that have been developed for other locations in Europe. We developed and validated new models for different combinations of years to test whether regression models can be used to predict migration intensity in independent years. Model performance was assessed by comparing model predictions against benchmark predictions based on measured migration intensity of the previous night and predictions based on a 6-year average trend. We also investigated the effect of the size of the calibration data set on model robustness. 3. All models performed better than the benchmarks, but the mismatch between measurements and predictions was large for existing models. Model performance was best for newly developed regression models. The performance of all models was best at intermediate migration intensities. The performance of our models clearly increased with sample size, up to about 90 nocturnal migration measurements. Significant input variables included seasonal migration trend, wind profit, 24-h trend in barometric pressure and rain. 4. Synthesis and applications. Migration intensities can be forecast with a regression model based on meteorological data. This and other existing models are only valid locally and cannot be extrapolated to new locations. Model development for new locations requires data sets with representative inter- and intraseasonal variability so that cross-validation can be applied effectively. The Royal Netherlands Air Force currently uses the regression model developed in this study to predict migration intensities 3 days ahead. This improves the reliability of migration intensity warnings and allows rescheduling of training flights if needed.

Wang, X.J., Feng, Z.Z., et al. (2007). "Dynamic response analysis of bird strike on aircraft windshield based on damage-modified nonlinear viscoelastic constitutive relation." Chinese Journal of Aeronautics **20**(6): 511-517.

Damage-modified nonlinear viscoelastic constitutive equation and failure criterion are introduced and the three-dimensional incremental forms are deduced based on the updated Lagrangian approach. A simple tensile test model and a split Hopkinson pressure bar model are built to verify the accuracy of the subroutine implemented within the non-linear finite element program LS-DYNA. A numerical model of bird strike on windshield is established to study the responses of windshield under three different bird velocities at three sites. The bird is represented by a cylinder with a hemisphere at each end and the contact-impact coupling algorithm is used in this study. It is found that the implemented subroutine can properly describe the mechanical behavior of polymethyl methacrylate under low and high strain rates and large deformation, and can be used validly.

Willlkms, T.J. (2007). "Responses of waterbirds to helicopter disturbance and fish poisoning by rotenone at Paardevlei, South Africa." Waterbirds **30**(3): 429-432.

Helicopter spraying of rotenone fish poison over Paardevlei, a lake near Cape Town, provided an opportunity to assess both the effect of helicopter disturbance on waterbirds and the immediate response of birds to fish poisoning. Birds were less disturbed by protracted helicopter activity than by a single fish eagle over-flight. Rotenone provided a food bonanza for pelicans and cormorants with no evidence of adverse effects on any birds.

Aas, C.K. (2007). Fly-fugl. Årsmøte i flytryggingsorganisasjonen i Luftforsvaret, UiO

Aas, C.K. (2007). Fly/fugl-rapport Andøya flystasjon 23.-25. april 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo. 3 pp.

Aas, C.K. (2007). Fly/fugl-rapport Gardermoen flystasjon 21. november 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo. 4 pp.

Aas, C.K. (2007). Fly/fugl-rapport Rygge flystasjon 10. oktober 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo. 1 pp.

Aas, C.K. (2007). Ornitologisk besøk ved Alta lufthavn 13. september 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo. 3 pp.

Aas, C.K. (2007). Ornitologisk besøk ved Bergen lufthavn, Flesland 8. juni 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 5 pp.

Aas, C.K. (2007). Ornitologisk besøk ved Mo i Rana lufthavn 10. juli 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 4 pp.

Aas, C.K. (2007). Ornitologisk besøk ved Røst lufthavn 12. juni 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 4 pp.

Aas, C.K. (2007). Ornitologisk besøk ved Stavanger lufthavn, Sola 5. oktober 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 3 pp.

Aas, C.K. (2007). Ornitologisk besøk ved Stokmarknes lufthavn 2. oktober 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 4 pp.

Aas, C.K. (2007). Ornitologisk besøk ved Tromsø lufthavn 13. juni 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 6 pp.

Aas, C.K. (2007). Ornitologisk besøk ved Trondheim lufthavn, Værnes 15. mai 2007. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 5 pp.

2006

Airoldi, A. and Cacchione, B. (2006). "Modelling of impact forces and pressures in Lagrangian bird strike analyses." International Journal of Impact Engineering **32**(10): 1651-1677.

The paper aims at evaluating and improving the accuracy of bird impact numerical analyses performed with finite element explicit codes, focusing on the modelling of the spatial and temporal pressure distributions exerted on the target by the impacting body. A Lagrangian approach is adopted, interfacing the ESI/Pam-Crash solver code with an automatic trial-and-error procedure for the elimination of the excessively distorted elements. The theoretical formulation relevant to the impact of a cylindrical soft body against a rigid target is reviewed and this ideallsed case is adopted to validate the presented approach with increasingly refined finite element schemes. A sensitivity study is then carried out, adopting differently shaped bird models and varying the material hydrodynamic and deviatoric responses. A set of models is selected comparing the results with the experimental average values and the scattering reported in literature for the most significant loading parameters in impacts on rigid targets. The model shape and the calibration parameters of the bird material used in these models are subsequently adopted in the analyses of impacts on a deformable polycarbonate plate. The numerical results obtained with increasingly refined bird models are presented and discussed. A range of modelling parameters is finally suggested to perform reliable numerical analyses on aircraft structures and a criterion is proposed to select the models for a reasonably conservative approach to the design of a bird proof structure. (c) 2005 Elsevier Ltd. All rights reserved.

Allan, J. (2006). "A heuristic risk assessment technique for birdstrike management at airports." Risk Analysis **26**(3): 723-729.

Collisions between birds and aircraft (birdstrikes) have caused the loss of at least 88 aircraft and 243 lives in world civil aviation. Conservative estimates suggest that more routine damage and delays following birdstrikes cost the industry and its insurers US$1.2-1.5 billion per year. The majority of strikes happen close to airports and most countries have regulations that require airport managers to control the birdstrike risk on their property. Birdstrike prevention has, however, lagged behind other aspects of flight safety in the development and implementation of risk assessment protocols, possibly because of the inherent difficulty in quantifying the variability in the populations and behavior of the various bird species involved. This article presents a technique that uses both national and airport-specific data to evaluate risk by creating a simple probability-times-severity matrix. It uses the frequency of strikes reported for different bird species at a given airport over the preceding five years as a measure of strike probability, and the proportion of strikes with each species that result in damage to aircraft, in the national birdstrike database, as a measure of likely severity. Action thresholds for risk levels for particular bird species are then defined, above which the airport should take action to reduce the risk further. The assessment is designed for airports where the reporting and collation of birdstrike events is reasonably consistent over time and where a bird hazard management program of some sort is already in place. This risk assessment is designed to measure risk to the airport as a business rather than risk to the traveling passenger individually. It therefore takes no account of aircraft movement rate in the calculations and is aimed at minimizing the number of damaging incidents rather than concentrating on catastrophic events. Once set up at an airport, the technique is simple to implement for nonexperts, and it allows managers to focus bird control resources on the species causing the greatest risk, hence maximizing the return on investment. This protocol is now being successfully used at major airports in the United Kingdom and elsewhere in the world.

Bies, L., Balzer, T.B., et al. (2006). "Pocosin Lakes National Wildlife Refuge: Can the military and migratory birds mix?" Wildlife Society Bulletin **34**(2): 502-503.

Blackwell, B.F. and Wright, S.E. (2006). "Collisions of red-tailed hawks (Buteo jamaicensis), Turkey Vultures (Cathartic's aura), and black vultures (Coragyps atratus) with aircraft: Implications for bird strike reduction." Journal of Raptor Research **40**(1): 76-80.

Caton, B.P., Dobbs, T.T., et al. (2006). "Arrivals of hitchhiking insect pests on international cargo aircraft at Miami International Airport." Biological Invasions **8**(4): 765-785.

In a study of hitchhiking or contaminating insect pests on international cargo aircraft at Miami International Airport from 1998 to 1999, it was found that contamination rates were greatest, 23%, on cargo flights from Central America and much lower, near 5%, on flights from all other regions. We reanalyzed the study data to test for associations between contaminated flights and factors such as season, cargo type, and time of departure (night or day), and developed probabilistic models for predicting insect pest arrivals by region and pest risk levels. Significant ($P < 0.05$) associations were detected between contaminated flights and (1) wet season flights from Central America, (2) flights carrying plant products and clothing or fabrics, and (3) flights departing at night from the country of origin. In Monte Carlo simulations, numbers of arriving mated insect pests were greatest for cargo flights from Central America, because of great contamination rates, and South America, because of the large volume of flights from there. Few insects arrived on flights from the Caribbean, and few high-risk insects arrived from anywhere. Although the likelihood of establishment in South Florida via this pathway could not be estimated, based upon arrivals the greatest threats were posed by moderate-risk insect pests on flights from Central and South America. Simulations indicated that switching to daytime departures only reduced pest arrivals by one-third. The simplest mechanism for pathway entry that explains the associations found is that insects entered aircraft randomly but sometimes remained because of the presence of certain cargo types. Hence, contamination rates were greater during the

wet season because of greater abundance locally, and on nighttime flights because of greater abundance around lighted loading operations. Empty planes probably had no pests because pests had no access to holds. Thus, the best mitigation strategies for this pathway will likely be those that exclude insects from holds or reduce the attractiveness of night loading operations. Optimizing inspections based on associations is also possible but will be less effective for regions such as South America, with high flight volumes and low contamination rates. Comparisons to other pathways indicates the potential importance of hitchhikers on cargo aircraft at MIA.

Chen, Z.X. and Maher, R.C. (2006). "Semi-automatic classification of bird vocalizations using spectral peak tracks." Journal of the Acoustical Society of America **120**(5): 2974-2984.

Automatic off-line classification and recognition of bird vocalizations has been a subject of interest to ornithologists and pattern detection researchers for many years. Several new applications, including bird vocalization classification for aircraft bird strike avoidance, will require real time classification in the presence of noise and other disturbances. The vocalizations of many common bird species can be represented using a sum-of-sinusoids model. An experiment using computer software to perform peak tracking of spectral analysis data demonstrates the usefulness of the sum-of-sinusoids model for rapid automatic recognition of isolated bird syllables. The technique derives a set of spectral features by time-variant analysis of the recorded bird vocalizations, then performs a calculation of the degree to which the derived parameters match a set of stored templates that were determined from a set of reference bird vocalizations. The results of this relatively simple technique are favorable for both clean and noisy recordings. (c) 2006 Acoustical Society of America.

Cleary, E.C., Dolbeer, R.A., et al. (2006). Wildlife strikes to civil aircraft in the United States, 1990–2005. **12**. Federal Aviation Administration, Washington, DC. 77 pp.

Demarchi, M.W. (2006). "Are Lesser Snow Geese, Chen caerulescens caerulescens, exceeding the carrying capacity of the Fraser River Delta's brackish marshes?" Canadian Field-Naturalist **120**(2): 213-223.

Brackish marshes of the Fraser River delta provide important habitats for such high-profile animals as White Sturgeon (Acipenser transmontanus), Pacific Eulachon (Thaleichthys pacificus), Pacific salmon (Oncorhynchus spp.), Western Sandpiper (Calidris mauri), and Lesser Snow Goose (Chen caerulescens caerulescens), the latter comprising the "Fraser-Skagit" segment of the Wrangel Island (Russia) population. This study assessed whether the current numbers of Snow Geese are exceeding the carrying capacity of brackish marshes in the Fraser River delta. Simulation modelling predicts that those marshes are presently capable of supporting similar to 17 500 Snow Geese-a value that is greatly exceeded by the numbers of geese that have over-wintered there in recent years (similar to 80 000 in 2004-2005). The Pacific Flyway Council's target 3-y average population and segment sizes of 120 000 and 50 000 - 70 000, respectively, were set without considering the carrying capacity of natural wintering habitats, the potential impacts of too many geese on upland agriculture, or implications for hazards to civilian aircraft at Vancouver International Airport. The modelled results of the present study suggest that the Fraser River delta can sustain the current numbers of Snow Geese that stage or winter there only if those birds also forage in agricultural and refuge fields-a relatively recent phenomenon that likely bolstered the Snow Goose population. Over-use by Snow Geese can degrade the productivity and habitat quality of marshes. There is documented evidence that some key plant species (e.g., Scirpus americanus) of the brackish marshes of the Fraser River delta are well below their biomass potential (similar to 15%), primarily because of grubbing by Snow Geese. Other species that depend on this brackish environment as well as human interests in the Fraser River delta may be adversely affected by an overabundance of Snow Geese. The future effectiveness of hunting as a primary means of population regulation is questioned.

Desholm, M., Fox, A.D., et al. (2006). "Remote techniques for counting and estimating the number of bird-wind turbine collisions at sea: a review." Ibis **148**: 76-89.

Since the early 1990s, marine wind farms have become a reality, with at least 13 000 offshore wind turbines currently proposed in European waters. There are public concerns that these man-made structures will have a significant negative impact on the many bird populations migrating and wintering at sea. We assess the degree of usefulness and the limitations of different remote technologies for studying bird behaviour in relation to bird-turbine collisions at offshore wind farms. Radar is one of the more powerful tools available to describe the movement of birds in three-dimensional space. Although radar cannot measure bird-turbine collisions directly, it offers the opportunity to quantify input data for collision models. Thermal Animal Detection System (TADS) is an infra red-based technology developed as a means of gathering highly specific information about actual collision rates, and also for parameterizing predictive collision models. TADS can provide information on avoidance behaviour of birds in close proximity to turbine rotor-blades, flock size and flight altitude. This review also assesses the potential of other (some as yet undeveloped) techniques for collecting information on bird flight and behaviour, both pre- and post-construction of the offshore wind farms. These include the use of ordinary video surveillance equipment, microphone systems, laser range finder, ceilometers and pressure sensors.

Dolbeer, R.A. (2006). "Height distribution of birds recorded by collisions with civil aircraft." Journal of Wildlife Management **70**(5): 1345-1350.

The National Wildlife Strike Database for Civil Aviation in the United States contained 38,961 reports of aircraft collisions with birds (bird strikes) from 1990-2004 in which the report indicated the height above ground level (AGL). I analyzed these strike reports to determine the distribution of all strikes and those strikes causing substantial damage to aircraft by height. For the 26% of strikes above 500 feet (152 m) AGL (n = 10, 143), a simple negative exponential model, with height as the independent variable, explained 99% of the variation in number of bird strikes per 1,000-foot (305-m) interval. Strikes declined consistently by 32% every 1,000 feet from 501-20,500 feet (153-6,248 m). For strikes at <= 500 feet, passerines, gulls and terns, pigeons and doves, and raptors were the identified species groups most frequently struck. For strikes at > 500 feet, waterfowl, gulls and terns, passerines, and vultures were the species groups most frequently struck. For strikes that resulted in substantial damage to the aircraft, 66% occurred at <= 500 feet, 29% between 501-3,500 feet (153-1,067 m), and 5% above 3,500 feet. A higher (P < 0.001) proportion of strikes between 501-3,500 feet caused substantial damage to the aircraft (6.0%) than did strikes at <= 500 feet (3.6%) or at > 3,500 feet (3.2%). For strikes at <= 500 feet, July-October were the months with the greatest proportion of strikes relative to aircraft movements. For strikes at > 500 feet, September-November and April-May had more strikes than expected. About 61% of the reported strikes above 500 feet occurred at night, compared to only 18% of civil aircraft movements. Thus, about 7 times more strikes occurred per aircraft movement at night compared to day above 500 feet. This analysis confirmed that management programs to reduce strikes should focus on the airport environment because 74% of all strikes and 66% of strikes causing substantial damage occur at <= 500 feet. To minimize significant strike events occurring outside the airport (> 500 feet), efforts to predict or monitor bird movements using bird avoidance models and bird-detecting radar need to focus on heights between 500 and 3,500 feet AGL, with special emphasis on night movements of birds during April-May and September-November.

Dolbeer, R.A. (2006). "Bird and other wildlife hazards at airports: liability issues for airport managers." USDA National Wildlife Reasearch Center - Staff Publications **15**: 1-6.

Jones, G.P., Pearlstine, L.G., et al. (2006). "An assessment of small unmanned aerial vehicles for wildlife research." Wildlife Society Bulletin **34**(3): 750-758.

Aerial surveys are valuable tools for wildlife research and management However, problems with safety, cost, statistical integrity and logistics continue to impede aerial surveys from manned aircraft. The use of small, unmanned aerial vehicles (UAVs) may offer promise for addressing these problems and become a useful tool for many wildlife applications, such as for collecting low-altitude aerial imagery. During 2002 and 2003, we used a 1.5-m wingspan UAV equipped with autonomous control and sophisticated video equipment to test the potential usefulness of such an aircraft for wildlife research applications in Florida, USA. The UAV we used completed > 30 missions (missions averaging 13 km linear distance covered) over 2 years before finally crashing due to engine failure. The UAV captured high-quality, progressive-scan video of a number of landscapes and wildlife species (white ibis [Eudocimus albus], other white wading birds, American alligator [Alligator mississippiensis], and Florida manatee [Trichechus manatus]). The UAV system was unable to collect georeferenced imagery and was difficult to deploy in unimproved areas. The performance of the autonomous control system and the quality of the progressive-scan imagery indicated strong promise for future UAVs as useful field tools. For small UAVs to be useful as management or research tools, they should be durable, modular, electric powered, launchable and recoverable in rugged terrain, autonomously controllable, operable with minimal training, and collect georeferenced imagery.

Kermanidis, T., Labeas, G., et al. (2006). "Bird strike simulation on a novel composite leading edge design." International Journal of Crashworthiness **11**(3): 189-201.

A methodology for the numerical simulation of bird strike on a novel leading edge (LE) structure of a horizontal tail plane is presented. The innovative LE design is based on the 'tensor skin' concept, comprising one or more folded composite sub-laminates that unfold during the bird impact, thus providing high-energy absorption characteristics. The Simulation technique is based on a non-linear dynamic finite element analysis and is performed in three steps. The first step deals with the development of suitable material damage models capable of representing the high-strain rate behaviour of the composite systems used in the LE structure. The second step deals with the development of a finite element modelling procedure for simulating the complex failure modes and unfolding mechanisms of quasi-static penetration of simple 'tensor skin' strips, which are representative of the complete LE composite structure. The third step deals with the numerical simulation of bird strike experiments on two novel aircraft LE designs. The influence on the numerical results of the critical modelling issues such as the mesh density of the highly impacted areas, the substitute bird flexibility as well as the material damage and contact interfaces parameters are discussed in detail. The numerical results are in good qualitative and quantitative agreement with the results of the experimental tests.

Khalafallah, A. and El-Rayes, K. (2006). "Optimizing airport construction site layouts to minimize wildlife hazards." Journal of Management in Engineering **22**(4): 176-185.

Construction operations in airport expansion projects often attract wildlife species to critical airport traffic areas leading to an increase in the risk of wildlife-aircraft collision accidents. Airport operators and construction planners need to carefully consider and minimize these wildlife hazards during the planning of construction site layouts in order to comply with Federal Aviation Administration recommendations. This paper presents the development of an advanced optimization model for planning airport construction site layouts that is capable of minimizing the hazards of wildlife attractants and minimizing the site layout costs, simultaneously. The model incorporates newly developed concepts and performance criteria that enable (1) quantifying, controlling, and minimizing the hazards of construction-related wildlife attractants near airport traffic areas; and (2) minimizing the travel cost of construction resources and the cost of devices installed to control wildlife on airport construction sites, while complying with all

relevant aviation safety constraints. The model is developed using a multiobjective genetic algorithm and an application example is analyzed to demonstrate the use of the model in optimizing airport construction site layouts and its unique capability of generating optimal trade-offs between wildlife control and site layout costs.

Kwan, C., Ho, K.C., et al. (2006). "An automated acoustic system to monitor and classify birds." Eurasip Journal on Applied Signal Processing.

This paper presents a novel bird monitoring and recognition system in noisy environments. The project objective is to avoid bird strikes to aircraft. First, a cost-effective microphone dish concept (microphone array with many concentric rings) is presented that can provide directional and accurate acquisition of bird sounds and can simultaneously pick up bird sounds from different directions. Second, direction-of-arrival (DOA) and beamforming algorithms have been developed for the circular array. Third, an efficient recognition algorithm is proposed which uses Gaussian mixture models (GMMs). The overall system is suitable for monitoring and recognition for a large number of birds. Fourth, a hardware prototype has been built and initial experiments demonstrated that the array can acquire and classify birds accurately.

Leader, N., Mokady, O., et al. (2006). "Indirect flight of an African bat to Israel: An example of the potential for zoonotic pathogens to move between continents." Vector-Borne and Zoonotic Diseases **6**(4): 347-350.

The transmission of harmful pathogens during commercial air flights is an increasing health concern. A potential, yet relatively overlooked source of zoonotic infectious diseases involves collisions of birds and bats with aircraft and long distance transport of their carcasses. We report a case of aerial transportation of the remains of an African fruit bat over three continents, following a collision with an aircraft, and demonstrate the relative ease with which zoonotic pathogens, such as rabies virus or other viruses associated with bats, may cross national boundaries and continents even. Improper handling and disposal of animal remains by airport personnel, may lead to exposure of both humans and local fauna to exotic pathogens. This in turn may trigger an epidemic with potentially devastating results.

Petel, T.D.V., Terhune, J.M., et al. (2006). "An assessment of the audibility of sound from human transport by breeding Weddell seals (Leptonychotes weddellii)." Wildlife Research **33**(4): 275-291.

Anthropogenic noise generated through travel in the Antarctic has the potential to affect the region's wildlife. Weddell seals (Leptonychotes weddellii) in particular can be exposed to anthropogenic noise because they live under, and breed on, the fast ice on which humans travel. To investigate the potential effects of anthropogenic noise on Weddell seals we developed sound profiles for pedestrian travel, over-snow vehicles, aircraft and watercraft operating at various distances and altitudes from breeding seals. The received 1/3- octave noise levels were then related to an assumed detection threshold for the Weddell seal. We found that most noise levels generated by the pedestrian, quad (4-wheeled, all-terrain vehicle) and Hagglunds (tracked, all-terrain vehicle) were commonly categorised in the inaudible and barely audible range of detection (both in-air and underwater), while noise levels generated by the helicopter, Twin Otter aircraft and Zodiac boat were categorised more commonly in the barely audible and clearly audible range. Experimental underwater recordings of vocal behaviour of Weddell seals exposed to continuous low-amplitude over-snow vehicle noise (i.e. Hagglund operation) were also made. Weddell seals underwater did not alter individual call types in response to low-level Hagglunds noise, but they did decrease their calling rate.

Seamans, T.W. and VerCauteren, K.C. (2006). "Evaluation of ElectroBraid (TM) fencing as a white-tailed deer barrier." Wildlife Society Bulletin **34**(1): 8-15.

White-tailed deer (Odocoileus virginianus) populations continue to increase, resulting in direct threats to public safety and increased agricultural losses. A variety of fencing methods are used to reduce deer presence at airports and agricultural areas. Electric fences may offer a less expensive alternative to expensive woven-wire. fences. We tested an electric fence product, ElectroBraid (TM) (Yarmouth, N.S., Canada), on free-ranging deer in northern Ohio. We conducted both 1- and 2-choice tests, measuring deer intrusions and corn consumption at 10 sites encompassed with charged, noncharged or no fence. Mean daily deer intrusions decreased in each test when the fence was powered. When power was immediately applied to the fence, intrusions decreased 88-99%. When power was delayed for 10 weeks, intrusions were reduced 90%. When power was turned on and off within a 4-week period, intrusions decreased 57%. Mean corn consumption differed between treated (< 2-6.4 kg/day) and control sites (15-32 kg/day). Under the conditions and time duration of this test, the fence was an effective deer barrier.

Shamoun-Baranes, J., van Loon, E., et al. (2006). "A comparitive analysis of the influence of weather on the flight altitudes of birds." Bulletin of the American Meteorological Society **87**(1): 47-61.

Birds pose a serious risk to flight safety worldwide. A Bird Avoidance Model (BAM) is being developed in the Netherlands to reduce the risk of bird-aircraft collisions. In order to develop a temporally and spatially dynamic model of bird densities, data are needed on the flight-altitude distribution of birds and how this is influenced by weather. This study focuses on the dynamics of flight altitudes of several species of birds during local flights over land in relation to meteorological conditions. We measured flight altitudes of several species in the southeastern Netherlands using tracking radar during spring and summer 2000. Representatives of different flight strategy groups included four species: a soaring species (buzzard Buteo buteo), an obligatory aerial forager (swift Apus apus), a flapping and gliding species (black-headed gull Larus ridibundus), and a flapping species (starling Sturnus vulgaris). Maximum flight altitudes varied among species, during the day and among days. Weather significantly influenced the flight altitudes of all species studied. Factors such as temperature, relative humidity, atmospheric instability, cloud cover, and sea level pressure were related to flight altitudes. Different combinations of factors explained 40%-70% of the variance in maximum flight altitudes. Weather affected flight strategy groups differently. Compared to flapping species, buzzards and swifts showed stronger variations in maximum daily altitude and flew higher under conditions reflecting stronger thermal convection. The dynamic vertical distributions of birds are important for risk assessment and mitigation measures in flight safety as well as wind turbine studies.

VerCauteren, K.C., Lavelle, M.J., et al. (2006). "Fences and deer-damage management: A review of designs and efficacy." Wildlife Society Bulletin **34**(1): 191-200.

White-tailed deer (Odocoileus virginianus) may cause more damage than any other species of wildlife. These damages include crop loss, automobile and aviation collisions, disease transmission, environmental degradation, and destruction of ornamental plantings. One practical method of controlling deer damage is the use of exclusionary fences. The relatively high cost of labor and materials required to build effective fences has limited most applications to the protection of orchards, vegetable farms, other high-value resources, and mitigation of human health and safety risks. Improvements in fence technology resulting in less expensive, yet effective fences have expanded the use of fences to manage damage caused by deer. Fences typically installed to manage white-tailed deer damage include wire or plastic mesh, electrified high-tensile steel wire, and electrified polytape or polyrope fence. We reviewed the scientific literature on fencing to determine which fence designs would be the most effective for excluding deer in a variety of situations.

Aas, C.K. (2006). Det er vår - trekkfuglene kommer nå! Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo 3pp.

Aas, C.K. (2006). Skarver, gjess og traner i lufta nå! Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo. 3 pp.

2005

[Anon] (2005). "BAE Systems develops new bird for bird-strike tests." Aircraft Engineering and Aerospace Technology **77**(6): 503-503.

Allan, J.R. (2005). Minimum best practice standards for aerodrome bird control International Bird Strike Committee, Athens. 8 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPV-5.pdf.

Despite almost 40 years of research effort and operational experience, there remains very limited consensus concerning the best methods for managing the birdstrike hazard at aerodromes. This is, in part, because the levels of risk, habitat type and bird species present at different aerodromes varies and the precise techniques that are successful at one site may not work at another. It is also partly due to differences in the levels of resources available at different airports and to differences in the attitude of airport managers and national regulators to the hazard posed by birdstrikes. Following the implementation of the new ICAO standards on airport bird control, IBSC agreed at the 26th meeting in Warsaw that a set of recommended minimum best practices should be developed to try and address these problems. This paper seeks to identify those areas where universally applicable practices can be identified, and suggests a minimum standard of equipment, manpower, airfield habitat management and control of hazards around the airport that any medium to large regional or international airport should have in place if it is to effectively manage the birdstrike risk to aircraft. The author, and the IBSC Steering Committee, invite debate and critical comment on these standards with a view to having them endorsed by the IBSC membership Key words: IBSC, bird control, aerodrome, best practice, standards.

Baxter, A.T. (2005). Effectiveness of best practice bird control on landfill sites in relation to gull feeding behaviour. International Bird Strike Committee, Athens. 8 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPIV-2.pdf.

This paper aims to show how bird behaviour can be used to guide best practice bird management plans for landfill sites. Bird hazards at landfill sites represent one of the most significant yet predominantly controllable off-airfield concerns for flight safety. ICAO standards provide airport operators with the opportunity to attempt to eliminate such hazards from the environment surrounding their aerodrome. Bird numbers were recorded at five landfill sites with active integrated deterrence regimes in place and at a landfill site with bird exclusion netting. Both netting and integrated strategies delivered highly effective levels of control although breakdown frequencies and amounts varied. Behavioural observations of birds showed that active systems can be significantly improved by ensuring dawn to dusk, seven day a week deterrence is implemented and that netting systems can be improved by ensuring adequate maintenance and back-up control is specified within management plans. Irregular failures in control do not generally result in birds utilising a site. Nevertheless, failures should be rectified immediately if birds are noted around a site or within 3 hours if not. Gulls required only 20 minutes of cumulative foraging time on a landfill site to meet their daily energy requirements. Spot checks of, for example, one hour are thus ineffective at highlighting failures in techniques. Airport operators need to ensure several full day visits are undertaken on random occassions. Bird management should be available seven days a week, 365 days a year from ”before birds arrive until after birds leave” as a pose to ”dawn to dusk”. Birds that roost near to a site can still gain sufficient foraging time to feed pre-dawn and post dusk when deterrence is removed. Standards within a

management plan may allow some tolerance towards small numbers of birds, however, they should always include targets for zero tolerance.

Baxter, A.T. and Cropper, P. (2005). Aeronautical studies to determine the spatial movements of hazardous birds. International Bird Strike Committee, Athens, IBSC27/WP IX-1 7p pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPIX-1.pdf.

Deterring birds from an attractive site in the vicinity of an aerodrome has the potential to increase risk if birds subsequently move to more hazardous areas. Aeronautical studies should be undertaken to determine the likely impact of bird management at sites within commuting distance of an aerodrome. This paper reports on a comprehensive aeronautical study to review hazardous bird movements between different foraging habitats and roost sites within 25 miles of an aerodrome in southern England. 1200 gulls were marked at a landfill site ten miles north of London Heathrow Airport. Their movements were monitored over a 12 month period in an attempt to predict the potential impacts of implementing bird deterrence at the site. Birds were recorded at 12 other landfill sites in the region, 7 sewage treatment works and 8 roost sites. Movements between some sites were confirmed using bird detection radar. Individual birds frequently used the same roost unless affected by environmental change such as reservoir drainage, freezing weather or unintentional disturbance. Birds showed a preference for the same foraging habitat. Movements throughout the area between landfill facilities and roost sites are presented. The flight safety risks posed by these movements are discussed and the influence of implementing bird deterrence at one or more of sites can be predicted. This study shows that, as some bird species may travel significantly greater distances than a safeguarding circle, aeronautical studies should be extended to cover distances traveled by particular species as a pose to distances covered by safeguarding circles.

Boldt, A. and Ingold, P. (2005). "Effects of air traffic, snow cover and weather on altitudinal short-term and medium-term movements of female Alpine chamois Rupicapra rupicapra in winter." Wildlife Biology **11**(4): 351-362.

We studied the altitudinal movements of eight radio-collared female Alpine chamois Rupicapra rupicapra in the Swiss Alps to investigate how air traffic and environmental factors affect daily movements and medium-term altitudinal displacements in winter. Average altitude was often similar during periods of several days depending mainly on snow cover. Daily altitudinal movements occurred at all altitude levels and seemed to be affected more by local topography and habitat structure than by current environmental conditions. In individuals that were above the timberline in the morning, and thus were potentially exposed to air traffic, the first aircraft of a day could induce a downward movement, and a high intensity of air traffic (i.e. many aircraft during most of the day) affected the altitudinal difference that was covered during the whole day. After a downward movement the chamois returned to higher altitudes within a day and the following night, confirming their preference for the open pastures above the timberline. Two groups of chamois that were exposed to different intensities of air traffic, did not differ in their altitudinal movements, indicating a weak effect of aircraft. The daily energy costs of altitudinal locomotion were not considerably increased. We estimate that, on an average winter day, the energy costs of locomotion were not increased by more than 0.1% of the field metabolic rate (FMR) due to aircraft. However, a combination of deep snow and very intensive air traffic may result in a much higher increase in the energy expenditures on certain days. Further reasons for this ambiguous influence of aircraft are discussed.

Briot, J.L. (2005). Last experiments with a laser equipment designed for avian dispersal in airport environment. International Bird Strike Committee, Athens. 5 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPV-1.pdf.

This paper and the video associated, presents an automatic runway protection system against bird strike using a laser light. Chronology of experiments, technical

specifications, eye safety, results on different bird species on civil and military airfields related with meteorological conditions, benefits and drawbacks of this equipment are presented and discussed.

Cleary, E.C. and Dolbeer, R.A. (2005). Wildlife hazard management at airports. Federal Aviation Administration, Office of Airport Safety and Standards, Airport Safety and Compliance Branch, Washington, DC, USA. 363 pp.

Cleary, E.C. and Dolbeer, R.A. (2005). Multi-engine bird strikes to turbine-powered aircraft International Bird Strike Committee, Athens. 15 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVI-2.pdf.

The aviation safety hazard posed by the possibility of multi-engine bird 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 U.S. Federal Aviation Administration (FAA) in 2001 studied the threat posed by large (weight > 1.15 kg.) flocking birds. Early in the process, there were questions raised as to the inadequacy of the database used by the ARAC group. Based on the strike records in the database, the ARAC group released their recommendations for ingestion standards of large flocking birds in 2002: 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: And for engines with an inlet throat area >3.9 m^2 - one 2.5 kg bird. To reexamine this issue, we analyzed bird/engine strike reports involving turbofan- and turbojet-powered aircraft (N=6,470, 1 January l990 - 28 February 2005) from the FAA National Wildlife Aircraft Strike Database. We found 312 instances of multi-engine bird strikes, 215 of these reports involved both engines on twin-engine aircraft. There were 83 reports of multiple engine damage; 70 of these reports involved both engines on a twin-engine aircraft. There were 139 (121 air carrier aircraft and 18 business jet aircraft) reports of single or multiple-engine ingestion events involving birds with a mass greater than 1.2 kg. There were 109 events that involved only 1 engine and 30 involved 2 or more engines, of which 24 involved both engines on a twin-engine aircraft. We believe these data indicate that the threat of multi-engine strikes and damage posed by flocking birds is more serious than the ARAC's recommendations would indicate, especially when combined with increases in populations of many large flocking-bird species in recent years and the increasing dominance of 2-engine aircraft in the worldwide commercial aviation fleet. We recommend that the FAA not accept the ARAC recommendations at this time, and re-initiate an analysis of this issue using a more complete worldwide dataset of strike events that has been checked for errors and harmonized for consistency.

de Hoon, A., Charalambidou, I., et al. (2005). Cyprus' flamingoes commuting across the runway: adapting the aircraft's or birds' flight schedule? International Bird Strike Committee, Athens. 4 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPV-3.pdf.

Cyprus is a popular holiday destination. Most tourists enter the country by plane via Larnaca airport. The water bodies surrounding the airport attract many waterfowl, including up to 4,000 Flamingoes. Commuting between those different water bodies, the birds cross the runway and pose a threat to the departing and landing aircraft. According to the new ICAO standards, the bird strike hazard shall be assessed and appropriate action shall be taken to decrease this hazard. Although data of bird strikes at Larnaca airport are missing, it's obvious that the waterfowl and especially the Flamingoes, with their big numbers, big size and poor manoeuvrability, are a potential hazard while crossing the runway. According to the EU Habitat and Bird Directives, areas of nature importance and their species shall be protected. The wetland complex surrounding the airport will be designated as a special protection area with special interest for the conservation of the Flamingo. What to do with these conflicting laws? We compared two opposite strategies; how do the bird control units of JFK New York

and Woens-drecht (NL) deal with gulls crossing their runways? Which strategy is the best to reduce the risk of colliding with Flamingoes at Larnaca airport?

DeFusco, R.P., Harper, J.T., et al. (2005). Alaska bird avoidance model (ak bam) development and implementation. International Bird Strike Committee, Athens. 6 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPI-4.pdf.

An Alaskan Bird Avoidance Model (AK BAM) based on historical data has been developed using much of the same methodology as was employed in the development of the United States Bird Avoidance Model (US BAM). The US and AK BAMs are now integrated in one system and may be accessed by all at www.usahas.com. The geographic information system graphic user interface depicts relative risk of bird strikes in time and space for each square kilometer of the entire state. Operational airspace, topography, land cover, land uses, infrastructure, and other data layers may be overlaid on the bird risk surfaces at the user's discretion. Alaska's extreme climactic and geophysical environment made modeling bird distributions and abundance a significant challenge in developing operational bird strike risk surfaces. From a baseline derived from Breeding Bird Survey (BBS) and Christmas Bird Count (CBC) data, new methodologies were investigated and developed. Improvements over the US BAM include statistical correlation of bird populations with habitat data, flexible daily activity patterns, seasonal population fluctuations, and regional migration analyses. These improvements have made the AK BAM much finer in its resolution and results in more realistic relative risk predictions. These methodologies are now being applied to the entire BAM structure along with improvements to the Internet mapping application user interface.

DeFusco, R.P., Hovan, M.J., et al. (2005). Integrated north american bird avoidance system: research and development strategic plan. International Bird Strike Committee, Athens. 9 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPX-4.pdf.

Bird strikes to both civil and military aircraft in North America reportedly cost over $US 1 billion annually. Bird control efforts and population management are conducted in the airfield environment, but many strikes and a disproportionate amount of damage are recorded in the off-airfield environment. Avoiding birds in flight remains a viable option that requires further research and development. Bird avoidance in time and space is scale dependent in both time and space. Long range planning can be addressed by such historical 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 by various agencies. Effort is now underway to integrate all these disparate systems under one overarching umbrella for the United States and Canada. The USAF Academy Institute for Information Technology Applications is currently hosting the program to consolidate such efforts. Maintenance and updates to the US BAM and the new Alaska BAM, 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 purview. A strategic plan for the proposed integrated North American Bird Avoidance System has been developed to outline research, development, and implementation of these efforts. Department of Defense, Federal Aviation Administration, Transport Canada, Canadian Defense Forces, and various contractors are current participants. The goals are to end competition and incompatibility between components and to create a unified system for all users. Ultimately, efforts to integrate systems in a worldwide network will be pursued with cooperating nations across the globe.

Dekker, A. and Buurma, L. (2005). Mandatory reporting of bird strikes in europe, who will report what to who? International Bird Strike Committee, Athens. 7 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPII-1.pdf.

Much of the present knowledge of bird strikes is based on anecdotal descriptions of those cases that -because of material or personal consequences- have drawn attention. Databases typically contain only a limited proportion of the real number of strikes that occurred. This partly is related to the fact that a firm and generally accepted definition of a bird strike is still lacking. Furthermore, bird strikes are often described incompletely. Bird strike databases therefore have only limited use and analyses need the eye of an expert in order to determine their value. Much of these shortcomings are thought to be connected to the fact that reporting is voluntary. During the 26th IBSC meeting Eschenfelder -as ALPA´s representative- stated that the time has come for mandatory reporting for civil aviation. He suggests that internet reporting infrastructures already exists in some countries or that existing websites easily can be modified to report bird strikes. This paper gives a short overview of reporting standards in military aviation, in which people are already used to detailed reporting on all aspects of flights. Experience with the European Military Bird Strike Database has learned that despite the best intention of nations the amalgamation of a set of different databases leads to loss of information. It is therefore suggested that mandatory reporting in Europe should not be national but European and structured around a uniform system. Such a system should allow accidents as well as incidents, should be able to process systematical as well as anecdotal information but should NOT contain information referring to personal liability such as names and formal legal statements. The custodian of such a European Database should preferably not be allocated to one of the member states but to an independent body.

Dekker, A. and Van Gasteren, H. (2005). Eurbase: military bird strike frequency in europe. International Bird Strike Committee, Athens. 10 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPIX-5.pdf.

This paper should be considered as a progress report of the EURBASE project (European Military Bird Strike Database). The contributions from participating Air Forces - as received by the summer of 2004 -- are presented and used for an analysis of the bird strike frequency of different Air Forces. Using flying hours as provided by the Air Forces Flight Safety Committee Europe (AFSCE), ratios were calculated for 9 Air Forces over the 10 years period 1991 - 2000. Restricted to jet fighters en-route and taking into account differences in damage patterns, normalised bird strike ratios are presented. These ratios vary considerable between the different Air Forces and are used to calculate the average yearly number of non-local bird strikes with jetfighters in Europe. Using GIS techniques on the normalised ratios a bird strike density map of Europe is calculated. Comparing this bird strike density map with a map of bird strike danger area´s (Anonymous 1979) learns that maps as a prevention tool are to coarse, to general, based on birds on the ground and to difficult to integrate in day-to-day operations. En-route bird strike prevention is far better served with dynamic models in which bird mobility is predicted in time and 3D space. The outcome of such models should be available for the pilots as end-users in their operational planning system.

DeVault, T.L., Reinhart, B.D., et al. (2005). "Flight behavior of black and turkey vultures: Implications for reducing bird-aircraft collisions." Journal of Wildlife Management **69**(2): 601-608.

Mid-air collisions with black vultures (Coragyps atratus) and turkey vultures (Cathartes aura) regularly cause substantial damage to military and civilian aircraft. Information concerning the flight behavior of black and turkey vultures potentially could improve predictive models designed to reduce bird strikes by aircraft. We examined the flight behavior of black and turkey vultures at the Savannah River Site (SRS) in South Carolina, USA, and determined whether flight characteristics were predictable with respect to weather and time variables. We captured birds at their primary roost and subsequently relocated them via aerial telemetry from l l February 2002 through 29 January 2003. One hundred eighty of 326 locations (55%) for 8 black vultures and 129 of 206 locations (63%) for 5 turkey vultures were of flying birds. Black vultures flew at

an average altitude of 169 +/- 115 (SD) m above ground level, whereas turkey vulture flight altitude averaged 163 +/- 92 m. Our results contrast with those of previous studies that reported, less frequent and lower altitude flights. The flight behavior of both species appeared to be influenced minimally by weather and time variables. However, we were unable to construct useful models predicting aspects of flight behavior using the variables we measured (all models had R-2 or pseudo R-2 values < 0.10). We suggest that other factors, such as food availability inter- and intra-specific interactions, and physiological demands play a larger role in vulture flight behavior than the variables we measured. Our results suggest that the development of bird avoidance strategies by aircraft operators should consider the variability of flight behaviors of black and turkey vultures across their ranges. Future research emphases should shift from examinations of the effects of local conditions on flight behavior to the elucidation of factors contributing to differences in flight behavior among regions.

Dickey, A.M., Newman, A.R., et al. (2005). Collection and dissemination of wildlife strike data at airports for the us federal aviation administration via the world wide web. International Bird Strike Committee, Athens. 12 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPII-4.pdf.

Embry-Riddle Aeronautical University (Prescott, AZ, USA) was awarded a grant from the William J. Hughes FAA Technical Center in October 1999 to develop and maintain a web site dealing with a wide variety of airport safety wildlife concerns. Initially, the web site enabled users to access related topics such as wildlife management (at/near airports), bird identification information, FAA wildlife management guidelines, education, pictures, current news, upcoming meetings and training, available jobs and discussion/forum sections. In April 2001, the web site was augmented with an on-line wildlife strike report (FAA Form 5200-7). Upon submittal on-line, “quick look” email notifications are sent to concerned government personnel. The distribution of these emails varies as to whether there was damage, human injuries/fatalities, and whether feather remains were collected and will be sent to the Smithsonian Institution for identification. In July 2002, a real-time on-line query system was incorporated to allow federal and local government agencies, airport and operator personnel, and USDA and airport wildlife biologists to access this database (which as of Nov 2004 contains 66,816 researched strike reports added to at a rate of approximately 500 strike reports/month) to formulate strategies to reduce the hazards wildlife present to aviation. To date (January 2005), over 10,800 on-line real-time queries were processed. In June 2004, ERAU was authorized to develop a graphical interface to this on-line query system. This graphical interface will give analysts the ability to view strike patterns with a wide variety of variables including species, seasons, migration patterns, etc.

Dolbeer, R.A., Wright, S.E., et al. (2005). Animal ambush at the airport: the need to broaden icao standards for bird strikes to include terrestrial wildlife. International Bird Strike Committee, Athens. 12 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVI-3.pdf.

Birds have long been recognized as a serious threat to aviation safety. However, terrestrial wildlife can also have a serious impact on aircraft. In the USA, 1,243 strikes to civil aircraft involving terrestrial vertebrates (mammals and reptiles [excluding bats]) were reported from 1990-2003. Deer (primarily Odocoileus spp., 622) and coyotes (Canis latrans, 153) were the most commonly reported terrestrial wildlife struck by aircraft. Whereas 13% of bird and bat strikes resulted in aircraft damage and 8% had a negative effect on the flight, 45% of strikes with terrestrial wildlife caused damage and 33% had a negative effect on the flight. Although terrestrial wildlife represented only 2.4% of the reported strikes in the USA from 1990-2003, 15 (56%) of the 27 civil aircraft that were destroyed due to wildlife strikes were caused by these non-bird species. A survey of other countries also revealed a number of significant strike events involving terrestrial wildlife. When data from all countries were combined, large herbivorous mammals represented 51% of 1,379 terrestrial wildlife strikes. However, these species comprised 93% of the 630 terrestrial wildlife strikes that caused damage and 96% of

the strikes that caused substantial damage or aircraft destruction. We conclude that 1) terrestrial wildlife is an important component of wildlife hazards to aviation in the USA and elsewhere; 2) the International Civil Aviation Organization (ICAO) should broaden the existing three standards regarding the management of bird hazards at airports to include terrestrial wildlife; 3) ICAO standards should address minimum requirements for airport fencing to exclude large herbivorous mammals and other hazardous wildlife; 4) terrestrial wildlife strikes should be reported to national aviation authorities and ICAO in the same manner as bird and flying mammal (bat) strikes; and 5) the size limit for reporting terrestrial wildlife strikes should be animals greater than 1 kg (the size of a muskrat [Ondatra zibethica] or small rabbit [Sylvilagus floridanus]).

Eschenfelder, P.F. (2005). High speed flight at low altitude: hazard to commercial aviation? International Bird Strike Committee, Athens. 8 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPI-3.pdf.

Commercial aircraft are capable of, and in fact, do, operate at high speed (>250 knots indicated airspeed [KIAS]) at low altitude (below 10,000' above ground level) worldwide. Design, construction and certification standards for these aircraft were developed over 40 years ago. Since the development of these standards populations of large flocking birds have increased dramatically in many parts of the world. Yet neither design/construction standards nor operational practice have changed to reflect the new threat. Subsequent serious damage resulting from recent collisions indicates change is necessary. Since 2003, flight rules in Canada and the United States have been amended, principally due to concern over bird strikes, to prohibit high-speed flight below 10,000'. As Mexico has already adopted such standard there is now no high-speed flight at low altitude in North America. Worldwide, however, various Flight Identification Regions (FIRs) have adopted a variety of speeds at low altitude to suit air traffic control (ATC) requirements. Most operators and regulators are unaware of the force imparted on airframes and engines by bird collisions, demonstrated by the equation: kinetic energy = (½ mass) times (velocity^2). For example, a 20% increase in aircraft speed from 250 to 300 KIAS results in a 44% increase in impact energy during a bird strike. Clearly the speed of the aircraft and engine rotation speed are more important in a collision than the size of the bird and more controllable than the size of the bird. While hardening the aircraft structure is an effective mitigation strategy, a faster and cheaper solution to reducing impact energy on the aircraft is to adopt operating strategies and rules which limit exposure to damage during collisions. One such strategy/rule is to prohibit high-speed flight at low altitude by commercial aircraft.

Fennessy, G., Kelly, T.C., et al. (2005). Ground versus air - seasonal changes is the use by birds of an irish airport. International Bird Strike Committee, Athens. 6 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPV-2.pdf.

Detailed surveys of the birds present on the field and over-flying the runways at Dublin Airport have been made for the last ten years. These data have now been collated to examine seasonal patterns of birds that are found on the field, and to compare these data with the profile of species (and their relative abundances) over-flying the runways at these times. This study highlights the relationship between species (and their relative abundances) in both data sets. Some comments are made about the pattern of bird strikes in relation to the species profile in both data sets.

Fennessy, G., Sheehy, S., et al. (2005). Over-flying of birds at an airport: developing a methology. International Bird Strike Committee, Athens. 6 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVIII-1.pdf.

Many airfield management practices have been developed to make grassland and hard standing areas less attractive for feeding and resting birds. It is more difficult to manage the surrounding habitats and, consequently, the birds that over-fly the airfield en route to roosting and feeding areas. To more fully understand the strike risks posed to aircraft it is important to quantify these over-flying rates in relation to species, flock size, flight

direction, time spent crossing the active runway, flight heights, etc., and how these factors are influenced by environmental conditions and airfield activity. This study outlines the methodology that has been developed to quantify and examine over-flying bird data at a busy civil airport. The field data are collected using a variety of observational techniques that have been applied in repeated visits throughout the past two years.

Fidgen, H., Robinson, A., et al. (2005). Do birds respond to infrasound? a study of low frequency sound as bird-deterring technology. International Bird Strike Committee, Athens. 12 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPIV-4.pdf.

Birdstrikes are a global problem costing the aviation industry billions of dollars each year. It was hypothesised that infrasound might play a role in birds' detection of approaching aircraft, as it has been shown that various species can detect or produce low frequency sound. To test this, various artificial and recorded aircraft sounds at infrasonic frequencies were tested on groups of birds (mean = 10) at a small airfield. Changes in bird behaviour were recorded, but only rarely did the birds lift or disperse and on these occasions no significant relationships with the frequencies or amplitudes of the sounds were established (P=0.554, P=0.456). It was concluded therefore that sounds of the frequency patterns and amplitude tested were not effective at deterring or scaring birds.

Froneman, A. (2005). Conservation and industry strategic partnerships - a model approach for the effective implementation of an airport authority bird hazard management program. International Bird Strike Committee, Athens. 13 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPIII-1.pdf.

It is common knowledge that in many instances modern industry has a negative impact on the environment. Environmental and conservation organisations therefore criticise industry and in association with government departments they endeavour to enforce stricter control measures on how to curb and better police those negative effects industries are having on the environment. What is however often neglected is the realisation that wildlife often also pose a threat to industry. Certain industries, particularly the aviation sector, are faced with potential catastrophic negative effects on their activities as a result of wildlife hazards. Conservation and environmental organisations should therefore not only pass judgment on industry but continuously seek opportunities to work together with industry to both address the negative effects that a particular industry might have on the environment but also seek to assist the industry where wildlife might pose a threat. Conservation organisations are often best positions to provide effective solutions to such problems. In South Africa the Endangered Wildlife Trust pioneered the establishment of two key industry partnership programs with the Aviation and Electricity sectors. Worldwide both these industries are negatively effected by wildlife - in particular birds. These industries could also have a negative impact on bird populations if destructive mitigation measures were to be implemented in an uninformed manner. It therefore made sense for the Endangered Wildlife Trust (EWT), a non-governmental conservation organisation, to engage with these industries in order to assist them in better understanding and mitigating the negative effects that wildlife are having on their operations in an environmentally sensitive manner. The EWT's Strategic Partnership with the aviation industry in South Africa was established during 1999. It has since been instrumental in forging a working model acting as intermediary between aviation industry stakeholders in South Africa to ultimately address the bird hazard risk experienced on South African airports. The programme is funded primarily by ACSA (Airports Company South Africa) who operates the 10 larger airports across South Africa. The partnership program has been instrumental in addressing bird hazards at ACSA airports. This paper outlines the structure and working model of the industry partnership program of the EWT with a specific focus on the ACSA - EWT Strategic Partnership and its achievements over the past five years. Further more the model of integrating conservation related

organisations with corporate / industry is proposed for establishing long term sustainable wildlife hazard management programmes at airports.

Gleizer, H., Bar, P., et al. (2005). The effect of habitat productivity and structure on bird spatial distribution in an airfield located at a semi-arid region. International Bird Strike Committee, Athens. 4 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPIII-2.pdf.

Military airfields in semi-arid regions in Israel protect vast areas from intensive grazing and any other interference, thus their primary productivity is higher than the adjacent areas. Accordingly, they attract massive avian populations by increasing: (a) grass biomass and seed quantities for granivorous birds (b) shelter for prey species provided by shrubs, and (c) viewpoints on higher shrubs and trees that are used by raptor birds that use them as hunting perches. Accordingly, bird-aircraft collision risk is significantly high. This study aims to determine the impact of vegetation biomass and other trophic levels, and habitat characteristics on the spatial and temporal distribution of birds in an airfield. The airfield chosen for the study is at a semi-arid area (260 mm/year) in south Israel. Several study sites were chosen, which differ in their productivity levels. One control site, which is under severe grazing pressure, is studied beyond the airfield fence. In each site we determine plant cover, biomass and seed production, insect biomass and density. Five bird species are investigated: Alauda arvensis and Ciconia ciconia that cause relatively many collisions with aircraft, Athene noctua and Falco tinnunculus that are common (although collision numbers are small) and Bubulcus ibis that is a large invasive species and thus potentially hazardous. Birds are observed and located by GPS using line transects biweekly. Initial results indicate that Skylarks select scarce grassland habitats far-off high perches. Kestrels select more dense grasslands with perches. Cattle egrets prefer low shrubs and little owls use open habitats with many low perches. The major outcome of ecological analysis combined with G.I.S and multi-spectral Ikonos satellite remote sensing data will be used as a basis for a predicting model of temporal and spatial bird abundance and distribution in various scenarios.

Goldstein, M.I., Poe, A.J., et al. (2005). "Mountain goat response to helicopter overflights in Alaska." Wildlife Society Bulletin **33**(2): 688-699.

The number of helicopter flights used to gain access to backcountry has increased in recent years. Biologists, land managers, and the public have expressed concern about disturbance impacts to mountain goats (Oreamnos americanus) resulting from helicopter activity. We recorded behavioral responses of 122 groups of mountain goats from 347 helicopter overflights at 4 geographic areas in Alaska and analyzed responses in relation to distance and angle from helicopters to mountain goats, reproductive class, season, and area of study. We used multinomial logistic regression modeling combined with a bootstrap randomization procedure to identify factors associated with increased probability of mountain goats being in 1 of the 4 behavioral response categories during helicopter overflights. The probability of a goat group being disturbed was inversely related to distance of the helicopter from the group. Odds of disturbance increased by a factor of 1.25 for every 100-m reduction in approach distance. Approach distances resulting in > 90% probability of maintenance were significantly larger where mountain goats had received less prior exposure to helicopters. When mountain goats were disturbed during overflights, a second analysis (i.e., gamma regression model with inverse link function) estimated elapsed time until mountain goats returned to maintenance behavior. The length of time that a goat remained in a disturbed state following overflight did not depend upon any of the covariates; mountain goats remained in a disturbed state for an average of 30.7 seconds (95% CI, 25.7-35.9 seconds). The results offer land managers an opportunity to evaluate risk for permitting helicopter activity.

Harris, C.M. (2005). "Aircraft operations near concentrations of birds in Antarctica: The development of practical guidelines." Biological Conservation **125**(3): 309-322.

Aircraft operations have the potential to disturb and to impact negatively on bird life. A gradient of increasing behavioural response is evident in birds when exposed to increasing aircraft stimulus. The most major disturbance is likely to lead to impacts on the health, breeding performance and survival of individual birds, and perhaps bird colonies. A process of revision to policies on aircraft operations contained in management plans for a number of specially protected areas in Antarctica by the United Kingdom, accompanied by consultations made within the scientific community through the Scientific Committee on Antarctic Research (SCAR) and with operational interests through the Council of Managers of National Antarctic Programmes (COMNAP) resulted in new guidelines being adopted by the Antarctic Treaty Consultative Parties in June 2004. The principal recommendations of the guidelines are that bird colonies should not be overflown below 2000 ft (similar to 610 m) above ground level and landings within 1/2 nautical mile (similar to 930 m) of bird colonies should be avoided wherever possible. These guidelines are less stringent and less specific than those that were recommended by the SCAR specialist group on birds, and represent a compromise to accommodate operational needs. While the adoption of clear and consistent guidelines for the operation of aircraft in Antarctica is welcome in that this provides practical advice that is likely to reduce incidences of close aircraft/bird encounters, there remains insufficient knowledge of the interactions between aircraft and birds in Antarctica, and the consequent impacts on individual birds and on bird populations. It is important, therefore, that the guidelines adopted are considered interim, and should be kept under scrutiny with revisions made as new and improved research results appear. (c) 2005 Elsevier Ltd. All rights reserved.

Hartup, B.K., Olsen, G.H., et al. (2005). "Fecal corticoid monitoring in whooping cranes (Grus americana) undergoing reintroduction." Zoo Biology **24**(1): 15-28.

We used radioimmunoassay to determine fecal corticoid concentrations and assess potential stress in 10 endangered whooping cranes (Grus americana) undergoing reintroduction to the wild. Fecal samples were collected shortly after hatching at a captive facility in Maryland, during field training in Wisconsin, and throughout a human-led migration to Florida. After a 14-day decline following hatching, fecal corticoid concentrations stabilized at baseline levels for the duration of the captive period, despite exposure to potentially stressful stimuli. Shipment of the cranes to the field training site was correlated with an eight- to 34-fold increase in fecal corticoid concentrations, which returned to baseline levels within 1 week. Increases were positively correlated with age but not body weight at the time of shipping. Fecal corticoid concentrations during the training period increased slightly and exhibited greater variation than levels observed at the captive facility, but were well within expected norms based on previous studies. Fecal corticoid concentrations increased twofold following premigration physical examinations and placement of radiotransmitters, and persisted for up to 4 days before they returned to baseline levels. Though fecal corticoid concentrations and variation during the migration period were similar to training levels, there was an overall decline in fecal corticoid concentrations during the artificial migration. Acute stressors, such as capture, restraint, and severe storms, were associated with stress responses by the cranes that varied in accordance with lasting physical or psychological stimuli. The overall reintroduction process of costume-rearing, ultralight aircraft habituation, training, and artificial migration was not associated with elevations in fecal corticoid concentrations suggestive of chronic stress.

Konowski, M.R., Breedveld, G.D., et al. (2005). "Natural gradient experiment on transport of jet fuel derived hydrocarbons in an unconfined sandy aquifer." Environmental Geology **48**(8): 1040-1057.

This paper deals with a field experiment, combining the push-pull and tracer tests, conducted under natural gradient conditions at the international Oslo airport. The studied aquifer, showing very complex hydrogeological settings, has been

contaminated by a jet fuel spill. The tracer solutes-bromide, toluene, o-xylene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene and naphthalene, have been injected into the plume. Their migration and changes in concentration of the electron acceptors and metabolic by-products have been monitored. Fast removal of both the non-reactive tracer as well as the aromatic organics has been observed. The tracer pulse could only be detected 2 m downgradient from the injection points. At this point, toluene and o-xylene have been completely removed, however, trimethylbenzenes and naphthalene have been detected. Their depletion, based on calculations of available electron acceptors, can, to a large extent, be accounted for intrinsic biodegradation, with Fe(III) and sulphate reductions as the major controlling processes.

Kupstein, H. and Carter, N.B. (2005). Grass species as a key element in bird control strategy around the airfield. International Bird Strike Committee, Athens. 4 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPIII-4.pdf.

Bird harassment, habitat management, and air traffic are the three major components of a bird control strategy to reduce bird strikes around the runways. Habitat management is essential to maintain sustainable minimum bird species diversity and to significantly increase harassment efficiency. Birds are just one element of the ecosystem and understanding the dynamic biotic and non-biotic components of the habitat helps reduce bird presence around the runways. Learning to control these components can greatly contribute to effective bird control. Maintaining uniform low landscape on the airfield generally reduces bird species diversity and improves harassment on the airfield (the ability to locate bird hazards quickly and chase them away in real-time). A specific species of grass, Coast Cross-One, is being tested at Ramat-David AFB to address the ecological requirements of northern Israel. The species has no seeds (vegetative reproduction), is highly aggressive competitively, can survive long summers with no water, can survive localized flooding and has tremendous economic potential as fodder for cattle. Grass management policy has been implemented on the airbase to maintain an average grass height of 20 cm. – too high for bird species that need open fields in order to see approaching predators but too low for species that need the shelter of high vegetation. This management policy (along with the elimination of habitat nuisances that attract birds like agriculture, trees, unnecessary signs and poles on the airfield, water ponds in the fields and on the runways) is part of a concerted effort to bring the airfield landscape into strict uniformity and control. Thus far, Coast Cross-One appears to be an effective factor in the overall Israeli Air Force bird control strategy.

Lawler, J.P., Magoun, A.J., et al. (2005). "Short-term impacts of military overflights on caribou during calving season." Journal of Wildlife Management **69**(3): 1133-1146.

The Fortymile Caribou Herd (FCH) is the most prominent caribou herd in interior Alaska. A large portion of the FCH calving and summer range lies beneath heavily used Military Operations Areas (MOA) that are important for flight training. We observed the behavior of Grant's cow caribou (Rangifer tarandus granti) and their calves before, during, and immediately following low-level military jet overflights. We also monitored movements of radiocollared cow caribou and survival of their calves. We conducted fieldwork from mid May through early June 2002. We concluded that military jet overflights did not cause deaths of caribou calves if the FCH during the calving period nor result in increased movements of cow-calf pairs over the 24-hour period following exposure to overflights. Short-term responses to overflights were generally mild in comparison to caribou reactions to predators or perceived predators. Caribou responses to overflights were variable, but responses were generally greater as slant distances decreased and jet speeds increased. A-10 jets caused less reaction than F-15s and F-16s. Although we found that short-term reactions of caribou to jet overflights were mild, we advise against assuming there are no long-term effects on calving caribou from jet overflights.

Leshem, Y., Ovadia, M.O., et al. (2005). A national network of bird and weather radars in Israel -from vision to reality. International Bird Strike Committee, Athens. 8 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPX-2.pdf.

The Israeli Air Force (IAF), Tel Aviv University, and the Society for the Protection of Nature in Israel initiated a joint research to reduce the number of collisions of migrating birds with aircrafts. The procedures were implemented in the flight regulations of the IAF and helped reduce the collisions since 1984 by 76%, saving a national budget of 690 million dollars. As a result of the research, the IAF decided in 1990 to develop a network of weather and bird radars to provide online information to allow low flight maneuvers even during the migration seasons. In 1998, the first MRL-5 Russian Radar located at Latrun, in central Israel, was modified from an analogical to a digital system, and since 2001 started to produce online data through the Internet to the entire range of the IAF units. Since 2003, a second Enterprise Weather Radar began to be a operational in the southern part of Israel in the Negev Desert after it was updated with a Doppler unit and a Sigmet Digital System. Since 2004, a bird center began to operate at the headquarters of the IAF providing radar pictures to the entire system. The network of the ground bird watchers, complimented the migration data from the northern part of Israel for the last twenty four years. The IAF already located all the funds for the third Enterprise Radar System, which will be located in 2006 in Northern Israel. The entire country will be covered as one national system. Results from the last two migration seasons will be presented. This system will be the base to develop a regional radar system in the Middle East. Jordan and Turkish Air Forces expressed their willingness to join.

Lykos, V., Kiohos, A., et al. (2005). Risk problem classification schemes in bird strikes risk policy strategies. International Bird Strike Committee, Athens. 14 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVI-4.pdf.

This study, which is a theoretical approach, presents a classification scheme based on two main factors: the potential consequences in bird strikes hazards (outcomes, losses, damages) and the uncertainties about consequences in parallel with the examination of a classification specifically directed at accident risk with the dimensions closeness to hazard and level authority i.e. airport operator, pilots, municipalities which are adjacent to airport, stakeholders etc.

The classification systems provide a knowledge base for structuring bird strikes' risk problems, risk policies and class-specific management strategies. Simultaneously in this study, three major management categories have been applied: risk - based, precautionary and discursive strategy. The risk - based policy means treatment of risk - avoidance, reduction, transfer and retention - using risk and decision analyses. The precautionary strategy means a policy of containment, constant monitoring, continuous research and the development of substitutes. Increasing resilience, i.e. resistance and robustness to surprises, is covered by the risk based strategy and the precautionary strategy. The discursive strategy means measures to build confidence and trustworthiness, through reduction of uncertainties, in air accidents and mishaps are caused by bird strikes, clarification of facts, involved human factors, deliberation and accountability. Nevertheless, in most cases, the appropriate strategy is a mixture of these strategies.

Matijaca, A. (2005). Court judgments : pro & contra. International Bird Strike Committee
14 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVII-1.pdf.

In the moment of a collision between the birds and an aircraft slight or bigger damages on the aircraft occur. In certain cases these damages can be extremely huge from the total destruction of the aircraft to the injuries and death of passengers, crewmembers or third persons on the field. Besides these kinds of direct damages there are also indirect and hidden damages for the aircraft operators and damages for the airport operators. With the occurrence of the damage the liability for the damage for which the claimant can request the reparation or indemnity in cash of the damage is established while the

other side has to effectuate the reparation or pay certain reimbursement. In these relations the participants in the air traffic especially the airport operators and aircraft operators as well as the insurance companies of the former and the last, face various forms of indemnity claims for the reimbursement of the damages on the property, requests for lost profit as well as indemnity for the case of injury or death of a physical person. These requests are sometimes realized in long lasting court processes. In these processes the plaintiffs more often are physical persons, air carriers and insurance companies, and the defendants: airport operators, air carriers, aircraft manufacturers, engine manufacturers, air traffic control, state institutions and the state itself. Researches in the field of the realization of the indemnity requests for the damages occurred show that in the world, regarding the number of the registered cases of collisions of birds and aircrafts, the question of the indemnity is mostly settled with the negotiations between the insurer and the damaged out of the court procedure. But in case this amicable way of settling is not possible the parties accept the final decision reached by the court. The subject of this paper is the survey of two very interesting court verdicts, which are completely different in their substance. One verdict is reached in favour of the plaintiff (insurance company) and the other in favour of a defendant (airport operator).

McCarthy, M.A., Xiao, J.R., et al. (2005). "Modelling bird impacts on an aircraft wing - Part 2: Modelling the impact with an SPH bird model." International Journal of Crashworthiness **10**(1): 51-59.

In a collaborative research project, aircraft wing leading edge structures with a glass-based Fibre Metal Laminate (FML) skin have been designed, built, and subjected to bird strike tests that have been modelled with finite element analysis. In this second part of a two-part paper, a finite element model is developed for simulating the bird strike tests, using Smooth Particle Hydrodynamics (SPH) for modelling the bird and the material model developed in Part I of the paper for modelling the leading edge skin. The bird parameters are obtained from a system identification analysis of strikes on flat plates. Pre-test simulations correctly predicted that the bird did no penetrate the leading edge skin, and correctly forecast that one FML lay-up would deform more than the other. The SPH bird model showed no signs of instability and correctly modelled the break-up of the bird into particles. The rivets connecting the skin to the ribs were found to have a profound effect on the performance of the structure.

McCarthy, M.A., Xiao, J.R., et al. (2005). "Modelling bird impacts on an aircraft wing - Part 1: Material modelling of the fibre metal laminate leading edge material with continuum damage mechanics." International Journal of Crashworthiness **10**(1): 41-49.

In a collaborative research project, aircraft wing leading edge structures with a glass-based Fibre Metal Laminate (FML) skin have been designed, built, and subjected to bird strike tests that have been modelled with finite element analysis. Fibre Metal Laminates have layers of aluminium alloy and high strength glass fibre composite and have been reported to possess excellent impact properties. In this first part of a two-part paper, a material model developed for FML suitable for use in impact modelling with explicit finite element analysis is presented. The material model is based on a recent implementation in the commercial finite element code PAM-CRASH/SHOCK of a Continuum Damage Mechanics model for composites, incorporating anisotropic strain rate effects. Results from the model are compared with experimental results on FML at variable strain rates and the model is shown to be capable of capturing most of the complex strain rate dependent behaviour exhibited by these materials.

Mode, N.A., Hackett, E.J., et al. (2005). "Unique occupational hazards of Alaska: Animal-related injuries." Wilderness & Environmental Medicine **16**(4): 185-191.

Objective.-During 1992-2000, an average of 40 fatal occupational injuries and 12 400 nonfatal occupational injuries and illnesses related to animals were recorded each year in the United States, most involving domestic farm animals. Although Alaska has a

relatively small farming industry, it supports several industries that require workers to regularly be in contact with animals. This study examines the pattern and characteristics of animal-related occupational injuries in Alaska. Methods.-Two data sources were accessed: the Alaska Trauma Registry for nonfatal injuries requiring hospitalization and the Alaska Occupational Injury Surveillance System for fatal injuries. The case definition included events in which the source of the injury was an animal or animal product (Occupational Injury and Illness Classification Manual source code 5 1). Results.-In Alaska during 1991-2000, there were 43 animal-related occupational injuries requiring hospitalization and 25 animal-related fatalities. There were only 2 fatal events: I bird-strike aircraft accident killing 24 military personnel and I bear attack. The majority of the nonfatal injury events were related to marine wildlife (n = 20), with the rest related to either domesticated (n = 11) or nondomesticated (n = 12) mammals. Of events reporting a hospital charge (23 of 43), the average cost was over $9700 per person. Conclusions.-The catastrophic aircraft crash increased bird-control efforts near airports around the state. The nonfatal animal-related injuries have received less notice, although they result in thousands of dollars in hospital costs and lost workdays. Fishing-industry workers in particular should be made aware of potential injuries and educated on how to treat them when away from definitive medical care.

Morgenroth, C. (2005). Bird deterrence at airports by means of long grass management - a strategic mistake? International Bird Strike Committee, Athens. 4 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPIII-3.pdf.

Since the middle of the 1990s, long-grass management is applied to the grassland areas of Dresden Airport according to the recommendations by HILD & HAHN (1997) for sustainable deterrence of bird species posing a flight-safety risk. Additionally, regular bird counts are conducted on the airport grounds in the framework the airport's bird-control activities, in which not only species and their densities, but also the vegetation heights on the respective observation areas are determined. The current presentation shows the findings of these surveys on the birddeterring qualities of grassland vegetation of different heights

Nicholls, D. and Bell, J. (2005). An assessment of bird strike risk at national level. International Bird Strike Committee, Athens. 10 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVI-1.pdf.

Bird strike is widely regarded with increasing concern, for reasons including the rising populations of certain hazardous species and the replacement of turboprop fleets by jets. The risk assessment described here was commissioned by the UK CAA to provide an informed basis for regulation. The study coincided with legislation requiring aircraft commanders to report all strikes, rather than only those causing damage, and a subsidiary aim was to assess the effectiveness of this mandate in improving the completeness and accuracy of reporting. The level of and trends in risk were assessed from historic data. Variations in reporting rate confound the picture, but the indications are that risk per movement is increasing. This is of concern, as the aviation community generally aims to reduce risks per movement over time, such that accident rates do not rise despite traffic growth. Also, while bird strike accounts for only a small fraction of the overall risk of flight, the risk is greater than that for other 'hot topics', such as runway incursions, that have been subject to recent safety campaigns. The implications are that further risk reduction measures need to be considered - an argument strengthened by an evaluation of the financial cost of strikes. The major influences on risk were identified and corresponding measures to reduce risk suggested. One specific finding was that simple criteria for controlling land uses around aerodromes, such as the 13 km safeguarding circle used in the UK, may be insufficient. A more sophisticated, risk-based approach is proposed. Analyses of strike data and interviews with operators indicate large fluctuations in reporting over recent years, mainly due to changes in information management within airlines. The mandate and associated publicity have

however been rewarded by a notable improvement which, if sustained, will provide a more reliable basis for future decisions.

Nikolaidis, E.D. (2005). Bird strikes in Greece - 2001 civil aviation. International Bird Strike Committee, Athens. 7 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPP-4.pdf.

This paper gives a brief summary of the bird strikes in Greece (Civil Aviation). It presents the results of bird strikes statistical analysis for the year 2001. The paper contains the strike seasons, risk per airport, reporting operators, top ten aircraft manufacturers model. In addition, for the first time in Greece, we have data collected also from New Athens International Airport and we can now have some indication on the reported and indicated (actual) bird strikes in Greece. Finally, this paper proposes actions for the near and distant future.

Nikolaidis, E.D. and Koloka, V. (2005). Bird strike in Hellas - civil aviation. International Bird Strike Committee, Athens. 7 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPI-1.pdf.

The paper contains brief details of all bird strikes avoidance methods used at Hellenic airports along with the particularities of each airport. Thereinafter, an analysis is made regarding the methods used and a risk assessment of bird strikes at airports. Finally it is concluded that Hellenic Civil Aviation Authority implements competent bird avoidance methods at Hellenic airports in order to ensure aviation safety.

Ovadia, M.O. (2005). Ten years of birdstrikes in the israeli air force. International Bird Strike Committee, Athens. 7 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVII-2.pdf.

Over the past ten years, the Israeli Air Force (IAF) had lost two pilots and two fighters in severe air collisions with birds. During these years there have been 2330 birdstrikes, which 200 of them ended with damage (accidents). The unique location of Israel as a junction of three continents causes hundreds of millions migrating birds to cross its airspace during spring and autumn, especially soaring birds that create a significant risk for low-level flights. In 1983, BPZ (Bird Plagued Zones) regulations were implemented so that low-level flight activity of jet planes were separated from the migrating birds temporally and physically. This led to a dramatic decrease in the number of accidents. Since the early eighties, the relative number of birdstrikes on route is gradually decreasing, but the migration is still the dominant cause for the number and severity of birdstrikes over Israel. Most of the birdstrikes occur during spring (March-May) and Autumn (September-November), mainly with low-level flights of helicopters and transporters. 970 feathers were identified in the last 10 years from 110 different species (20% of all the known species in Israel). The most frequent species involved in birdstrikes are the Stone Curlew (Burhinus oedicnemus), Feral Pigeon (Columba livia) and Spur Winged Plover (Vanellus spinosus). The White Stork (Ciconia ciconia) and Honey Buzzard (Pernis apivorus) caused the most severe accidents. Hundred of thousands from these two species cross over Israel during few weeks in spring and autumn and their rate of accidents is very high (43% and 60% respectively). The IAF suffered a yearly damage of less then 100,000$ in the last two years. The intensive birdstrike prevention activity in the airbases together with the development of real time warning system for migrating birds are the main projects for near future. This activity will help to minimize the number of accidents and the damage for IAF training in low altitude over large areas around Israel.

Rees, E.C., Bruce, J.H., et al. (2005). "Factors affecting the behavioural responses of whooper swans (Cygnus c. cygnus) to various human activities." Biological Conservation **121**(3): 369-382.

The effects of human activity on bird behaviour and distribution have been studied extensively in recent years, but variation in their response to disturbance is still poorly

understood. Here, we analyse variation in the behaviour of wintering whooper swans Cygnus c. cygnus, to determine whether their susceptibility to human activity changes with time, location and the type of disturbance involved. Overall, the swans' feeding activity varied within and between years, and in relation to feeding site, but there was less variation in the amount of time spent alert. Disturbance frequency resulting from human activity was lower with increasing flock size and with increased distance to the nearest road or track. Distances that humans could approach before alerting the birds similarly varied with field characteristics (e.g. size and proximity to roads or tracks), and also with the type of disturbance involved. The distance at which >5% of the flock became alert because of human activity decreased with the number of previous disturbance incidents in the day, indicating that swans become less sensitive to disturbance events if daily disturbance frequency is high, but there was no evidence that habituation to disturbance persisted over longer periods. The time taken for the birds to resume undisturbed behaviour varied with the duration of the disturbance event, which in turn depended on the type of disturbance involved, with pedestrians alerting the birds for longer periods than vehicles and aircraft. Recovery rates following disturbance were also associated with field size, flock size and the proportion of the flock alerted. Feeding activity was influenced by a range of variables, including year, season, field location, crop type and the number of days that the flock had used the field (32.9% of variance in the data explained by these variables), with disturbance factors explaining an additional 4.9% of variance in the proportion feeding per hour. Conversely, alert activity was influenced mainly by disturbance events. The range of factors influencing the swans' feeding behaviour, and variability in their response to human activity, has implications for management programmes and for attempts to predict the effects of human activity on the birds at a local and larger scale. (C) 2004 Elsevier Ltd. All rights reserved.

Richardson, W.J. and West, T. (2005). Serious birdstrike accidents to u.k. military aircraft, 1923 to 2004: numbers and circumstances. International Bird Strike Committee, Athens. 19 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPI-2.pdf.

Available records of serious bird-related accidents to U.K. military aircraft are more complete than are military data from other countries. This paper provides an updated list and analysis of the U.K. military accidents, now for 82 years (1923-2004). Serious accidents are those where the aircraft was destroyed or damaged beyond repair, plus any others with a human fatality. Previously we documented 65 serious bird-related accidents to U.K. military aircraft, and 9 aircrew fatalities, during 1950–1999 [Richardson & West 2000: IBSC 25/WP SA1]. We now list 108 losses of U.K. military aircraft, 101 to birdstrikes and 7 to crashes during attempts to avoid birds. Of these accidents, 99 were Royal Air Force (RAF), 7 Royal Navy (RN), and 2 Army Air Corps (AAC). These totals are still underestimates as records for early years are incomplete, and losses for which birdstrike evidence is lacking or weak are omitted. Of 108 known serious bird-related accidents to U.K. military aircraft, 63 were in or near the U.K., 12 in continental Europe, 23 in south and SE Asia, 4 in the Mideast/SW Asia region, 4 in Africa, 1 in the Falklands, and 1 unknown. At least 25 aircrew were killed. The many bird-related losses of U.K. military aircraft before 1950 (at least 39, all piston-engined and all RAF) are notable; the first confirmed U.K. loss of a turbine-engine aircraft to birds was in 1952. Although documented in RAF and aviation history records, most pre-1950 losses seem to have been previously unknown to bird-hazard specialists. The highest loss rates were in 1943-1945, when the U.K.'s annual losses to birds were at least 7-8 aircraft. Known pre-1950 losses included 18 singleand 21 multi-engine aircraft. Of these 39 pre-1950 losses, 21 were in southern Asia. Vultures were the predominant problem there, with gulls being more problematic in the U.K. There were more confirmed U.K. aircrew fatalities to birdstrikes before 1950 than since 1950 (at least 16 vs. 9), largely related to the use of ejection seats in most jet aircraft, which have predominated since 1950. Since 1955, 41 aircrew are known to have ejected successfully from U.K. military aircraft lost to birdstrikes. This paper cross-tabulates the

numbers of known accidents for various combinations of three eras (pre-1950, 1950–79, 1980–2004), region, type of aircraft, number of engines, month, phase of flight, near aerodrome vs. en route, altitude and speed, part(s) struck, and type of bird. An Appendix lists the circumstances of the 108 individual accidents. A separate list identifies 27 additional accidents to U.K. military aircraft that are discounted as “not bird related” or “not confirmed as bird related”, and otherwise excluded from this paper.

Robinson, A.P. (2005). Modelling the birdstrike risk from hazardous birds attracted to restored mineral extraction sites. International Bird Strike Committee, Athens. 6 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVIII-3.pdf.

Mineral extraction for sand and gravel is often concentrated in lowland river valleys near major towns and airports. Where restoration schemes for such sites include open water, they frequently attract large numbers of waterfowl and other hazardous bird species that pose a birdstrike risk to aircraft. There is a need, therefore, to predict the numbers of birds likely to be attracted to a potential restoration and to assess how any movements will impact upon flight safety prior to a site being developed. Regression analysis was used to determine whether waterfowl count data from over three hundred separate locations in the UK could be related to morphological variables derived from available maps. Variables available for the study included area of open water, length of bank and number of islands. Results showed significant relationships, but suggested that for a truly useful predictive model a number of more detailed measurements would be required. A literature search revealed a range of potential factors that might be included in any model, though little research had been conducted on mineral extraction sites per se. A distinction needs to be made between factors that might be measurable in a planning situation before extraction at a site is completed, such as the physical dimensions of a proposed waterbody, and factors that are unpredictable at this time, such as the development of aquatic vegetation or changes in water chemistry over time. A major study of gravel pit restorations is planned for the UK, incorporating measurements of all potential factors that might influence hazardous bird numbers. Measurements of the number and nature of bird movements generated by the bird populations present on these pits will also be recorded. It is hoped that this will provide an objective measure of the birdstrike risk posed by differing types of restoration.

Ruhe, W. (2005). Bird avoidance models vs. realtime birdstrike warning systems - a comparison. International Bird Strike Committee, Athens. 5 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPX-3.pdf.

Bird Avoidance Models provide either short range bird strike risk forecasts or historically based average bird strike risk levels. Bird strike warning systems are based on real time monitoring and bird strike risk assessment of imminent bird hazard. In military aviation both concepts have proven to be effective tools to decrease the number of bird aircraft collisions. Based on personal knowledge about current models and systems as well as the experience with the Bundeswehr Geoinformation Office Real Time Observation and Warning System and working with the US and Alaska BAM the basic design concepts, advantages and limitations are discussed. An attempt is being made to define and classify different types of existing models/systems and a proposal is made on a standardisation of naming conventions, which appears to be necessary, in order to use the same wording for similar products and not confuse the aviation community.

Shamoun-Baranes, J., Sierdsema, H., et al. (2005). Linking horizontal and vertical models to predict 3d + time distributions of bird densities. International Bird Strike Committee, Athens. 10 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPIX-3.pdf.

The MAMBAS (Bird Avoidance Model/Bird Avoidance System) team aims at developing a Bird Avoidance Model (BAM) to predict spatial (horizontal and vertical) and temporal bird densities under changing meteorological conditions. The BAM will be used as a decision support tool for experts in the Royal Netherlands Air Force providing

bird hazard warnings in real time and predictions for flight planning to reduce the risk of bird aircraft collisions. The BAM consists of several models that will be linked after their completion. In this paper we present results from the flight altitude and bird distribution models and describe how these will be integrated into an operating system. The distribution of birds in the Netherlands is being modelled based using the large SOVON database of a spatially dense network of counts in the breeding season and around Christmas. Observations have been analysed in relation to several variables including land cover, landscape characteristics, and vegetation to interpolate densities at places and at times where measurements are lacking. Regression analysis and spatial statistics have been integrated to develop these predictions, visualized in GIS. These spatial distributions with low temporal resolution were combined with time series obtained from systematic daily observations at airfields, to generate a 2D+time evolution over 25 years. Several models have been developed that predict flight altitudes of birds using different flight strategies in relation to local meteorological conditions. A bird's flight altitude and flight strategy is strongly influenced by weather. Weather has a stronger influence on the flight altitudes of birds using predominantly soaring and gliding flight. The main factors influencing flight altitudes differ between flight strategy groups. Local real time or forecast weather conditions are used as input to the flight altitude models directly linked to the distribution models to create the high-resolution full 3D+time predictions of bird densities under changing environmental conditions.

Sheehy, S., Kelly, T.C., et al. (2005). Bird strike syndrome: towards developing an index of bird injury. International Bird Strike Committee, Athens. 8 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVII-5.pdf.

The use of trauma scoring techniques is well established in clinical medicine. These techniques allow the semi-quantitative description of injuries in patients with extensive physical trauma. The novel use of analogous methods to describe the injuries sustained by aircraft - killed birds is described here. By assigning trauma scores to injuries of aircraft struck birds it is hoped that a signature of injuries associated with bird strike will emerge. In other words this study examines whether or not a 'Bird Strike Syndrome' exists. Such a 'syndrome' could have major implications for post mortem analysis of airfield carcasses, the definition of a bird strike and the assembly of bird strike databases. This paper discusses the methodology used in this study, and the suggested application of trauma scoring for improved quality control in the compilation of bird strike statistics.

Shorr, B., Mel'nikova, G., et al. (2005). Numerical and experimental analysis of a large bird impact on fan blades for the certification purpose. International Bird Strike Committee, Athens. 8 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVII-3.pdf.

With the purpose of flights safety, the more and more rigid requirements on fan blades resistance to collision with birds are showed. It is expressed, first of all, in increase of bird mass, which should not result in destruction of engine units or inadmissible changes of its parameters. For new engines, bird ingestion certification tests are exploited. However there are many successfully maintained old engines, which were tested under earlier less rigid certification requirements. To carry out their tests anew it would be very expensive and not too informatively in comparison with the operating experience. Another acceptable way to confirm blade resistance to bird strike could be based upon a mixture of previous tests, service experience and a numerical bird impact analysis. However, reliability of the numerical method should be validated by comparison to experimental data. In the paper some results of such numerical-experimental analysis referred to a large bird impact upon a fan blades are resulted for the certification purpose. For increase of computational reliability some models of bird impact and two program modules have been used: universal system of finite element dynamic analysis MSC.DYTRAN with bird representation as a jelly-like body and the original computational system that develops the earlier checked up approach using bird

representation as a solid completely collapsing body [1, 2]. Comparison of computational results of blade damage evaluation with the data of earlier bird ingestion tests has shown satisfactory concurrence.

Smallie, J. and Froneman, A. (2005). Bird strike data analysis at south african airports and spatial representation of bird patrols in relation to bird strike occurrences. International Bird Strike Committee, Athens. 19 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPV-4.pdf.

The bird hazard risk at South Africa Airports has been monitored for the past 5 years through the ACSA - EWT Strategic Partnership. Reporting of bird strike occurrences and subsequent data management forms an integral part of the activities of the partnership. This paper provides a statistical overview of the bird strike incidents reported at Airports Company South Africa Airports over the past five years 1999 - 2004. In excess of 1500 bird strike occurrences have been reported and the data review presented here will focus on the following factors: seasonal variation, time of day, aircraft model, species, size of bird, effect on flight, and part struck / damaged. The data presented is used on a regular basis to assess the effectiveness of control measures being implemented on the airfield both in terms of proactive as well reactive interventions on the airfield. Bird Strike data collected is also represented spatially on a map of the airfield to establish high frequency bird strike zones on the runways of the respective airports. The paper will present the spatial distribution of bird strike data from the airfields where sufficient data with regard to exact locations of incidents have been recorded over the past five years. At Durban International Airport a Global Positioning System (GPS) tracking of wildlife control patrols was recently implemented. A geographic Information System is used to overlay this information onto bird strike occurrence locations and times and as a result the effectiveness of presence and location of patrols out on the airfield can be assessed.

Southwell, C. (2005). "Response behaviour of seals and penguins to helicopter surveys over the pack ice off East Antarctica." Antarctic science **17**(3): 328-334.

Data on the response behaviour of seals (crabeater, leopard and Ross) and penguins (Adelie and emperor) to helicopter surveys over the pack ice off East Antarctica are presented. The surveys involved Sikorsky S76 helicopters flying at altitude 130 m and speed 90 knots along straight-line transects. The relative frequency of alert and movement behaviours by seal and penguin groups decreased with distance out to 800 m from the flight path. Penguin groups were more likely to show a movement response than seals at all distances. The perpendicular distances moved relative to the flight path were small (maximum 20 m, mean degree 3 m, for both seal and penguin groups) relative to the width of the area searched (800 m), and there was no evidence that response movement resulted in a spiked detection histogram. Observers were more likely to feel confident in identifying seal and penguin species if the animals responded to the helicopter by changing the body posture or moving. In this application of aerial survey, the response behaviour elicited by the passing helicopter was considered to be beneficial from a technical perspective, and the disturbance caused to the surveyed populations negligible from an ethical perspective.

Tareh, H.A. and de Hoon, A. (2005). Water birds, aircraft and bird strikes in I.R. Iran. International Bird Strike Committee, Athens. 4 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPP-5.pdf.

Iran is situated in the south-western part of Asia and can be divided into four physiographical regions: the Caspian (forest), the Central Plateau (desert), the Zagros (mountainous), and the south-eastern coastal area (tropical temperature). The paleartic, oriental and Ethiopian influences, together with the West Siberian-Caspian-East African and Central Siberian-Indus-South Asian flyways crossing the country, cause the presence of the varied Iranian avifauna. In total 517 bird species of 79 families and 19 orders have been recorded in Iran. During the mid-winter water bird

censuses, more than a million waterfowl is being counted every year in more than 220 sites throughout the country. Since Iran is a very large country (1.65 million km^2, 2,200 km northwest - southeast, 1,300 km north - south, 67 million inhabitants) travelling by air is very popular and is, compared with other means of transport, relatively cheap. Iran has 64 civil airports of which some are situated next to wetlands. According to the data recorded by Civil Aviation Organisation of Iran, the bird species involved in bird strikes are mostly unidentified. Fortunately, bird strikes have never resulted in casualties in Iran, but the material damage may exceed millions of dollars per year. Several suggestions to minimise the bird strike risk are given.

Thapaliya, R.M. (2005). The role of the government and non-government organization towards the aviation safety by minimizing the wild hazard problem from tia and other airport of Nepal International Bird Strike Committee, Athens. 21 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVI-7.pdf.

Thorpe, J. (2005). Fatalities and destroyed civil aircraft due to bird strikes, 2002 to 2004. International Bird Strike Committee, Athens. 9 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPII-3.pdf.

At the 1996 Meeting in London of the International Bird Strike Committee, an illustrated Working Paper was presented that provided brief details of all fatalities and destroyed aircraft due to bird strikes during the period 1912 to 1995. The paper was felt to be useful in drawing attention to the scale of the problem, especially when dealing with those who know little about the subject or who are newly appointed to decision-making positions. Since that paper was published, information has come to light on a number of previously unknown accidents, as well as information on subsequent accidents. Thus, a revised paper, published in the Proceedings as WP-SA1, 'Fatalities and Destroyed Civil Aircraft due to Bird Strikes, 1912 to 2002' was presented at IBSC 26, May 2003 in Warsaw, Poland. This Paper for the Athens Meeting provides an up-date to WP-SA1 covering the years 2002 to 2004. It is now believed that the number of fatal bird strike accidents has risen to 47 killing 242 people. In addition the total of aircraft destroyed is now 90. These additional accidents are briefly detailed in the Paper so that the totals are now: • Airliners and Executive Jets - 12 fatal accidents killing 174 and destroying 37 aircraft. • Aeroplanes 5,700 kg and below - 29 fatal accidents killing 58 and destroying 45 aircraft. • Helicopters - 6 fatal accidents killing 10 people and destroying 8 helicopters. The results are broadly unchanged in that the major threat (nearly 80% of accidents) to Airliners and Executive jets is engine ingestion, often due to flocks of gulls (Larus sp.). Aircraft of 5,700 kg and below as well as helicopters are most at risk from windshield penetration, mainly the result of collision with birds of prey (Accipitriformes). These groups of aircraft mainly fly at heights where birds are most likely to be encountered. Some accidents are the result of pilots attempting to avoid birds. The new or revised material included since the Athens Meeting is shown with a marginal line. The Appendix on Animal Strikes, which was in the original version of the Athens Paper, has been removed as better information is available in WP Paper VI -3.

Vasilis, L., Jerrentrup, H., et al. (2005). Assessment and integrated risk management of collissions aircrafts to birds at international civil aerodrome of Kavala (N.E. Greece). International Bird Strike Committee, Athens. 16 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVIII-2.pdf.

Collisions between aircraft and birds (bird strikes) are a concern throughout the world because they threaten passengers' safety, result in loss of revenue and costly repairs to aircraft and can also erode public confidence in the air transport industry as a whole. This study funded by the Hellenic Ministry of Transportation and Communications and the Hellenic Civil Aviation Authority, concerns aerodrome of Kavala which is adjacent to Nestos' wetlands, one of the most fundamental refuges for migrating avifauna in Greece. According to International Civil Aviation Authority (I. C. A. O.) data, this airport runs greater risk of having a bird strike (39%) among all the civil airports in Greece,

with an increase between May to September. This on going study, estimates bird abundance, distribution, movement patterns and their habitat attractors at Kavala airport and within an 3.2 km radius, which is the “bird critical zone”, with a view to assess current air-strikes hazards in real time and also to provide wildlife hazard management plans through the modifications of habitat and food sources potentially related with bird hazards. The detection of birds in real time depends on time - area field surveys and also on the development of a prototype modified surveillance radar for obtaining ground track data and consequently, bird temporal and spatial flight patterns.

Walker, A. (2005). Bird control -what new technologies airports should be considering in terns of birdstrike avoidance. International Bird Strike Committee, Athens. 4 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVII-6.pdf.

Walls, R. (2005). Monitoring avian movement using bird detection radar; impacts of nocturnal movement on flight safety at a military aerodrome. International Bird Strike Committee, Athens. 8 pp. from http://www.int-birdstrike.org/Athens_Papers/IBSC27%20WPVIII-4.pdf.

Spatial patterns of avian movement and their impacts on flight safety on a local scale are often poorly understood. Birdstrike statistics conclude that the majority of incidents occur on or around an aerodrome. Monitoring movements of birds both on, and around an aerodrome, can therefore provide significant insights into off-airfield flight safety hazards. These can then be identified, and efforts made to eliminate or reduce the risk associated with these sites through the safeguarding process. Daylight movements were monitored and assessed using traditional visual techniques at Cotswold water park and RAF Fairford near Gloucester, England during March and December 2004. RAF Fairford is used by the United States Air Force (USAF) as a forward deployment base for American operations in Europe. Bird detection radar using x-band vertical and s-band horizontal scanning was implemented in parallel over two continuous five day periods to contrast diurnal movements, flightline directions and provide altitudinal measurements. Significant differences in the movements of birds were recorded depending on both time of day and species observed. Changes in the altitude at which birds fly at the local level could have significant impacts on birdstrike risks. Monitoring using multiple techniques allows the hazards from particular sites to be identified, the risks they present determined and techniques applied to help meet the new ICAO standards for off-airfield bird management.

Werner, S.J., Homan, H.J., et al. (2005). "Evaluation of Bird Shield (TM) as a blackbird repellent in ripening rice and sunflower fields." Wildlife Society Bulletin **33**(1): 251-257.

Chemical repellents sometimes can provide a nonlethal alternative for reducing wildlife impacts to agricultural production. In late summer and autumn 2002, we evaluated Bird Shield (TM) (active ingredient: methyl anthranilate, Bird Shield Repellent Corporation, Spokane, Wash.) as a blackbird (Icteridae) repellent in Missouri rice fields and North Dakota sunflower fields. We selected 5 pairs of ripening rice fields in southeastern Missouri and randomly allocated treatments (treated and control) within pairs. The repellent was aerially applied by fixed-winged aircraft at the recommended label rate and volume (1.17 L Bird Shield/ha and 46.7 L/ha, respectively); 1 field received 2X the label rate. We observed no difference in average bird activity (birds/minute) between treated and control fields over the 3-day post-treatment period (P = 0.503). We used reversed-phase liquid chromatography to quantify methyl anthranilate residues in treated fields. The maximum concentration of methyl anthrandate in rice samples was 4.71 mu g/g. This concentration was below reported threshold values that irritate birds. In North Dakota we selected 6 pairs of sunflower fields used by foraging blackbirds. We randomly selected 1 field from each pair for 2 aerial applications of Bird Shield at the label-recommended rate similar to 1 week apart. The remaining 6 fields served as controls. Daily bird counts, starting the first day of application and continuing for 5-7 days after the second application, showed similar numbers of blackbirds within treated

and control fields (P = 0.964). We observed no difference in sunflower damage within treated and control fields (P = 0.172) prior and subsequent to the treatment. Bird Shield was not effective for repelling blackbirds from ripening rice and sunflower fields.

Wobeser, G., Gillespie, M., et al. (2005). "Mortality of geese as a result of collision with the ground." Journal of Wildlife Diseases **41**(2): 463-466.

Two incidents are reported in which groups of migrating wild geese were found dead in agricultural fields in southern Manitoba during spring. In each case, the birds died overnight and poisoning was suspected; however, the birds had lesions of severe traumatic injury. The first incident, in 1985, involved about 150 lesser snow geese (Anser caerulescens caerulescens); the second, in 2003, involved 62 Canada geese (Branta canadensis). Both incidents occurred on dark, moonless nights. One possible explanation is that the birds became disoriented in a manner analogous to spatial disorientation described in aircraft pilots and flew as a flock directly into the earth. In the first incident, geese might have been frightened by sonic booms from aircraft; in the second, there was a thunderstorm With strong gusty winds in the area.

Wright, S.E. and Dolbeer, R.A. (2005). Percentage of wildlife strikes reported and species identified under a voluntary reporting system. 2005 Bird Strike Committee-USA/Canada 7th Annual Meeting, Vancouver, BC, University of Nebraska - Lincoln. 10 pp. from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1010&context=birdstrike2005.

Reporting of wildlife strikes with civil aircraft in the USA is voluntary but strongly encouraged by the Federal Aviation Administration (FAA) through Advisory Circulars and FAA publications. The National Wildlife Strike Database contained 59,196 strike reports for civil aircraft, 1990-2004. An initial analysis of independent strike data from an eastern USA airport in 1994 indicated that less than 20% of strikes were actually reported to the FAA for inclusion in the National Wildlife Strike Database. To obtain an improved estimate of the percent of strikes reported, we obtained 14 sets of wildlife strike data maintained by three airlines and three airports for various years, 1991-2004. Only 489 (10.7%) of the 4,561 strikes recorded in these independent databases had been reported to the FAA for inclusion in the National Wildlife Strike Database. The National Wildlife Strike Database contained an additional 591 strike reports for the relevant time periods unknown to the airlines or airports, making a total of 5,152 known strike events in the combined databases. If we assume that these 5,152 known strike events in the combined databases represented all strikes that occurred for those airlines and airports during those time periods, then the National Wildlife Strike Database contained 1,080 (21.0%) of the total strikes. Because it is highly probable that additional strike events occurred that were not recorded in either the national or local databases, the percent of strikes reported to the FAA probably fell somewhere between 10.7 and 21.0%. Thus, our initial estimate from 1994 that less than 20% of wildlife strikes with civil aircraft in the USA are reported to the FAA for inclusion in the national database is supported by this more extensive analysis. Further, only about 44% of the 59,196 wildlife strikes that were reported during 1990-2004, provided information on the type of wildlife struck to species group (e.g., gull, deer) and only 25% identified the wildlife to exact species (e.g., ring-billed gull [*Larus delawarensis*], white-tailed deer [*Odocoileus virginianus*]). Based on these analyses, there obviously is a need for increased and more detailed

reporting of wildlife strikes. Improvements in reporting will increase the usefulness of the database as a foundation of information for understanding and managing wildlife hazards to aviation.

Zakrajsek, E.J. and Bissonette, J.A. (2005). "Ranking the risk of wildlife species hazardous to military aircraft." Wildlife Society Bulletin **33**(1): 258-264.

Collisions between birds and aircraft (birdstrikes) pose a major threat to aviation safety. Different species pose different levels of threat; thus, identification of the most hazardous species can help managers identify the level of hazard and prioritize

mitigation efforts. Dolbeer et al. (2000) assessed the hazard posed by birds to civilian aircraft by analyzing data from the Federal Aviation Administration's (FAA) Wildlife Strike Database to rank the hazardous species and species groups. A similar analysis has not been done for the military but would be useful and necessary. Military flight characteristics differ from those of civilian flights. During the period 1985-1998, birdstrikes cost the United States Air Force (USAF) an average of $35 million/year in damage. Using the USAF Birdstrike Database, we selected and evaluated each species or species group by the number of strikes recorded in each of 3 damage categories. We weighted damage categories to reflect extent and cost of damage. The USAF Birdstrike Database contained 25,519 records of wildlife strikes in the United States. During the period 1985-1998, 22 (mean =1.6/year) Class-A birdstrikes (>$1,000,000 damage, loss of aircraft, loss of life, or permanent total disability) were sustained, accounting for 80% of total monetary losses caused by birds. Vultures (Cathartes aura, Coragyps atratus, Caracara cheriway) were ranked the most hazardous species group (Hazard Index Rank [HIR] = 127) to USAF aircraft, followed by geese (Branta canadensis, Chen caerulescens, HIR=76), pelicans (Pelecanus erythrorhynchos, P occidentalis, HIR=47), and buteos (Buteo sp., HIR=30). Of the smaller flocking birds, blackbirds and starlings (mostly Agelaius phoeniceus, Euphagus cyanocephalus, Molothrus ater, Sturnus vulgaris, HIR=46), horned larks (Eremophila alpestris, HIR=24), and swallows (Families Hirundinidae, Apodidae, HIR= 23) were species groups ranked highest. Coupling these results with local bird census data to adjust hazard rank indices to specific locations can facilitate hazard management and lead to meaningful reductions in hazards and costs associated with birdstrikes.

Aas, C.K. (2005). Civil aircraft bird strike analysis in Norway 2000. Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo, Oslo. 6 pp.

Aas, C.K. (2005). Civil aircraft bird strike analysis in Norway 2001. Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo, Oslo. 6 pp.

Aas, C.K. (2005). Civil aircraft bird strike analysis in Norway 2002. Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo., Oslo. 6 pp.

Aas, C.K. (2005). Civil aircraft bird strike analysis in Norway 2000-2002. Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo, Oslo. 6 pp.

Aas, C.K. (2005). Fly-fugl. Årsmøte i flytryggingsorganisasjonen i Luftforsvaret, UiO.

Aas, C.K. (2005). Ornitologisk besøk ved Stavanger lufthavn, Sola 13. oktober 2005. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo.

Aas, C.K. (2005). Referat fra besøk ved Ørland flystasjon 6. september 2005. Fly/fugl-kontoret, Naturhistorisk museum, UiO Oslo.

2004

Abeyratne, R.I.R. (2004). Aviation in crisis. Aldershot, Ashgate.

Avery, M.L. and Genchi, A.C. (2004). "Avian perching deterrents on ultrasonic sensors at airport Wind-Shear Alert Systems." Wildlife Society Bulletin **32**(3): 718-725.

Preventing birds from perching on the sensor units of the Federal Aviation Administration's Low Level Wind-shear Alert System (LLWAS) is crucial to its successful operation. In this study we evaluated, under controlled conditions, responses of brown-headed cowbirds (Molothrus ater), fish crows (Corvus ossifragus), great horned owls (Bubo virginianus), barred owls (Strix varia), and black vultures (Coragyps atratus) to several anti-perching devices. No device was totally successful against every species. Of the 5 original test devices, the most effective perching

deterrent was a set of 17 stout spikes ("AgSpikes") secured to the central portion of the sensor unit that point up 00 to 300 from the vertical. The central spikes were subsequently redesigned and combined with 9 metal bushings (3 for each arm of the sensor unit) that fit loosely on the sensor arms and that were armed with 5 sharp spikes each. This "AgSpikes and SpikedSpinner" combination unit was as effective as the original AgSpikes for all birds except owls, which were able to place their feet within the open spaces of the redesigned AgSpike portion of the device and perch on the 3 horizontal spikes. The combination units should adequately discourage most large and small birds from perching on LLWAS sensors. The availability of alternate perches in the field will likely enhance the effectiveness of the deterrent. Monitoring performance of the combination units deployed in the field is recommended to verify that they are working as expected.

Bentz, P.-G. (2004). Landvetter och fåglarna. Rapport från ett projekt med syfte att kartlägga fågelförekomsten och om möjligt reducera risken för kollisioner mellan fåglar och flygplan. Luftfartsverket - Göteborg-Landvetter flygplats. 43 pp.

Blackwell, B.F. and Bernhardt, G.E. (2004). "Efficacy of aircraft landing lights in stimulating avoidance behavior in birds." Journal of Wildlife Management **68**(3): 725-732.

Aircraft collisions with wildlife (primarily birds) are costly in terms of injury or loss of human life, loss of the animals involved, damage to property and business, and the use of lethal control of wildlife at airports worldwide. One potential nonlethal technique to reduce bird-aircraft collisions-pulsed white and wavelength-specific aircraft-mounted light-has been considered for nearly 3 decades, but the efficacy of the technique has not been evaluated quantitatively. We tested the hypothesis that during daylight, captive birds exposed to an approaching ground-based vehicle exhibiting pulsing 250-W white aircraft landing lights would initiate avoidance behavior more quickly than birds experiencing an oncoming vehicle with nonpulsing (steady) or no lights (control). In experiments involving captive brown-headed cowbirds (Molothrus ater), Canada geese (Branta canadensis), European starlings (Sturnis vulgaris), herring gulls (Larus argentatus), and mourning doves (Zenaida macroura), only cowbirds exhibited a response to the landing lights, but not consistently. Specifically, cowbird groups (9 groups/treatment, 6 birds/group) responded more quickly to pulse versus control treatments, equating to a greater distance ((x) over bar +/- SE) of the approaching vehicle from mid-cage per reacting bird (control: 35.8 +/- 9.7 m, pulse: 50.5 +/- 10.9 m; P = 0.015). However, in a subsequent experiment involving the exposure of cowbirds to control, pulse, and steady-light treatments, we observed no difference in response among treatment groups. Although 250-W white landing lights pulsed at 45 cycles/min influenced behavior of captive birds in response to an oncoming ground-based vehicle, the avoidance response was inconsistent across experiments with cowbirds, and we observed little or no avoidance behavior in experiments with other species. We suggest that further research is needed to investigate avian response to specific light wavelengths and pulse frequencies.

Dorsey, J.T., Poteet, C.C., et al. (2004). "Metallic thermal protection system requirements, environments, and integrated concepts." Journal of Spacecraft and Rockets **41**(2): 162-172.

Achieving the ultimate goal of an economically viable reusable launch vehicle will eventually require developing Federal Aviation Regulation-type performance-based requirements and certification by the Federal Aviation Administration, as is currently done for commercial transports. Because the necessary requirements do not currently exist, there is no verifiable and traceable link between thermal protection system design implementation and resulting performance, safety, and cost. An initial attempt has been made to outline a set of performance-based thermal protection system design requirements. Critical requirements that will have a profound effect on the economic viability of a reusable launch vehicle, such as those for ground hail strike, lightning strike, bird strike, rain/rain erosion, and on-orbit debris/micrometeoroid hypervelocity

impact have been proposed. In addition to design requirements, the importance of both compiling a comprehensive loads envelope and deriving time- and location-consistent loads for thermal protection system design and sizing is addressed. Including ascent abort trajectories as limit-load cases and on-orbit debris/micrometeoroid hypervelocity impact as one of the discrete-source-damage cases is imperative because of their significant impact on thermal protection system design and resulting performance, reliability, and operability. General features of a suite of integrated airframe concepts is summarized, and the specific details of a metallic thermal protection system concept having design flexibility that enables weight and operability to be traded and balanced is described.

Garthe, S. and Huppop, O. (2004). "Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index." Journal of Applied Ecology **41**(4): 724-734.

1. Marine wind farms have attracted substantial public interest. The construction of wind facilities offshore may become Europe's most extensive technical development in marine habitats. Due to political pressure to complete construction soon, assessments of possible wind farm locations, for example in the German sectors of the North Sea and Baltic Sea, have to be based on existing knowledge. 2. In this study, we developed a wind farm sensitivity index (WSI) for seabirds. We applied this index to the Exclusive Economic Zone and the national waters of Germany in the North Sea. We chose nine factors, derived from species' attributes, to be included in the WSI: flight manoeuvrability; flight altitude; percentage of time flying; nocturnal flight activity; sensitivity towards disturbance by ship and helicopter traffic; flexibility in habitat use; biogeographical population size; adult survival rate; and European threat and conservation status. Each factor was scored on a 5-point scale from 1 (low vulnerability of seabirds) to 5 (high vulnerability of seabirds). Five of these factors could be dealt with by real data but four could only be assessed by subjective considerations based on at-sea experience; in the latter cases, suggestions of the first author were independently modulated by experts. 3. Species differed greatly in their sensitivity index (SSI). Black-throated diver Gavia arctica and red-throated diver Gavia stellata ranked highest (= most sensitive), followed by velvet scoter Melanitta fusca, sandwich tern Sterna sandvicensis and great cormorant Phalacrocorax carbo. The lowest values were recorded for black-legged kittiwake Rissa tridactyla, black-headed gull Larus ridibundus and northern fulmar Fulmarus glacialis. 4. A WSI score for areas of the North Sea and Baltic Sea was calculated from the species-specific sensitivity index values. Coastal waters in the south-eastern North Sea had values indicating greater vulnerability than waters further offshore throughout the whole year. 5. Derived from the frequency distribution of the WSI, we suggest a 'level of concern' and a 'level of major concern' that are visualized spatially and could act as a basis for the selection of marine wind farm locations. 6. Synthesis and applications. The wind farm sensitivity index might be useful in strategic environmental impact assessments (EIA). Results of small-scale EIA from wind installations should be considered within a more global perspective, provided, for example, by large mapping projects and detailed behavioural studies. This is difficult in normal EIA, particularly in highly dynamic coastal/marine habitats, and the results of this study fill an important gap by providing information on the potential sensitivity of seabirds and the importance of locations of wind installations.

Goudie, R.I. and Jones, I.L. (2004). "Dose-response relationships of harlequin duck behaviour to noise from low-level military jet over-flights in central Labrador." Environmental Conservation **31**(4): 289-298.

Concern for the lack of field studies on the effects of low-level military jet over-flights on wildlife resulted in directed research in the Military Training Area of Labrador, 1999-2002. At Fig River, a tributary of the Lower Churchill River, a before-after-control-impact (BACI) study design quantified effects of aircraft over-flights on behaviour of individual harlequin ducks (Histrionicus histrionicus) in the 130000 km 2 Military

Training Area of central Labrador. Noise generated from low-level passes (30-100 m above ground level) by military jets was sudden in onset and high in amplitude (> 100 dBA), substantially above background sound levels both at Fig Lake outlet (40-50 dBA) and rapid sections of Fig River (60-70dBA). Harlequin ducks reacted to noise from military jets with alert behaviour, showing a positive dose-response that especially intensified when noise exceeded 80dBA. Residual effects, in other words, deviations from normal behaviour patterns after initial responses, were decreased courtship behaviour for up to 1.5 h after, and increased agonistic behaviour for up to 2 h after military jet over-flights. Direct behavioural responses to military jet over-flights were of short duration (generally < 1 min), and were unlikely to affect critical behaviours such as feeding and resting in the overall time-activity budgets of breeding pairs. However, the presence of residual effects on behaviour implied whole-body stress responses that were potentially more serious; these require further study because they are potentially more detrimental than immediate responses, and may not be detected in studies that focus on readily observed overt responses. A dose-response curve relating particular behaviours of harlequin ducks to associated noise of over-flights could be a valuable conservation tool for the research and mitigation of environmental impacts of aircraft and other noise.

Krausman, P.R., Harris, L.K., et al. (2004). "Effects of military operations on behavior and hearing of endangered Sonoran pronghorn." Wildlife Monographs(157): 1-41.

Our objectives in this study were to determine whether military activities (e.g., overflight noise, noise from ordnance delivery, ground-based human activity) on the Barry M. Goldwater Range (BMGR) affect the behavior and hearing of Sonoran pronghorn (Antilocapra americana sonoriensis). We contrasted the behavior of pronghorn on BMGR with the closest population of pronghorn in the United States that was not subjected to routine military activity (i.e., on the Buenos Aires National Wildlife Refuge [BANWR], Arizona). Forty percent of the landscape used by the endangered Sonoran pronghorn in the United States is within the 5,739 km(2) BMGR, a bombing and gunnery facility in southwestern Arizona. The range of Sonoran pronghorn covers about 88% of BMGR. The 179 Sonoran pronghorn that lived in the United States in December 1992 declined to 99 by December 2000. The Sonoran pronghorn has been listed as endangered for >30 years, but population limiting factors are unknown. Because Sonoran pronghorn use BMGR, land and wildlife managers raised concerns about the potential effects of military activities on the population. Possible indirect effects of military activities on Sonoran pronghorn, aside from direct mortality or injury, from ordnance delivery, chaff, flares, live ammunition, aircraft mishaps, interference from ground vehicles and personnel, include alteration of behavior or physiology. We conducted the study on the North and South Tactical Ranges (NTAC and STAC), BMGR, from February 1998 to June 2000. Hearing exams were conducted in Camp Verde, Arizona, the University of Arizona, and on the East Tactical Range (ETAC), BMGR. Interactions between pronghorn and military activity were restricted to 4 observation points that provided viewing areas from which pronghorn and military activity could be observed from less than or equal to10 km. We systematically located pronghorn with spotting scopes and telemetry. When located, we described their behavior and military activity using scan sampling. We tested hearing using auditory brainstem responses (ABR). We could not test the hearing of Sonoran pronghorn because of their endangered status, so we contrasted hearing of pronghorn near Camp Verde, Arizona, and desert mule deer (Odocoileus hemionus eremicus) that were and were not exposed to sound pressure levels from military activity. We recorded behavior observations of Sonoran pronghorn on 172 days (44,375 observation events [i.e., 1 observation/30 second]) over 373 hours. These data were compared with 93 days of behavioral data (24,297 observation events) over 202 hours for pronghorn not regularly influenced by military aircraft. Overall, we did not detect behavioral differences (i.e., time spent bedding, standing, foraging, traveling) between males and females. Pronghorn exposed to military activity, and those that were not, bedded the same

amount of time. Pronghorn at BMGR foraged less and stood and traveled more than pronghorn not exposed to military activity. These trends were the same with and without anthropogenic activity. Only 7.3% of behavioral events occurred with identifiable stimuli. Military overflights occurred 363 times (0.8%) and non-military overflights occurred 77 times (<0.2%). Pronghorn rarely responded to military aircraft, but often moved >10 m when ground stimuli were present. Ambient noise levels ranged up to 123.1 decibels (dB). The average sound pressure level on days with military activity was 65.3 dB compared to 35.0 dB without military activity. Because we obtained hearing tests from deer and pronghorn, we were able to develop an ungulate weighting filter on the noise generated from overflights of A-10 and F-16 aircraft. Desert ungulates do not hear sound pressure levels generated from these aircraft as well as humans do (i.e., 14-19 dB lower). The military activity we examined had only marginal influence on Sonoran pronghorn. Pronghorn used the ranges shared with the military throughout the year and behavioral patterns of pronghorn were similar with and without the presence of military stimuli. Furthermore, pronghorn behavior exposed to military activity was similar to behaviors of pronghorn not exposed to regular military activity. The auditory characteristics of pronghorn were similar for those that have and have not been exposed to military activity. The population of Sonoran pronghorn in the United States continues to decline and is in serious danger of extirpation. Clearly, additional work needs to be done, but military activity as measured herein is not a limiting factor.

MacKinnon, B., Sowden, R., et al. (2004). Sharing the skies. An aviation industry guide to the management of wildlife hazards. 366 pp.

McCarthy, M.A., Xiao, J.R., et al. (2004). "Modelling of bird strike on an aircraft wing leading edge made from fibre metal laminates - Part 2: Modelling of impact with SPH bird model." Applied Composite Materials **11**(5): 317-340.

Fibre Metal Laminates with layers of aluminium alloy and high strength glass fibre composite have been reported to possess excellent impact properties and be suitable for aircraft parts likely to be subjected to impacts such as runway debris or bird strikes. In a collaborative research project, aircraft wing leading edge structures with a glass-based FML skin have been designed, built, and subjected to bird strike tests that have been modelled with finite element analysis. In this second part of a two-part paper, a finite element model is developed for simulating the bird strike tests, using Smooth Particle Hydrodynamics (SPH) for modelling the bird and the material model developed in Part 1 of the paper for modelling the leading edge skin. The bird parameters are obtained from a system identification analysis of strikes on flat plates. Pre-test simulations correctly predicted that the bird did not penetrate the leading edge skin, and correctly forecast that one FML lay-up would deform more than the other. Post test simulations included a model of the structure supporting the test article, and the predicted loads transferred to the supporting structure were in good agreement with the experimental values. The SPH bird model showed no signs of instability and correctly modelled the break-up of the bird into particles. The rivets connecting the skin to the ribs were found to have a profound effect on the performance of the structure.

McCarthy, M.A., Xiao, J.R., et al. (2004). "Modelling of bird strike on an aircraft wing leading edge made from fibre metal laminates - Part 1: Material modelling." Applied Composite Materials **11**(5): 295-315.

Fibre Metal Laminates with layers of aluminium alloy and high strength glass fibre composite have been reported to possess excellent impact properties and be suitable for aircraft parts likely to be subjected to impacts from objects such as runway debris or birds. In a collaborative research project, aircraft wing leading edge structures with a glass-based FML skin have been designed, built, and subjected to bird strike tests that have been modelled with finite element analysis. In this first part of a two-part paper, a material model developed for FML suitable for use in impact modelling with explicit finite element analysis is presented. The material model is based on a recent

implementation in the commercial finite element code PAM-CRASH/SHOCK of a Continuum Damage Mechanics (CDM) model for composites, incorporating anisotropic strain rate effects. Results from the model are compared with experimental results on FML at variable strain rates and the model is shown to be capable of capturing most of the complex strain rate dependent behaviour exhibited by these materials.

Owino, A., Biwott, N., et al. (2004). "Bird strike incidents involving Kenya Airways flights at three Kenyan airports, 1991-2001." African Journal of Ecology **42**(2): 122-128.

Bird strike data involving Kenya Airways aircraft at three Kenya's international airports located at Mombasa (Moi International Airport), Nairobi (Jomo Kenyatta International Airport) and Kisumu (Kisumu International Airport) have been regularly gathered by Kenya Airways during the period 1991-2001. The Department of Ornithology, National Museums of Kenya, has been a key collaborator in this effort by identifying the bird species, often just from remains of the carcass or a few feathers. A total of 224 bird strike incidents were reported at the three airports during the study period. Nairobi had the highest number of strikes (n = 90), followed by Kisumu (n = 88) and Mombasa (n = 46). Seven bird families, namely Ciconiidae, Accipitridae, Threskiornithidae, Numididae, Ardeidae, Corvidae and Gruidae accounted for most incidents in different phases of aeroplane flights, time of day and seasons. The general trend of bird strike incidents at the three airports showed a consistent increase during the study period, with Nairobi experiencing a significant rise (regression analysis, P = 0.03) over the 10-year period. This preliminary analysis provides baseline information necessary for bird hazard management at the three airports.

Seamans, T.W. and Bernhardt, G.E. (2004). Response of Canada geese to a dead goose effigy. Proceedings 21th Vertebrate Pest Conference, Univ. of Calif., Davis. pp 104-106.

The North American Canada goose population increased at a rate of 10.5% per year, 1966 - 2001. Canada geese rank as the third most hazardous species in regards to collisions with aircraft. Sound Canada goose management tools are critical for a safer airport environment. We conducted field evaluations of a Canada goose effigy during the breeding season with tenitorial pain and in late summer with post-fledging flocks to determine if geese were deterred by the efflgy. No difference in tenitorial pairs was found between pretreatment and treatment periods for Canada geese when goose effigies were placed within their territories. In post-fledging flocks, the mean number of geese observed during pretreatment (74.9 i 12.9), treatment (14.8 + 4.9, and posttreatment (53.6 i 14.2) periods differed (P < 0.01). There was no difference (P = 0.56) between the mean number of geese observed during a second round of 5-day pretreatment (58.7) and 5-day second round treatment (43.7) periods. By itself, the goose effigy was not effective as a Canada goose deterrent after approximately 5 days. However, this effigy may have some potential in an integrated goose control program conducted outside of the breeding season. Further evaluation of the effigy as part of an integrated Canada goose contml program is recommended.

Sheikh, P.A. and Uhl, C. (2004). "Airplane noise: a pervasive disturbance in Pennsylvania Parks, USA." Journal of Sound and Vibration **274**(1-2): 411-420.

Washburn, B.E. and Seamans, T.W. (2004). Management of vegetation to reduce wildlife hazards at airports. 2004 FAA Worldwide Airport Technology Transfer Conference, Atlantic City, New Jersey, USA, University of Nebraska - Lincoln. 7 pp. from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1391&context=icwdm_usdanwrc.

Aas, C.K. (2004). Rapport over fugler skutt på norske flyplasser i 2003. Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo. 2 pp.

Aas, C.K. (2004). Fly-fugl. Årsmøte i flytryggingsorganisasjonen i Luftforsvaret, UiO

Aas, C.K. (2004). Kollisjon mellom SAS-fly og fugler 24. oktober 2004 kl. 18.08 ved innflyging til OSL - identifisering av involvert fugleart. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 2 pp.

Aas, C.K. (2004). Referat fra besøk ved Andøya flystasjon 8.-9. juni 2004. Fly/fugl-kontoret, Naturhistorisk museum , UiO, Oslo. 3 pp.

2003

Anagnostopoulos, A. (2003). Bird strike risk assessment for Athens international airport. 26th IBSC meeting, Warsaw. 17 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPAE2.pdf.

Anagnostopoulos, A., Nikolaidis, E., et al. (2003). Risk assesment model case study Hellenic airports. 26th IBSC meeting, Warsaw. 14 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPAV1.pdf.

Battistoni, V. (2003). Bird strikes and the courts: The Genoa case. 26th IBSC meeting, Warsaw. 6 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPLE3.pdf.

Baxter, A., St. James, K., et al. (2003). Predicting the birdstike hazard from gulls at landfill sites. 26th IBSC meeting, Warsaw. 10 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPBAM5.pdf.

Beason, R. (2003). Avian sensory perception: What do we need to know to improve avian detection of aircraft? 26th IBSC meeting, Warsaw.

Bentz, P.-G. (2003). Flygplansbuller och fåglar – Underlag för komplettering av Miljökonsekvensbeskrivning Malmens flygplats 2002. 5 pp.

Bloise, C., Reis, S., et al. (2003). Diurnal local bird movements in the area of the new Lisbon airport. 26th IBSC meeting Warsaw. 15 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPOS3.pdf.

Bouten, W., Van Belle, J., et al. (2003). Towards an operational bird avoidance system: combining models and measurements. 26th IBSC meeting, Warsaw. 13 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPOS2.pdf.

Briot, J.L. and Bataille, P. (2003). A new laser equipment designed for avian dispersal in airport environment. 26th IBSC meeting, Warsaw. 6 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPAE7.pdf.

Budgey, R. (2003). Modelling bird abundamce across a range of land use types for use in a bird avoidance model. 26th IBSC meeting, Warsaw.

Buurma, L. and Goes, B. (2003). Hunting or scaring, 50 years of fruitful debate in the Royal Netherlands Airforce. 26th IBSC meeting, Warsaw.

Carter, N.B. and Cohen, E. (2003). A paradigm shift in bird strike prevention by Israeli air force. 26th IBSC meeting Warsaw.

Carter, N.B. and Ovadia, M.O. (2003). Agriculture on airfields: short-term benefit, long-term loss. 26th IBSC meeting Warsaw.

Deacon, N. (2003). The use of birdstrike statistics as an aerorome bird hazard control auditing tool. 26th IBSC meeting, Warsaw.

Degrieck, J., Verleysen, P., et al. (2003). "Optical measurement of target displacement and velocity in bird strike simulation experiments." Measurement Science & Technology **14**(1): 1-6.

Thousands of bird strikes on aircraft occur annually with subsequent consequences for repair costs but also for public safety. In bird strike simulation experiments a bird or birdlike object is usually accelerated towards a target. Knowledge of the parameters of the impact, such as the velocities involved, the target displacement and the energy transferred from the projectile to the target, lead to a better understanding of the phenomenon, and eventually to better protection against damage caused by bird strikes. However, due to the extremely high velocities and energies involved in the experiments, methods for registration of the impact parameters are not obvious. Non-contact measurement techniques have a number of advantages over the more common mechanical contact methods. In this paper, a relatively simple optical technique is presented for recording the history of target displacement, from which the target velocity and energy can be readily obtained. The technique is based on the relative displacement of two moire line gratings: one grating attached to the target and the other serving as a stationary reference grating. The proposed technique has proved to be useful. Results of a representative bird strike experiment are presented.

Dekker, A. (2003). Taking habitat management one step further. 26th IBSC meeting, Warsaw. 7 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPAE6.pdf.

Dekker, A. and Buurma, L. (2003). Zero-tolerance a panacea? 26th IBSC meeting, Warsaw. 9 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPOS6.pdf.

Dekker, A., van Gasteren, H., et al. (2003). Eurbase, progress report and first impressions on bird species. 26th IBSC meeting, Warsaw. 15 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPID2.pdf.

Dolbeer, R.A., Chipman, R.B., et al. (2003). Does shooting alter flight patterns of gulls: case study at John F. Kennedy International airport. 26th IBSC meeting Warsaw. 20 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPBB5.pdf.

Dolbeer, R.A. and Eschenfelder, P. (2003). Amplified bird-strike risks related to population increases of large birds in North America. 26th IBSC meeting Warsaw. 19 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPOS4.pdf.

Ellis, D.H., Sladen, W.J.L., et al. (2003). "Motorized migrations: The future or mere fantasy?" Bioscience **53**(3): 260-264.

In 15 experiments from 1993 to 2002, we led cranes, geese, and swans on their first southward migration with either ultralight aircraft or vehicles on the ground. These experiments reveal that large birds can be readily trained to follow, and most will return north (and South) in subsequent migrations unassisted. These techniques can be used to teach birds new (or forgotten) migration paths. Although we are constantly improving our training techniques, we now have an operational program that can be broadly applied to those species whose juveniles learn migration routes from their parents.

Fennessy, G., Kelly, T.C., et al. (2003). Bird aircraft interaction in relation to ambient light conditions. 26th IBSC meeting, Warsaw. 8 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPBB2.pdf.

Frid, A. (2003). "Dall's sheep responses to overflights by helicopter and fixed-wing aircraft." Biological Conservation **110**(3): 387-399.

High rates of behavioural disruption caused by human activities could jeopardize the body condition and reproductive success of wildlife. I exposed Dail's sheep (Ovis dalli dalli) of the Yukon Territory to experimental overflights by a fixed-wing aircraft and a helicopter. Aircraft approaches that were more direct (as determined by the aircraft's

elevation and horizontal distance from sheep) were more likely to elicit fleeing or to disrupt resting. Latency to resume feeding or resting after fixed-wing overflights was longer during more direct approaches. During indirect approaches by helicopters, sheep far from rocky slopes were much more likely to flee than sheep on rocky slopes. Sheep did not flee while nearby helicopters flew along the opposite side of a ridge, presumably because the obstructive cover buffered disturbing stimuli. Results provide preliminary parameters for predicting energetic and fitness costs incurred as a function of overflight rates, and can help mitigate disturbance by guiding temporal and spatial restrictions to aircraft. (C) 2002 Elsevier Science Ltd. All rights reserved.

Froneman, A. and van Rooyen, M. (2003). The successful implementation of border collie bird scaring program at Durban International airport, South Africa. 26th IBSC meeting Warsaw. 13 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPAE1.pdf.

Kelly, T.C. and Bolger, R. (2003). The changing pattern of bird strikes caused by pigeons at an Irish airport. 26th IBSC meeting, Warsaw.

Kelly, T.C., Bourke, P.D., et al. (2003). The effect of length of daylight on bird-strike rates. 26th IBSC meeting, Warsaw.

Klein, L.A., Hovan, M., et al. (2003). MMW radar for dedicated bird detection at airports and airfields. pp 204- 220.

Komenda-Zehnder, S., Cevallos, M., et al. (2003). Effects of disturbance by aircraft overflight on waterbirds - an experimental approach. 26th IBSC meeting, Warsaw. 13 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPLE2.pdf.

Landon, D.M., Krausman, P.R., et al. (2003). "Pronghorn use of areas with varying sound pressure levels." Southwestern Naturalist **48**(4): 725-728.

The Sonoran pronghorn (Antilocapra americana sonoriensis), a subspecies in danger of extinction, inhabits all area of the Barry M. Goldwater Range (BMGR) in southwestern Arizona. Since 1941, BMGR has been a training site for military pilots. We evaluated whether this Subspecies of pronghorn used areas, as defined by noise levels produced by military aircraft, in proportion to their availability. Radiocollar-equipped pronghorn were monitored during September 1994 to August 1998, and their locations were recorded on a map of sound levels. In general, pronghorn used areas with lower levels of noise (<45 decibels [dB]) more than expected and areas with higher levels (greater than or equal to55 dB) less than expected. More intensive monitoring, habitat influences, and additional measurements of noise in the area, could produce a clearer picture of the factors that determine areas Of use Within the BMGR by Sonoran pronghorn.

Lensink, R. and Dirksen, S. (2003). Dealing with resrictions due to the airport surroundings directive schiphol in the Netherlands. 26th IBSC meeting, Warsaw.

Leshem, Y. and Froneman, A. (2003). Flight safety and nature conservation - the ultimate connection, the Great Rift Valley case study. 26th IBSC meeting, Warsaw. 17 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPOS1.pdf.

The majority of the global community members who are involved in the aircraft-bird conflict usually focus on a narrow spectrum of the factors involved, in accordance with their field of expertise: civilian aviation as opposed to military, airfield maintenance as opposed to military training zones, basic research as opposed to applicable techniques, and so forth. In most of the cases the handling of the conflict focuses around a single specific sitesuch as an airfield, some of the activities focus within the borders of a single country, and only in a few cases does the handling develop to a regional level involving a number of countries co-operating to resolve the conflict. One such example

consists of the developing during the last decade - Bird Avoidance Model (BAM) - among the NATO countries in West Europe, and the co-operation in the Middle East. In many cases budget considerations constitute a central limiting factor in the failure todevelop applicable solutions to the conflict. Furthermore, a significant portion of the IBSCcommunity does not initiate any contact with the scientific community and with the natureconservation organisations. On many occasions, the scientific community also shows amarked lack of interest in subjects of aviation safety and treats it as a technical matter. Someof the nature conservation organisations also view this conflict as problematic in the harmcaused to birds and therefore show no readiness to contribute towards its solution. In this article we will present the Israeli Air Force (IAF) concept as a test case. During the last 20 years, the IAF has been in a yearly contract with 3 bodies: the leading NGO in Israel - the Society for the Protection of Nature in Israel (SPNI), Nature and Parks Authority (a government agent), and Tel Aviv University as the academic component, together leading the handling of the conflict with relatively high success rates. This model has also developed in recent years among the aviation authorities in South Africa who have formed ties with Endangered Wildlife Trust(EWT), a leading NGO in South Africa. In this article we will present an additional and highly significant concept initiated by action on a regional and continental level involving the need for inter-country co-operation while tying together aviation safety and nature conservation bodies through shared action. In May 2001 Israel and South Africa lead a conference in which 20 African countries participated. The conference title was: Wings Over Africa - Research, Conservation, Education and Flight Safety. We will present the action plan as developed at this conference in Israel. We will also present an initiative that has been presented to the UNESCO World Heritage Center involving the declaration of the Great Rift Valley as one integral site all its 7,000 km length, thus uniting 22 countries in the framework of a shared program involvingnature conservation, cultural heritage, and flight safety issues as a global corridor of migration. We believe that by involving nature conservation, academic and flight safety bodies the recruiting of larger resources that can be used in the reduction of the conflict between aircraft and birds will be aided.

Mathew, D.N., Palat, R., et al. (2003). Bird strike rates in the aerodromes of Kerala, India in relation to preventive measures 1999- 2002. 26th IBSC meeting, Warsaw. 5 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPSA5.pdf.

Mathew, D.N., Palat, R., et al. (2003). Rewiew of bird strike reports sent to BNHS India (1997-2000). 26th IBSC meeting, Warsaw. 13 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPSA7.pdf.

Matijaca, A. (2003). Bird strike outside airport boundaries. 26th IBSC meeting Warsaw. 14 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPLE1.pdf.

Meo, M., Morris, A., et al. (2003). "Numerical simulations of low-velocity impact on an aircraft sandwich panel." Composite Structures **62**(3-4): 353-360.

The potential hazards resulting from a low-velocity impact (bird-strike, tool drop, runway debris, etc.) on aircraft structures, such as engine nacelle or a leading edge, has been a long-term concern to the aircraft industry. Certification authorities require that exposed aircraft components must be tested to prove their capability to withstand low-velocity impact without suffering critical damage. This paper describes the results from experimental and numerical simulation studies on the impact and penetration damage of a sandwich panel by a solid, round-shaped impactor. The main aim was to prove that a correct mathematical model can yield significant information for the designer to understand the mechanism involved in the low-velocity impact event, prior to conducting tests, and therefore to design an impact-resistant aircraft structure. Part of this work presented is focused on the recent progress on the materials modelling and numerical simulation of low-velocity impact response onto a composite aircraft

sandwich panel. It is based on the application of explicit finite element (FE) analysis codes to study aircraft sandwich structures behaviour under low-velocity impact conditions. Good agreement was obtained between numerical and experimental results, in particular, the numerical simulation was able to predict impact damage and impact energy absorbed by the structure. (C) 2003 Elsevier Ltd. All rights reserved.

Nikolaidis, E.D. (2003). Bird strike in Greece 1999-2000, civil aviation. 26th IBSC meeting, Warsaw. 11 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPSA4.pdf.

Palmer, A.G., Nordmeyer, D.L., et al. (2003). "Effects of jet aircraft overflights on parental care of peregrine falcons." Wildlife Society Bulletin **31**(2): 499-509.

Concerns voiced by resource managers caused us to examine the hypothesis that low-altitude jet aircraft overflights affect parental care by peregrine falcons. Specifically, we studied effects on nest attendance, time-activity budgets, and provisioning rates of peregrine falcons (Falco peregrinus) breeding along the Tanana River, Alaska in 1995, 1996, and 1997. We detected subtle effects of jet overflights on peregrine falcon parental behavior, but found no evidence that overall attendance patterns differed depending on exposure to overflights. Nest attendance and time-activity budgets of peregrine falcons during periods of overflights differed from those of peregrines at reference nests (nests rarely overflown). Differences depended on stage of the nesting cycle and gender. During the incubation and brooding stages of the nesting cycle, males attended the nest ledge less when overflights occurred than did males from reference nests. Females attended the nest ledge more during overflown periods compared to females from reference nests. Additionally, while females were still brooding nestlings, they were less likely to be absent from the nest area during periods when overflights occurred than females from reference nests. Although we found differences in nest attendance and time-activity budgets between overflown and reference nests, we did not observe differences between periods with overflights and periods without overflights at the same nests. Nor did we detect a relationship between nest attendance and the number of overflights occurring within a given time period, the cumulative number of above-threshold noise events at each nest, or the average sound-exposure level of overflights. Furthermore, we found no evidence that nestling provisioning rates were affected by overflights.

Pepper, C.B., Nascarella, M.A., et al. (2003). "A review of the effects of aircraft noise on wildlife and humans, current control mechanisms, and the need for further study." Environmental Management **32**(4): 418-432.

Military and civilian aircraft overflights are an issue that may impact the quality of life for millions of United States residents. Aircraft noise annoys many people worldwide and is generally thought to adversely affect some wildlife species. In light of increasing demands being placed on airspace, and because of technological improvements in acoustical testing, there is a need to reexamine the effects of aircraft noise exposure on humans and wild-life. This paper reviews past research, current laws and legislation, and presents an argument for the need to revisit the effects of aircraft noise on humans and wildlife. Some evidence suggests that noise may adversely impact wildlife and humans, however, many of the past studies were inconclusive and based on relatively small sample sizes. Given that aircraft noise abatement legislation has been enacted and because of the recent promulgation of community-based noise awareness programs, future studies should be conducted to resolve public policy problems and debates associated with aircraft noise. The need to further study the effects of aircraft noise on humans and wildlife is critical for creating sustainable land use policies near aircraft installations. Data derived from these studies will be used to create sound public policies that enhance the operational capacity of military and civilian aircraft while reducing the opportunity for human and wildlife exposure to aircraft noise.

Rochard, B. and Deacon, N. (2003). Bird hazard created by wetlands near aerodromes. 26th IBSC meeting, Warsaw. 4 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPAV3.pdf.

Rozell, K.B. (2003). Effects of military overflights on nesting neotropical migrant birds. Alaska Bird Observatory, Fairbanks, VS.

Ruhe, W. (2003). Radar bird observation and bird strike warnings in the western Baltic region. 26th IBSC meeting, Warsaw. 8 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPBAM6.pdf.

Sasse, D.B. (2003). "Job-related mortality of wildlife workers in the United States, 1937-2000." Wildlife Society Bulletin **31**(4): 1015-1020.

wildlife biologists face a variety of job-related hazards that are unique to this profession, most of them involving the remote areas where work is performed and the unusual techniques used to study or manage wildlife. information on biologists and others killed while conducting wildlife research or management was obtained from state and federal natural resources agencies, solicitations on wildlife-based internet discussion groups, and published obituaries. Ninety-one job-related deaths were documented from 1937 to 2000. Aviation accidents, drowning, car and truck accidents, and murder were the most common causes of death. Thirty-nine aviation accidents accounted for 66% of deaths, with aerodynamic stalls and power-line collisions being the most significant causes of accidents for which information was available. These safety threats should be taken into consideration during the design and planning of future research and management projects.

Shamoun-Baranes, J. (2003). Bird migration, wether and flight safety: Towards a bird avoidance model in the middle East. 26th IBSC meeting Warsaw.

Shamoun-Baranes, J., Liechti, O., et al. (2003). "Using a convection model to predict altitudes of white stork migration over central Israel." Boundary-Layer Meteorology **107**(3): 673-681.

Soaring migrants such as storks, pelicans and large birds of prey rely on thermal convection during migration. The convection model ALPTHERM was designed to predict the onset, strength, duration and depth of thermal convection for varying topographies for glider pilots, based on atmospheric conditions at midnight. We tested ALPTHERM predictions as configured for two topographies of central Israel, the Coastal Plains and the Judean and Samarian Mountains in order to predict altitudes of migrating white storks (Ciconia ciconia). Migrating flocks of white storks were tracked with a motorized glider, to measure maximum altitudes of migration during spring 2000. A significant positive correlation was found between the maximum daily altitudes of migration measured and the predicted upper boundary of thermal convection for the Coastal Plains and Samarian Mountains. Thirty-minute predictions for the Coastal Plains and Samarian Mountains correlated positively with measured maximum migration altitudes per thermal. ALPTHERM forecasts can be used to alter flight altitudes in both civil and especially military aviation and reduce the hazard of serious aircraft collisions with soaring migrants.

Sheehy, S., Kelly, T.C., et al. (2003). A comparison of the injury syndromes associated with different sources of avian mortality. 26th IBSC meeting, Warsaw. 8 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPBB1.pdf.

Sierdsema, H. (2003). Using bird atlas and monitoring data for a bird avoidance model. 26th IBSC meeting, Warsaw. 22 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPBAM1.pdf.

Szczepanik, R. and Szymczak, J. (2003). Colisions of military aircraft with birds inthe airfield airspace in Poland. 26th IBSC meeting, Warsaw.

Thingstad, P.G. (2003). Mulige konsekvenser av vern av Vikanbukta for flytrafikken ved Trondheim lufthavn, Værnes: en naturfaglig vurdering. Trondheim, Norges teknisk-naturvitenskapelige universitet, Vitenskapsmuseet.

Thorpe, J. (2003). Fatalities and destroyed civil aircraft due to bird strikes, 1912-2002. International Bird Strike Committee, 26th Meeting, Warsaw, Poland.

Thorpe, J. (2003). The bird strike implications of low-cost airlines using smaller airports. 26th IBSC meeting, Warsaw. 4 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPAE9.pdf.

Wattel, J. (2003). Prevention and identification. 26th IBSC meeting, Warsaw. 4 pp. from http://www.int-birdstrike.org/Warsaw_Papers/IBSC26%20WPID1.pdf.

Yo, S.-p. and Lee, C.-C. (2003). Community dynamic study of insect foraging guild at cck air force base in Taiwan. 26th IBSC meeting Warsaw. pp 6.

Yohannes, E. (2003). The role of local weather conditions on the rate of bird strike incidents: a case study at Addis Ababa airport, Ethiopia. 26th IBSC meeting, Warsaw.

Zolotarev, S. and Silaeva, O. (2003). Coordination center for ornithological safty of aerodromes: The main purpose and tasks. 26th IBSC meeting, Warsaw.

Aas, C.K. (2003). Bird Hazards. Årsmøte i flytryggingsorganisasjonen i Luftforsvaret; 2003-04-22 - 2003-04-24, UiO

Aas, C.K. (2003). Fly/fugl - Sola flystasjon 26.-27. november 2003. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 3 pp.

Aas, C.K. (2003). Fly/fugl - Ørland hovedflystasjon 27.-28. mai 2003. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 2 pp.

Aas, C.K. (2003). Historikk/internasjonalt arbeid. Møte i Nasjonalt utvalg for forebyggelse av konflikt mellom luftfartøy og fugler; 2003-11-11 - 2003-11-11, UiO

Aas, C.K. (2003). Ornitologisk besøk ved Sola flystasjon 26.-27. november 2003. Fly/fugl-kontoret, Naturhistorisk museum, UiO, Oslo. 2 pp.

Aas, C.K. (2003). Present bird warnings in Norway and elements for future bird warnings. EuroBAM - Kick-off meeting; 2003-07-08 - 2003-07-08 UiO.

2002

[Anon] (2002). "Airport bird/wildlife control program." Aircraft Engineering and Aerospace Technology **74**(1): 76-77.

Allan, J.R., Ed. (2002). The costs of bird strikes and bird strike prevention. Human Conflicts with Wildlife: Economic Considerations. Fort Collins, US Department of Agriculture.

Collisions between birds (and other wildlife) and aircraft are known to cause substantial losses to the aviation industry in terms of damage and delays every year. Techniques exist to control bird numbers on airfields and hence to reduce the number of wildlife strikes, but they are applied at widely different levels from airport to airport. Some of this variation may be due to differing levels of strike-risk at the different sites, but much of it is due to the unwillingness or inability of the airports concerned to invest in bird

strike prevention. Part of the reason for this reluctance to invest in airport bird control is a lack of understanding of the true costs to the airlines in terms of direct damage to aircraft and in delays and cancellations. Previous estimates of the cost of bird strikes have concentrated only on measurable repair costs and have not attempted to assign costs to aircraft delays. My paper uses newly available data from major international airlines to provide the first estimate for the total cost of bird strikes to the world's airline fleet. Much of the data are commercially confidential and sources cannot be quoted nor the accuracy of the data verified. The estimates also rely on information from a very small number of airlines to produce extrapolations for the worldwide costs of damage and delays. Although these are major international carriers, and as representative as possible of the world bird strike problem as a whole, the results should be interpreted with a suitable level of caution. A tentative and probably conservative estimate of US$1.2 billion per year in damage and delays is the outcome of this calculation. The costs of bird damage are evaluated relative to the ability of managers to pay for bird control programs and the derived benefits thereof. Reasons for the industry's failure to invest further to reduce the costs of bird strikes are examined.

Arfsten, D.P., Wilson, C.L., et al. (2002). "Radio frequency chaff: The effects of its use in training on the environment." Ecotoxicology and Environmental Safety **53**(1): 1-11.

Chaff is a radiofrequency countermeasure released by military aircraft, ships, and vehicles to confuse enemy radar. Chaff consists of aluminum-coated glass fibers ranging in lengths from 0.8 to 0.75 cm and is released in packets of 0.5 to 100 million fibers. The Department of Defense has determined that use of chaff in training is required for maintaining proficiency in the use of this countermeasure. At least 500 tons of chaff is released annually during training within selected military operating areas in the United States. Concerns have been raised about impact on the environment and its potential toxicity to humans, livestock, and wildlife. Many of these concerns have been addressed or are being researched by the Department of Defense and other agencies, tout much of the data are unpublished. Herein, the authors summarize the issues and review scientific data for the impact of chaff use on humans, animals, and the environment. (C) 2002 Elsevier Science (USA).

Barras, S.C. and Seamans, T.W. (2002). Habitat management approaches for reducing wildlife use of airfields. Proc. 20th Vertebr. Pest Conf., Univ. of Calif., Davis. pp 309-315.

Barras, S.C. and Wright, S.E. (2002). "Civil aircraft collisions with birds and other wildlife in Ohio, 1990-1999." Ohio Journal of Science **102**(2): 2-7.

Collisions between wildlife and aircraft (wildlife strikes) cost civil aviation more than $380 million annually in the US and pose a safety risk to flight personnel and passengers. We investigated wildlife strike trends and characteristics of strikes at airports in Ohio, 1990-1999, by analysis of data from the Federal Aviation Administration (FAA) National Wildlife Strike Database. Of 903 reported wildlife strikes with civil aircraft in Ohio, 98% were bird strikes and 2% involved mammals (primarily white-tailed deer [Odocoileus virginiana] and coyote [Canis latrans]). Reported wildlife strikes increased ($P < 0.01$) from 39 in 1990 to 165 in 1999. Species groups most commonly involved in bird strikes were gulls (Larus spp., 135), raptors (Falconiformes and Strigiformes, 55), and waterfowl (Anseriformes, 49). The estimated cost of damage (mean = $85,816/aircraft; total = $3,175,192) was provided for only 37 (29%) of the 126 strike reports that indicated damage occurred. Assuming all damaging strikes had comparable mean damage and 20% of all strikes were reported, the total cost of these strikes may have been as high as $54 million. Airport managers in Ohio and elsewhere should develop wildlife hazard management programs to minimize the risk of wildlife strikes, especially with deer, geese, gulls and other Large species.

Bentz, P.-G. (2002). Dragracing på Sättna flygplats – Generellt utlåtande om fåglar på flygplatser och fågelskyddsaspekten. 6 pp.

Bentz, P.-G. (2002). Fåglar och vattenmagasin på flygplatser – Bedömning av risken för fågelkollisioner vid svenska flygflottiljer. 52 pp.

Bruggers, R.L., Owens, R., et al. (2002). "Wildlife damage management research needs: perceptions of scientists, wildlife managers, and stakeholders of the USDA/Wildlife Services program." International Biodeterioration & Biodegradation **49**(2-3): 213-223.

This paper presents the results of a nationwide research needs assessment of the important wildlife-human conflict issues and associated research needs of the USDA/APHIS-Wildlife Services (WS) program and its stakeholders. Thirty-six WS State Directors, 23 WS/National Wildlife Research Center (NWRC) scientists and 6 members of the National Wildlife Services Advisory Committee (NWSAC) to the US Secretary of Agriculture responded to a request for participation. This paper compares these current research needs with previous regional and national research needs assessments for wildlife damage management in the United States. Important national problems identified included issues related to aviation, timber, agriculture, aquaculture, and livestock industries, as well as wildlife-borne diseases, invasive species, and overabundant wildlife populations. This assessment provides useful input, along with legislative and administrative guidance, to NWRC for allocating resources to specific research projects that address the WS program's needs for knowledge and new methods. Published by Elsevier Science Ltd.

Byron, J. and Downs, C.T. (2002). "Bird presence at Oribi Airport and recommendations to avoid bird strikes." South African Journal of Wildlife Research **32**(1): 49-58.

Birds have been responsible for damage to aircraft and the subsequent loss of human life ever since the development of aviation. At Oribi Airport (Pietermaritzburg, KwaZulu-Natal), there is a higher incidence of bird strikes relative to other South African airports. Hadeda ibis (Bostrychia hagedash) and crowned plovers (Vanellus coronatus) are responsible for most bird strikes at Oribi Airport. During winter, the hadeda ibis was the most frequently seen bird (per hour) and used a predictable daily flight route beginning with movement to feeding grounds (SE-NW) around sunrise and returning (NW-SE) to a roosting site around sunset. Time of movement, with respect to season, varied according to sunrise or sunset flight time, i.e. in summer they moved earlier and returned later and vice versa. These bird flight patterns increased the probability of a strike with departing or arriving aircraft. During summer, there was a decrease in presence and use of Oribi Airport as a feeding ground for the hadeda ibis. Although the number of birds at the airport, particularly raptors, increased during the summer, few were present at any time. Recommendations for the prevention of bird strikes at Oribi Airport are presented.

Dove, C.J. and Heacker, M. (2002). "Egyptian Nightjar (Caprimulgus aegyptius) in North America?" Journal of Field Ornithology **73**(1): 60-61.

An Egyptian Nightjar (Caprimulgus aegyptius) specimen was salvaged on 5 September 2000 from the landing gear of a DC-10 airliner that had landed at Langley Air Force Base, Virginia. The bird likely collided with the plane during its stop the previous day in Kuwait City, Kuwait, within the typical range of this nightjar. This incident illustrates the importance of proper documentation of specimens and shows that aircraft transport of avian specimens can occur.

Engeman, R.M., Peterla, J., et al. (2002). "Methyl anthranilate aerosol for dispersing birds from the flight lines at Homestead Air Reserve Station." International Biodeterioration & Biodegradation **49**(2-3): 175-178.

The failure of traditional hazing methods to provide a lasting dispersal of birds from the flight lines at Homestead Air Reserve Station, Florida led to trials with Rejex-it(R) TP-40 methyl anthranilate (MA) formulation as an aerosol. A variety of civil, military and other government aircraft use the base, including combat aircraft which are particularly prone

to bird airstrikes due to low altitude, high speed flights. Migrating swallows and killdeer congregate at the airfield to forage on insects, and the large numbers of birds cause restrictions in airfield operations because of potential strike hazards with aircraft. MA applied by fogger upwind of the areas to be protected was found to provide a dispersal lasting the remainder of the day. The median time from imposition of airfield restrictions on flight operations to a declaration of a low bird hazard potential was approximately 45 min, and 75% of applications resulted in removal of airfield restrictions within 1.5 h. Published by Elsevier Science Ltd.

Johnson, C.L. and Reynolds, R.T. (2002). Responses of Mexican Spotted Owls to low-flying military aircraft.

Krausman, P.R. and Harris, L.K. (2002). "Military jet activity and Sonoran pronghorn." Zeitschrift Fur Jagdwissenschaft **48**: 140-147.

Forty percent of the habitat for the endangered Sonoran pronghorn (Antilocapra americana sonoriensis) in the United States is on the Barry M. Goldwater Range (BMGR), a bombing and gunnery range located in southwestern Arizona, USA. Wildlife and land managers have expressed concerns that military aircraft activity may be detrimental to Sonoran pronhorn. We observed the response of Sonoran pronghorn to military jet activity from 4 vantage points, BMGR from February 1998 to June 2000. We obtained behavioral observations on 172 days and obtained 44,773 observation events (i.e., 1 observation / 30 seconds). Pronghorn were exposed to 109 direct military overflights, but only 6 were <305 in above ground level. Overall, behavior of males and females was not significantly different and the presence of military aircraft did not cause changes in behavior.

Mason, J.R., Pitt, W.C., et al. (2002). "Factors influencing the efficiency of fixed wing aerial hunting for coyotes in the western United States." International Biodeterioration & Biodegradation **49**(2-3): 189-197.

Aerial hunting is an effective tool for the removal of problem coyotes (Cams latrans). However, factors that predict hunt success remain largely obscure. To address this issue, we asked USDA-APHIS-Wildlife Services pilots in five western states to record meteorological data, ground conditions, and flight circumstances (e.g., purpose of flight, whether or not a ground crew was used) between December 1998 and August 1999. We obtained 426 flight records and evaluated them in relation to coyotes seen/h and coyotes killed/h of aerial hunting, with pilot as a covariate. Air temperature, resource to be protected, use of ground crew, degree of preventative control, cloud cover, snow cover, vegetative cover, wind direction, season, and lunar phase were significantly (p less than or equal to 0.05) related to coyotes killed/h of aerial hunting. Variables that were not significantly (p greater than or equal to 0.05) related to coyotes killed/h were wind speed, steepness of terrain, barometric pressure and shotgun cartridge type. Our findings may have practical implications for increasing the efficiency of both aerial survey and aerial hunting operations important for coyote damage management. (C) 2002 Published by Elsevier Science Ltd.

Patenaude, N.J., Richardson, W.J., et al. (2002). "Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea." Marine Mammal Science **18**(2): 309-335.

Short-term behavioral responses of bowhead whales (Balaena mysticetus) and beluga whales (Delphinapterus leucas) to a Bell 212 helicopter and Twin Otter fixed-wing aircraft were observed opportunistically during four spring seasons (1989-1991 and 1994). Behaviors classified as reactions consisted of short surfacings, immediate dives or turns, changes in behavior state, vigorous swimming, and breaching. The helicopter elicited fewer detectable responses by bowheads (14% of 63 groups) than by belugas (38% of 40). Most observed reactions by bowheads (63%) and belugas (86%) urred when the helicopter was at altitudes less than or equal to150 m and lateral distances

less than or equal to 250 m. Belugas reacted significantly more frequently during overflights at lateral distances ! 250 m than at longer lateral distances (P = 0.004). When the helicopter was on the ice with engines running, 7 of 14 groups of belugas reacted, up to 320 m away, sometimes with small-scale (less than or equal to100 m) diversion; only 1 of 8 groups of bowheads reacted. For the fixed-wing aircraft, few bowheads (2.2%) or belugas (3.2%) were observed to react to overflights at altitudes 60-460 m. Most observed reactions by bowheads (73%) and belugas (70%) occurred when the fixed-wing aircraft was at altitudes :5182 m and lateral distances less than or equal to250 m. However, the proportions reacting, especially to low-altitude flights (e.g.,less than or equal to 182 m), were underestimated for both species because observation opportunities were brief. Even so, reactions were more common when the aircraft was low (less than or equal to 182 m): P = 0.009 for belugas, P = 0.06 for bowheads. There was little if any reaction by bowheads when the aircraft circled at altitude 460 m and radius 1 km. Aircraft sounds measured underwater at depths 3 m and 18 m showed that a Bell 212 helicopter was 7-17.5 dB noisier than a Twin Otter (10-500 Hz band). Belt 212 sound consisted mainly of main rotor tones ahead of the helicopter and tail rotor tones behind it. Twin Otter sound contained fewer prominent tones. Peak sound level as received underwater was inversely related to aircraft altitude, and received levels at 3 m depth averaged 2.5 dB higher than at IS m depth. The dominant low-frequency components of aircraft sound are presumed to be readily audible to bowheads. For belugas, these components may be inaudible, or at most only weakly audible. Mid-frequency sound components, visual cues, or both, are probably important in eliciting beluga reactions to aircraft.

Sodhi, N.S. (2002). "Competition in the air: Birds versus aircraft." Auk **119**(3): 587-595.

Ting, C., Garrelick, J., et al. (2002). "An analysis of the response of sooty tern eggs to sonic boom overpressures." J. Acoust. Soc. Am. **111**(1): 562-568.

Troxel, S., Echels, B., et al. (2002). Progress report on development of a terminal area bird detection and monitoring system using the ASR-9. 2002 Bird Strike Committee-USA/Canada, 4th Annual Meeting, Sacramento, CA. pp 9.

Aas, C.K. (2002). Det er ikke bare fugler som flyr!, UiO.

Aas, C.K. (2002). Hvilke problemer skaper fugler for flytrafikken?, UiO.

2001

Allan, J.R. and Orosz, A.P. (2001). The costs of birdstrikes to commercial aviation. 2001 Bird Strike Committee-USA/Canada, Third Joint Annual Meeting, Calgary, AB, University of Nebraska - Lincoln. pp 218-226.

Collisions between birds (and other wildlife) and aircraft are known to cause substantial losses to the aviation industry in terms of damage and delays every year. Techniques exist to control bird numbers on airfields and hence to reduce the numbers of wildlife strikes but they are applied at widely different levels from airport to airport. Some of this variation may be due to differing levels of strike risk at the different sites, but much of it is due to the unwillingness or inability of the airports concerned to invest in birdstrike prevention. Part of the reason for this reluctance to invest in airport bird control is a lack of understanding of the true costs involved to the airlines in terms of direct damage to aircraft and in delays and cancellations. Previous estimates of the cost of birdstrikes have concentrated on measurable repair costs and have not been able to assign costs to aircraft delays. This paper uses newly available data from major international airlines to provide the first estimate for the total cost of birdstrikes to the world's commercial airline fleet. Some of the data are commercially confidential and some of the sources cannot, therefore, be quoted nor the accuracy of the data verified. The estimates also rely on information from a very small number of airlines to produce extrapolations for

the world wide costs of damage and delays. Although the data sources are major international carriers, and as representative as possible of the world birdstrike problem as a whole, the results should be interpreted with a suitable level of caution. A tentative estimate of US$1.2 billion in damage and delays to commercial airlines for 1999 has been produced using this calculation. This does not include damage to general aviation aircraft or helicopters. This paper refines that estimation based on a more complete data set for 1999 plus the full data set for 2000. The revised figure of US$ 1.28 billion (range US$ 1.21 – US$ 1.36 billion) per year is also presented as cost per flight and cost per strike to allow other carriers to estimate the costs to their operation. These costs are compared with examples of the costs of bird control programmes from various parts of the world. Clear cases of the ability to invest money in bird control and save a greater sum in reduced birdstrike costs are identified. Reasons for the industry's failure to invest further to reduce the costs of birdstrikes are examined.

Bentz, P.-G. (2001). Västerås flygplats och planerad våtmark – Förslag till åtgärder för att reducera risken för fågelkollisioner. 7 pp.

Bentz, P.-G. (2001). International Bird Strike Committee – Rapport från IBSC 25th Meeting Amsterdam 17-21 april 2000. Fort.verket. 5 pp.

Bentz, P.-G. (2001). Vattenmagasin för mottag av ureabemängt dagvatten vid Blekinge flygflottilj F 17, Kallinge – Bedömning av risken för fågelkollisioner. Fort.verket. 8 pp.

Bentz, P.-G. (2001). Fåglar och flygplansbuller – En sammanfattning. Fort.verket. 2 pp.

Bentz, P.-G. (2001). Oljefälla och infiltrationsmagasin för mottag av dagvatten vid Luleå – Kallax flygplats/Norrbottens flygflottilj F 21 – Förslag till kompletterande åtgärder för att reducera risken för fågelkollisioner. Fort.verket. 5 pp.

Blokpoel, H. and MacKinnon, B. (2001). The need for a radar-based, operational bird-warning system for civil aviation. 2001 Bird Strike Committee-USA/Canada, Third Joint Annual Meeting Calgary, AB, University of Nebraska - Lincoln. pp 227-231.

Serious multi-engine strikes on civil aviation aircraft continue to occur despite bird control efforts at and around airports. Radar-based bird warning systems currently used in military aviation are largely unsuitable for operational use in civil aviation because of the considerable constraints and inflexibility inherent in civil aviation operations. Pilots of civil aviation aircraft need to get timely, pertinent information on bird hazards, complete with options on how to minimize the associated risk. Recent advances in the design of radars and computers allow for the development of a real-time radar-based system to detect and warn of high-risk situations involving birds. High-risk situations are those that may result in serious damage such as multi-engine power loss and/or fatalities. The bird information, as collected by a radar and analyzed for risk by a computer, could be passed on to the pilots either directly via an up-link or through the Air Traffic Services (ATS) providers. The airport bird controllers could obtain the bird warnings directly at the radar site and/or through the ATS providers. A radar-based bird warning system will need to be developed in close consultation with all the stakeholders involved, i.e., pilots, ATS providers, airlines, airport operators and their bird control staff, and regulatory agencies.

Brown, K.M., Erwin, R.M., et al. (2001). "Managing birds and controlling aircraft in the Kennedy Airport-Jamaica Bay Wildlife Refuge complex: The need for hard data and soft opinions." Environmental Management **28**(2): 207-224.

During the 1980s, the exponential growth of laughing gull (Larus atricilla) colonies, from 15 to about 7600 nests in 1990, in the Jamaica Bay Wildlife Refuge and a correlated increase in the bird-strike rate at nearby John F. Kennedy International Airport (New York City) led to a controversy between wildlife and airport managers over the

elimination of the colonies. In this paper, we review data to evaluate if: (1) the colonies have increased the level of risk to the flying public; (2) on-colony population control would reduce the presence of gulls, and subsequently bird strikes, at the airport; and (3) all on-airport management alternatives have been adequately implemented. Since 1979, most (2987, 87%) of the 3444 bird strikes (number of aircraft struck) were actually bird carcasses found near runways (cause of death unknown bur assumed to be bird strikes by definition). Of the 457 pilot-reported strikes (mean = 23 +/- 6 aircraft/yr, N = 20 years), 78 (17%) involved laughing gulls, Since a gull-shooting program was initiated on airport property in 1991, over 50,000 adult laughing gulls have been killed and the number of reported bird strikes involving laughing gulls has declined from 6.9 +/- 2.9 (1983-1990) to 2.6 +/- 1.3 (1991-1998) aircraft/yr; nongull reported bird strikes, however, have more than doubled (6.4 +/- 2.6, 1983-1990; 14.9 +/- 5.1, 1991-1998). We found no evidence to indicate that on-colony management would yield a reduction of bird strikes at Kennedy Airport. Dietary and mark-recapture studies suggest that 60%-90% of the laughing gulls collected on-airport were either failed breeders and/or nonbreeding birds. We argue that the Jamaica Bay laughing gull colonies, the only ones in New York State, should not be managed at least until all on-airport management alternatives have been properly implemented and demonstrated to be ineffective at reducing bird strikes, including habitat alterations and increasing the capability of the bird control unit to eliminate bird flocks on-airport using nonlethal bird dispersal techniques. Because the gull-shooting program may be resulting in a nonsustainable regional population of laughing gulls (>30% decline), we also recommend that attempts be made to initiate an experimental colony elsewhere on Long Island to determine if colony relocation is a feasible management option.

Brown, K.M., Tims, J.L., et al. (2001). "Changes in the nesting populations of colonial waterbirds in Jamaica Bay Wildlife Refuge, New York, 1974-1998." Northeastern Naturalist **8**(3): 275-292.

The Jamaica Bay Wildlife Refuge (JBWR) represents the largest protected area Cor over 300 species of migratory and resident birds on Long Island (LI), New York, and occupies a key position along the Atlantic flyway. We identified changes in nesting populations for 18 species of colonial waterbirds in JBWR and on LI, during 1974 - 1998, to provide a basis for future wildlife management decisions in JBWR and also at nearby John F. Kennedy International Airport. None of the populations was stable over the past 25 years in JBWR or on LI. Some populations in JBWR increased (Laughing Gull L. atricilla Linnaeus, Great Black-backed Gull L. marinus Linnaeus, Forster's Tern Sterna forsteri Nuttall) while others decreased (Herring Gull Larus argentatus Cones, Snowy Egret Egretta thula Molina), but only Cattle Egrets (Bubulcus ibis Linnaeus) have disappeared from the refuge. Common Tern (S. hirundo Linnaeus), Least Tern (S. antillarum Lesson), Roseate Tern (S. dougallii Montagu), Black Skimmer (Rynchops niger Linnaeus), Black-crowned Night Heron (Nycticorax nycticorax Linnaeus) and Great Egret (Ardea alba Linnaeus) populations all increased on LI over the sampling period although the Common Tern colonies in JBWR have been declining since 1986. The continued protection of the colony sites, particularly saltmarsh islands, in JBWR will be important to the conservation efforts of many colonial waterbird populations on Long Island. The JBWR colonies may serve as a source of emigrants to other Long Island colonies, and in some cases, act as a "sink" for birds immigrating from New Jersey and elsewhere.

Burger, J. (2001). "Landfills, nocturnal foraging, and risk to aircraft." Journal of Toxicology and Environmental Health-Part A **64**(3): 273-290.

Open landfills serve as an attractant to birds, with increasing risk of bird-plane collisions. Managers are searching for methods to allow landfilling while reducing potential bird problems near airports. Some municipalities are considering nighttime landfilling as an avian deterrent, particularly where waste management facilities are located near airports. The objective of this report was to evaluate whether nighttime

landfilling will result in increased risk to aircraft from birds at the Atlantic County Airport in coastal New Jersey. The risk to nearby aircraft from nighttime landfill is a function of (1) attractiveness of landfills, airports, or other habitats, (2) nocturnal behavior of gulfs and other birds, (3) elevations and flight paths of birds, (4) changes in population levels of gulls and other potentially hazardous birds, and (5) harassment techniques that can deter birds from the landfills, adjacent habitat, and airports. The latter, however, can serve to move birds to locations or attitudes that pose an even greater risk to aircraft. The number of strikes is generally increasing. While most air strikes occur during the day at the Atlantic County Airport, over 12% occur at night and nearly 20% occur at dawn when any garbage remaining from nighttime landfilling would be an attractant. The peak of strikes occurs in the early fall, when young birds are learning to forage. Risk data suggests that gulls and a wide variety of other birds are active at night, and if any garbage is available they will be attracted, increasing the risk to aircraft landing at night. Some actual night dumping has been carried out since October 3 1997 without apparently attracting gulls, suggesting that careful operations with appropriate institutional controls can make nighttime dumping feasible.

Choularton, R. (2001). "Complex learning: organizational learning from disasters." Safety Science **39**(1-2): 61-70.

This paper examines how organizations and society learn from disasters. While learning can and does take place, the depth of this learning is often superficial. The paper argues that lessons that are more fundamental are learnt with difficulty. In order to examine the aetiology of disasters and organizational learning from them, the paper presents a theoretical framework based on systems theory. Contemporary thought on organizational learning complements this theoretical framework. Two industries, the oil industry and aviation industry. are examined in order to examine different types of learning. Finally, the paper addresses obstacles to learning and the issue of risk migration. (C) 2001 Elsevier Science Ltd. All rights reserved.

Deng, J. and Frederick, P. (2001). "Nocturnal flight behavior of waterbirds in close proximity to a transmission powerline in the Florida Everglades." Waterbirds **24**(3): 419-424.

Many birds move at night, and although there is strong potential for collisions with stationary structures, the behavior of birds in response to such structures is poorly understood. We studied the nocturnal interactions of waterbirds with a 550v transmission powerline in the flat, open landscape of the Florida Everglades using a combination of surveillance radar to detect incoming birds, and night vision optical equipment to observe flight behavior. During 118 hours of observation we recorded a total of 285 flocks of ciconiiform birds crossing the powerline during spring 1997. We visually observed 663 birds in 187 flocks, and documented their response to the powerline. We found that the flight directions and the colony site locality strongly suggested regular nocturnal foraging behavior of some species, especially Black-crowned Night Herons (Nycticorax nycticorax) and Wood Storks (Mycteria americana). Birds flying at night were less likely to react to the powerline, suggesting that powerlines may pose more of a collision threat during darkness. However, we also found that waterbirds flew higher at night than during the day and thus came into a zone of potential contact with the powerline much less often than during the day.

Efroymson, R.A. and Suter, G.W. (2001). "Ecological risk assessment framework for low-altitude aircraft overflights: II. Estimating effects on wildlife." Risk Analysis **21**(2): 263-274.

An ecological risk assessment framework for aircraft overflights has been developed, with special emphasis on military applications. This article presents the analysis of effects and risk characterization phases; the problem formulation and exposure analysis phases are presented in a companion article. The framework addresses the effects of sound, visual stressors, and collision on the abundance and production of wildlife populations. Profiles of effects, including thresholds, are highlighted for two groups of endpoint species: ungulates (hoofed mammals) and pinnipeds (seals, sea

lions, walruses). Several factors complicate the analysis of effects for aircraft overflights. Studies of the effects of aircraft overflights previously have not been associated with a quantitative assessment framework; therefore no consistent relations between exposure and population-level response have been developed. Information on behavioral effects of overflights by military aircraft (or component stressors) on most wildlife species is sparse. Moreover, models that relate behavioral changes to abundance or reproduction, and those that relate behavioral or hearing effects thresholds from one population to another are generally not available. The aggregation of sound frequencies, durations, and the view of the aircraft into the single exposure metric of slant distance is not always the best predictor of effects, but effects associated with more specific exposure metrics (e.g., narrow sound spectra) may not be easily determined or added. The weight of evidence and uncertainty analyses of the risk characterization for overflights are also discussed in this article.

Efroymson, R.A., Suter, G.W., et al. (2001). "Ecological risk assessment framework for low-altitude aircraft overflights: I. Planning the analysis and estimating exposure." Risk Analysis **21**(2): 251-262.

An ecological risk assessment framework for low-altitude aircraft overflights was developed, with special emphasis on military applications. The problem formulation and exposure analysis phases are presented in this article; an analysis of effects and risk characterization is presented in a companion article. The intent of this article is threefold: (1) to illustrate the development of a generic framework for the ecological risk assessment of an activity, (2) to show how the U.S. Environmental Protection Agency's ecological risk assessment paradigm can be applied to an activity other than the release of a chemical, and (3) to provide guidance for the assessment of ecological risks from low-altitude aircraft overflights. The key stressor for low-altitude aircraft overflights is usually sound, although visual and physical (collision) stressors may also be Significant. Susceptible and regulated wildlife populations are the major assessment endpoint entities, although plant communities may be impacted by takeoffs and landings. The exposure analysis utilizes measurements of wildlife locations, measurements of sound levels at the wildlife locations, measurements of slant distances from aircraft to wildlife, medals that extrapolate sound from the source aircraft to the ground, and bird-strike probability models. Some of the challenges to conducting a risk assessment for aircraft overflights include prioritizing potential stressors and endpoints, choosing exposure metrics that relate to wildlife responses, obtaining good estimates of sound or distance, and estimating wildlife locations.

Eschenfelder, P. (2001). Wildlife Hazards to Aviation. Icao/Aci Airports Conference Miami, Florida, CSL, United Kingdom. pp 1-11.

Jordhøy, P. and Brøseth, H. (2001). Lavtflygningsproblematikk og dyreliv. 6 pp.

Kitowski, I. (2001). "Military impact on a colony of Grey Heron Ardea cinerea protected in the nature reserve." Ekologia-Bratislava **20**: 191-197.

This paper presents the influence of low - flying military aircrafts during the breeding season on Grey Heron Ardea cinerea colony in natural reserve. The observation results were compared with those conducted in an area of heron colony under going a slight anthropopressure. Aircrafts effect the whole breeding cycle of the heron, which in the light of studies, seems to be most dangerous in the incubation period in which aircrafts disturb incubating and even enable penetration of a heronary by birds of prey, and predatory mammals. In the testing period of nestlings remaining nests aircraft flights were observed to disturb their brooding and feeding and contribute to penetration of predatory animals. They also enhanced premature abandoning nests by fledglings. Over many years these processes resulted in reducing the number of breeding pair of Grey herons in the area located near a military airport.

Wright, S.E. (2001). An analysis of deer strikes with civil aircraft, USA, 1982–2000. Bird Strike Committee Proceedings, 2001 Bird Strike Committee-USA/Canada, Third Joint Annual Meeting, Calgary, AB, University of Nebraska - Lincoln. pp 31-41.

Zalakevicius, M. and Zalakeviciute, R. (2001). "Global climate change impact on birds: a review of research in Lithuania." Folia Zoologica **50**(1): 1-17.

The aim of this paper is to demonstrate the effect of climate change on different migratory processes: spring arrival, migratory take-off, spring and autumnal en mure migration The analysis of arrival dates of 128 bird species registered in Zuvintas and 48 species registered in Vilnius showed that, under the effect of global warming, spring arrival became markedly earlier both for short- and long-distance migrants. The difference between these arrival dates is more pronounced at the beginning of the arrival season, and it is less at the end of the season for short-distance migrants but more constant for long-distance migrants. We tried to explain the effect of climate change upon species specificity of bird migration, mechanisms controlling migratory movements. The article presents material confirming the impact of the global climate change on different breeding bird species and populations, changes of their ranges and population state. It was established that the impact of global warming upon birds of terrestrial and wetland complexes is more evident than upon waterfowl. We also attempted to explain changes in bird staging and wintering concentrations areas due to climate change. Attention is focussed on the aspects of the effect of climate change upon birds in environmental protection, aviation flight safety and other branches of economy.

Aas, C.K. (2001). Effekten av lavflyging på fugl - en oversikt. Forsvarsdepartementet, Oslo. 126-133 pp.

Aas, C.K. (2001). SAS' birdstrikes in Norway 1995-2000 and migrating birds in the air. **2**. 7-9 pp.

Aas, C.K. (2001). Rapport fra Fly/fugl-kontoret etter F-16 havari 17. mars 2001 ved Landegode utenfor Bodø. Fly/fugl-kontoret, Naturhistorisk museum, UiO. 3 pp.

Aas, C.K. (2001). Fly/fugl-prosjektet. Torsdagsseminar Naturhistorisk museum; 2001-04-05 - 2001-04-05, UiO.

Aas, C.K. (2001). Fugler i luftrommet nå? UiO. 9-10 pp.

Aas, C.K. (2001). Militær fly/fugl-statistikk 1985-2001 og "Bird Avoidance modeller" - et nyttig redskap for planlegging av flyruter. Årsmøte i flytryggingsorganisasjonen i Luftforsvaret; 2001-10-31 - 2001-11-02, UiO.

2000

Allan, J.R. (2000). A protocol for bird strike risk assessment at airports. 25th IBSC meeting, Amsterdam. 18 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPOS3.pdf.

In order for airports to manage the bird strike risk effectively, a risk assessment process needs to be carried out to identify the major hazards at the airport, the levels of risk that they produce, and the most cost effective means of reducing that risk. Despite the fact that bird controllers, managers and consultants make informal bird strike risk assessments throughout their working lives, there is no generally accepted methodology for assessing bird strike risk at airports. Other parts of the transport industry, indeed other parts of airport operations, are subject to detailed risk analysis, often with carefully calculated probabilities attached to each step of the process that leads to a particular adverse event occurring. The variability, and consequent unpredictability, of bird behaviour, combined with the lack of familiarity of the

ornithologists involved in bird strike prevention consultancy with the formal risk assessment process, has led to bird strike prevention lagging behind other areas of airport safety in the development of risk assessment systems. The aim of this paper is to produce a basic protocol for the analysis of bird strike risk on airports. The intention is that the protocol should be generally applicable to all airports, and can be modified to suit the particular circumstances at different airports around the world. I do not suggest that this is the definitive answer to the problem of bird strike risk assessment, but, hopefully, it will stimulate further thought and development of better systems that will contribute to flight safety in the future.

Anagnostopoulos, A. (2000). Monitoring avifauna for risk analysis at athens international airport s.a. 25th IBSC meeting, Amsterdam. 8 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPAV3.pdf.

Athens International Airport (A.I.A.) is under construction at the area of Mesogaia (East Attiki, Hellas) and is expected to start operating in March 1st, 2001. A Baseline Survey has already been conducted for the Bio-monitoring Programme of the airport. Special care has been taken during this survey not only to record data for conservation purposes, but also to record valuable data useful for the Bird Control Programme during operation. Therefore special interest has been paid for recording avifauna species and their activities in the vicinity of the airport. All data observed have been recorded in a specially designed database, the A.I.A. **BIO-M**onitoring **I**nformation **S**ystem (A.I.A. BIOMIS). Quantitative and ualitative data for birds like diversity in species and populations, daily or seasonal movements (migration included), staging, nesting, or feeding activities, nutrition habits as well as habitat type analysis for the avifauna biotopes and conservation attributes have been studied. Risk analysis for aviation safety purposes is being performed mainly using ArcView GIS. A.I.A. BIOMIS is directly connected with the GIS software and data input is directly converted in map information providing real time information for Bird Control. Some data from the above-mentioned Baseline Survey, visualized through ArcView GIS, as well as the online abilities of the designed system are being presented.

Barras, S.C. and Dolbeer, R.A. (2000). Reporting bias in bird strikes at John F Kennedy International Airport, New York, 1979-1998. 25th IBSC meeting, Amsterdam. pp 99-112.

Bird-aircraft strike databases have been used to identify, monitor, and manage bird strike problems in the USA nationally and at individual airports. Up to 75% of all bird strikes that occur in the USA may not be reported by pilots or airport control tower personnel. Recent studies have suggested that individual airports may improve their strike reporting rates by having personnel regularly search runways for the remains of birds struck by aircraft. We analyzed a 20-year dataset of runway searches from John F. Kennedy International Airport (JFKIA) in New York to determine the degree of bias in reports of strikes at that airport. At JFKIA from 1979 - 1998, strikes were under-reported by an average of 86.8% ($P < 0.01$), and only 33.9 % ($P < 0.01$) of bird species struck were reported. The addition of unreported strikes to the local strike database also changed the seasonal distribution of strike rates ($P < 0.01$). The local database was essential for evaluating the effectiveness of bird control and habitat management programs at the airport. We recommend the use of runway carcass searches to establish or augment local bird strike databases at airports. Information from these databases should be used to help guide the development and evaluate the effectiveness of wildlife hazard management programs for airports worldwide.

Bastos, L.C.m. (2000). Brazilian avian hazard control program - educational initiatives. 25th IBSC meeting, Amsterdam. pp 383-400.

Brazil has the second civilian aircraft fleet in the world and also the second largest catalogued bird species. Its vast territory and ecosystem variety have brought the Tourism Industry which has increased demand for new domestic routes and airports. Besides that, the air traffic growth in the big cities provokes a constant and high rate of

airport facilities enlargement and modernization. At the same time, due to human population growth and poor policies of garbage disposal in the past, nowadays we have open dumps near some big airports. That causes an ever-increasing population growth of a bird specie that survives eating carrion, the Black Vulture (Coragyps atratus, wt 2Kg, 4lb). Therefore, we have faced the rising risk of bird strikes in the vicinity of those airfields. The solution of the problem encompasses many institutions and requires, among other measures, the implementation of educational actions for the general public and local authorities. The paper presents the educacional actions that have been undertaken by the SIPAER, the Brazilian Aviation safety System, to keep the avian hazard under control in Brazil.

Baxter, A. (2000). Use of distress calls to deter birds from landfill sites near airports. 25th IBSC meeting, Amsterdam. pp 401-408.

It is well known that domestic waste landfill sites can attract large numbers of flocking birds. When situated in close proximity to airports, these sites can cause a major hazard to the aircraft. In some countries the development of landfills is prohibited within a set distance of airfields, whilst in others landfill operators are required to prevent birds from accumulating on the site by some means of bird control. Problems are also encountered if birds transport litter off the landfill site or there is the possibility of transmission of disease in the bird's droppings. In the UK, those wishing to operate landfills near airports are required to exclude all birds, usually by the use of a netting exclosure, which is both expensive and inconvenient to operate. The data presented here form part of a project designed to critically evaluate a variety of alternative techniques to manage birds on landfill sites. The ultimate objective is to identify successful techniques and to develop integrated strategies which have been tested and are known to provide a given level of control if applied properly. This paper reports the viability of using one of these techniques (Bioacoustic distress calls) for short and long term bird control on landfill sites. Six distress call recordings were used to deter birds at two domestic waste landfill sites during the summer of 1999. Results from both sites showed that the effectiveness of the technique reduced with time. Calls were played by trained personnel on weekdays during landfill operating hours. Deterrence was successful in stopping birds from loafing and feeding on the site during the initial period. Birds did, however, remain in the general area and fed on the waste each day before and after the use of calls. After four to six weeks habituation began to occur. Numbers of birds returned to pre-trial levels after 10 weeks at both sites. Data suggest that the use of distress calls on their own can provide short term, effective cover to control birds on landfill sites. The results of this trial also suggest that long term bird dispersal using this method at highly attractive sites such as landfills results in habituation.

Bentz, P.-G. (2000). Planerade åtgärder för att begränsa utsläppen av ureabemängt dagvatten från Upplands flygflottilj F 16, Uppsala – Bedömning av risken för fågelkollisioner. Fort.verket. 8 pp.

Bentz, P.-G., Strid, T., et al. (2000). Förekomst av fåglar vid de föreslagna flygplatslägena Almnäs och Hall – en studie av sträckande, rastande och stationära fåglar samt en bedömning av risken för fågelkollisioner. Sveriges Ornitologiska För. , Stockholm. 53 pp.

Bokulich, F. (2000). "Birdstrikes remain a concern for pilots." Aerospace Engineering **20**(3): 8-9.

Brown, J. and Hickling, G. (2000). "The problems of analysis of pilot-reported bird-strikes as an index for actual bird-strikes at airports." New Zealand Journal of Zoology **27**(1): 45-47.

Brown, S. (2000). Ensuring that landfill sites do not attract birds. 25th IBSC meeting, Amsterdam. pp 207-221.

In the United Kingdom all the major aerodromes are safeguarded. A safeguarding map is lodged with the Planning Authorities and any development within 13 km which is likely to attract birds is the subject of a safeguarding consultation and assessment process. If the assessment concludes that the development is likely to attract birds then measures should be adopted to either prevent such development or impose measures to prevent the site attracting birds. Landfill sites used for the disposal of household waste and food are particularly attractive to birds and it would be desirable not to have such sites within 13 km of an aerodrome. However, even this measure would not necessarily prevent flight line problems of birds transiting from feeding to roosting sites. Unfortunately, with the demise of incineration, landfill is the only major option for the disposal of household and food waste in the United Kingdom. Therefore, in order that aircraft safety would not be compromised, the UK CAA proposed a system of measures to allow for the introduction of landfill sites within the vicinity of aerodromes. It has been known for a long time that effective exclusion netting can deter birds from landfill sites. The major problem has been implementing and maintaining an effective management plan and fall back proposals to ensure that the site remains unattractive to birds throughout its lifetime. The CAA has promoted a management plan which ensures that the site will be operated with exclusion netting at all times. The controlling measures are: If the netting is damaged short term active bird control measures may be used to deter birds until repairs are carried out. However, if the site attracts birds then all exposed waste will be covered and tipping will cease immediately. Legally binding contracts between the operator and the planning authorities. Additional contracts between the operator and the CAA. All parties also have the right to enter and inspect the site. An independent assessor is funded by the landfill operator reporting to the aerodrome and the CAA as well as to the operator. Tipping will only be allowed to resume when the problems are resolved. Landfill operators have found an additional benefit in the use of netting. They can operate in wind speeds which in the past prevented tipping.

Carter, N.B. (2000). The use of border collies in avian and wildlife control programs. 25th IBSC meeting, Amsterdam. pp 251-260.

Airports attract large numbers of birds and deer primarily because they offer immense tracts of foraging and nesting habitats free from the threat of predation. Border Collies can serve as an effective means of wildlife control in these environments by introducing a predator into the ecosystem. Many wildlife dispersal methods seek to imitate predators or the effect of predators and become increasingly ineffective as the birds or deer habituate to the stimuli. Border Collies however, are true predators, representing an actual, not perceived, threat to wildlife thereby eliminating the problems of habituation. Since Border Collies are under the direct control of a handler, they disperse wildlife only in prescribed areas and at the direction of the handler. Border Collies can be stopped at any point in time, by either recalling the dog to the handler or lying the dog down. Border Collies, being top predators, elicit flight reactions from almost all forms of wildlife and birds. Border Collies have been bred to run a hundred miles a day and will work for hours on end. Not only can they deter the largest of birds, particularly Canada geese, but are also highly effective against wildlife like deer and rabbits. Border Collies are also bred not to harm wildlife, including birds, so they can be employed in dispersing protected or endangered species of birds or mammals. A single Border Collie and handler can easily maintain an area of approximately 2 square miles free of larger birds and wildlife. In February 1999, Southwest Florida International Airport became the first commercial airport in the world to employ Border Collies in an airfield wildlife control program. Since then, several other airports and airbases have instituted similar programs at their facilities – including Vancouver International Airport, Cold Lake Air Force Base, and Dover Air Force Base – and have met with similar success. At Southwest Florida International Airport, strike data for the months of January 1998 through September 1998 showed 13 confirmed birdstrikes. After

employment of a Border Collie the following year, strike data for the same months (January 1999 through September 1999) showed 0 birdstrikes.

Davidse, C.T., Harte, M., et al. (2000). Estimation of bird strike rate on a new island in the north sea. 25th IBSC meeting, Amsterdam. pp 375-381.

Since 1997 North Sea Directorate has been participating in the research on the consequences of the National Airport Development in the Netherlands. For the long term the Dutch government sees three options: Limited growth of the air traffic on Schiphol, comprehensive reorganisation of the runway system at Schiphol itself and transfer the airport to an North Sea Island. In the design of the two alternatives (North Sea island and redesign Schiphol) many uncertainties still exist. Additional research is crucial for finding realistic solutions. One of the main subjects for a North Sea island is flight safety and birds on or in the surroundings of the island. The North Sea Directorate is responsible for this subject. To estimate the bird strike rate on a new island in the North Sea information about bird biomass on and in the near vicinity (5,5 km) of a North Sea island is needed. To estimate the bird biomass on a new island in the North Sea is a difficult task. North Sea Directorate decided to organise an international expert workshop in which the participators gave their best professional judgement about the bird numbers on and in the vicinity of a new island in the North Sea. The working method used to estimate the bird numbers on a new island in the North Sea during the workshop will be described in the presentation during the meeting. At the end of 1999 the Dutch government decided to sustain the option limited growth of air traffic on Schiphol Airport. Although the uncertainties about the option to transfer the airport to an North Sea Island seem to high at this moment it is still a interesting option. Therefore the Dutch Government decided to start a long term research program on this option in which airport safety in relation to birds plays an important role.

de Hoon, A. and Buurma, L. (2000). Influence of land use on bird mobility, a case study of eindhoven airport, 1998-1999. 25th IBSC meeting, Amsterdam. 14 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPRS8.pdf.

Density of birds in the air principally determines bird strike risk. Traditionally the attention was focused on birds present in the runway environment. Not only these birds, but also birds that cross the runway on their flights to and from locations outside the airport cause collisions. This raises the question to what extent bird presence in the airport vicinity relates to bird flying activity above the runway. In the period between August 1998 and August 1999 systematic visual observations in the form of standardised horizon scans with binoculars were carried out once a week on 19 observation points at and around Eindhoven Airport in a circular area with a 5.5-km radius. Additional investigations were conducted in order to track the flight paths of those species that crossed the runway. The 19 observation points were situated in a grid in such a manner that a good representation of the land use at the airport and its vicinity was achieved. Land use was subdivided in 10 land use groups. The most abundant groups in the research area were meadows and agricultural fields (mainly maize), built up and forested areas. The year-round mass of birds in the air ranged between 40 and 280 kg / km3, with an average of 214 kg / km3. The lowest density was found above heath land and the highest above maize fields and agricultural meadows. A clear relation was found between short distance flights and land use. Long distance flights were mainly related to land use at the start and at the end. The track in between hardly related to land use. Outside migratory season the number of species crossing the runway was small. These species mainly frequented the close vicinity of the runway. Number of birds from further away, crossing the runway, was limited. One achievement has already been made: a recommendation resulted in the cancelling of the construction of a 35 ha recreation lake in a newly built city part 1.5 kilometre away from the runway, because of the high risk of collisions with commuting gulls.

Deacon, N. (2000). Aerodrome bird hazard control training in the uk. 25th IBSC meeting, Amsterdam. 12 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPPR4.pdf.

Formal training courses for persons involved in bird hazard control on civil and military aerodromes have been run since the late 1960s. Over the years, course content has evolved to reflect the ever-increasing knowledge and expertise available, and to improve presentation. The current 3-day course was developed for the Civil Aviation Authority. The syllabus follows a sequence to build up an understanding of bird control strategy, starting with the nature and severity of the bird hazard, and progressing through bird biology, habitat management on and off the airfield, appropriate (and inappropriate) dispersal techniques, operations, and record keeping and analysis. Increasingly, revision and updating courses are provided for experienced staff. Management courses are run annually for persons responsible for planning and providing resources for bird hazard control, and for ensuring that standards are maintained. For many years, about 50 people were trained each year. However, from the mid-1990s, the CAA's requirement for the introduction of safety management systems on civil airports has resulted in nearly all staff who undertake bird dispersal operations, and their supervisors and managers, attending courses. Over 100 persons are now trained annually on residential courses and at their own aerodromes.

Deacon, N. and Rochard, B. (2000). Fifty years of airfield grass management in the uk. 25th IBSC meeting, Amsterdam. 9 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPA1.pdf.

In 1949, the Royal Air Force was advised to permit airfield grass to grow taller by biologists tasked with devising means of controlling the increasing birdstrike hazard. The recommendation was not adopted but was repeated until a limited trial was commenced on RAF stations in 1967. A marked reduction in bird usage of long grass areas was obvious, and the RAF adopted long grass with a specially designed maintenance regime in 1974. The civil sector was at first slow to follow but, by the 1990s, a long grass policy had become a major element in bird hazard control policy on most airports. Many years' experience has accrued of the mechanisms by which longer grass deters birds, how it should be maintained, and problems that can arise to reduce its effectiveness. The RAF has adhered to a fixed maintenance regime that, if applied fully, virtually guarantees a bird deterrent sward. However, some civil airports, from ignorance of the requirements or in attempting to cut maintenance costs, have suffered a number of problems, including increased bird infestation and high rectification costs. Successful long grass is almost always linked with the aerodrome's bird control organization being closely involved in planning and monitoring the maintenance program. Experience now enables bird hazards to be predicted from inspection of the grass alone and, in some cases, problems with the grass to be diagnosed from analysis of birdstrikes. A fixed formula for grass height is not appropriate in all situations. The management regime that successfully deters medium-sized birds from feeding on soil invertebrates on western European aerodromes is not necessarily ideal in, for example, Africa where the birds are much larger and hunt prey that lives in the grass, rather than in the soil.

DeFusco, R.P. (2000). Current status of the usaf bird avoidance model (bam). 25th IBSC meeting, Amsterdam. pp 51-55.

The Unites States Air Force (USAF) has been developing versions of a Bird Avoidance Model (BAM) through the efforts of the USAF Bird Aircraft Strike Hazard (BASH) Team since the early 1980's. It was recognized early in the developmental phases of the first models that avoiding birds on low-level routes and ranges was the only solution to the significant problem of bird strikes to these military operations nationwide. The early versions of BAM were limited in coverage, biological data, and resolution. With the advent of sophisticated Geographic Information System (GIS) technology and the enormous advances in computational capability, the modern versions of the USAF

BAM have become increasingly robust and user friendly. The current version of BAM, released to the USAF in 1999, incorporates data layers from a very large number of sources to display risk surfaces at 1Km resolution for the entire continental United States for each two-week period of the year and four daily time periods. All available data on over 60 bird species considered most hazardous to flight operations, as well as hundreds of environmental variables, infrastructure, and aeronautical charts are incorporated into the model. The user interface is an extremely simple, menu-driven package that allows pilots and schedulers to assess hazards on chosen routes with minimal effort and in mere minutes. More sophisticated analyses, down to the level of the original data layers, are possible for other user groups. These applications are available on CD for the personal computer and over the internet, with both options fully interactively capable. Preliminary reports from the user community have indicated savings of several million dollars in USAF aircraft assets in just the first year of operation. Demand from the military community outside the continental US as well as the civil aviation community indicates a necessity for expansion of the BAM to other areas of the world and for continued refinement of data layers. It is apparent that international cooperation in the development of models will be necessary to ensure more global coverage and perhaps most importantly, compatibility of systems between cooperating nations. The USAF has demonstrated its willingness to share its technology and experience to ensure such interoperability between cooperating agencies and nations.

Dekker, A. (2000). Poor long grass; low bird density ground cover for the runway environment. 25th IBSC meeting, Amsterdam. pp 227-236.

Among bird strike specialists it is generally agreed that making the runway environment unattractive for birds is a better approach than relying on corrective actions that expel birds. The vegetation that best approximates the creation of such an unattractive runway environment is of course dependent on local circumstances like climate and soil condition. Nevertheless, since its successful introduction in the UK in the seventies, the long grass policy (LGP) has been considered the standard in grassland management for runway environments, and is widely ecommended by National Aviation Authorities. Meanwhile the LGP in its original, pure form is getting rare. Conditions that differed from the standard UK situation often demanded modifications that sometimes resulted in quite deviant management strategies but aimed for the same results. The RNLAF developed an even more radical, and equally successful terrain management system that is not primarily based on the height of the vegetation but on the reduction of biomass production and is not limited to grass as a groundcover. Since there is no common agreement on how to implement LPG and new strategies in terrain management are being developed, in this paper a plea is made to replace the very general, but suggestive phrase “Long Grass Policy” by one that better fits reality. Wordings like "Airfield Vegetation" or "Low Bird Density Ground Cover" express the aim instead of the mean by which to realise this aim and therefore are more suitable alternatives. Irrespective the phrase, it should be defined as any vegetation for the runway environment that is unattractive for birds, drought, fire and erosion resistant, having sufficient carrying capacity and preferably requiring low maintenance. Long grass, poor grass (and all their intermediates) and strategies that still have to be developed are then simply different approaches to reach such a vegetation. National Aviation Authorities and international agencies like ICAO could use such an alternative phrase in their recommendations instead of the dogmatic LGP and leave it to the specific circumstances in any country to choose for a strategy by which to realise this.

Dolbeer, R.A., Wright, S.E., et al. (2000). "Ranking the hazard level of wildlife species to aviation." Wildlife Society Bulletin **28**(2): 372-378.

Aircraft collisions with birds and other wildlife are a serious economic and safety problem. However, all wildlife species are not equally hazardous to aviation. in

implementing programs to reduce wildlife hazards, airport operators need guidance on the relative risk posed by various species so that management actions can be prioritized by the most hazardous species. Our objective was to rank various wildlife species as to their relative hazard to aircraft. We selected 21 species or species groups (e.g., gulls [Larus spp.]) for which there were greater than or equal to 17 strike reports in the Federal Aviation Administration's (FAA) Wildlife Strike Database for civil aircraft in the United States, 1991-1998. We ranked the 21 groups for relative hazard to aircraft based on the percentage of strikes causing damage, major damage, and an efiect-on-flight. Deer (Cervidae, primarily Odocoileus virginianus), Vultures (Carhartidae), and geese (Anserini, primarily Branta canadensis) were ranked 1, 2, and 3, respectively, in the composite ranking for most hazardous species groups. Based on the relative hazard score, deer were clearly the most hazardous group, with the second (vultures) and third (geese) groups being only 52 to 63% as hazardous as deer. The 3 lowest-ranked groups (19-21; blackbirds-startings [Icerinae-Sturnus vulgaris], sparrows [Emberizidae excluding Icterinae, Passeridae], and swallows [Hirundinidae]) were only 2 to 9% as hazardous as deer. Relative hazard score was strongly related (P<0.07) to mean body mass for the 21 species groups. Vultures and ospreys (Pandion haliaetus) showed a greater-than-expected hazard score relative to their mean body masses, whereas coyotes (Canis latrans) showed a less-than-expected rating. We believe this initial hazard rating system provides a useful guide to assist airport operators in prioritizing management actions to reduce strike hazards. These ratings should be used in conjunction with site-specific wildlife surveys to determine relative abundance and use patterns of wildlife species for the airports in question. A critical action needed to improve the rating system is to increase the identification of species struck by aircraft, which presently stands at <50%.

Ebbinge, B.S. and Buurma, L.S. (2000). Mid winter movements of geese in the netherlands as a risk to aviation safety. 25th IBSC meeting, Amsterdam. 9 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WP0S5.pdf.

Recent tracking radar observations by the Royal Netherlands Air Force along the West Coast of The Netherlands have shown that weather induced mass movements of geese may pose a serious threat to aviation safety. Mid winter movements of geese are fairly well known to field ornithologists in and around the Netherlands, but so far nobody realised at what scale (nation wide) and altitude (up to 1 km high) these flights occur. Coupled with the tenfold increase in goose numbers during the last decades this certainly is a reason for concern. In this paper we summarise the knowledge on numbers and movements of wintering geese into and within the Netherlands. We explore the possibilities to understand the causes and thus predict the mobility of the geese. Thanks to (colour)ringing and neck-banding programs a lot of information is available about flying strategies based on decisions the birds take. Such decisions are both individual choices related to food availability, competition and hunting as well as collective choices based on sudden changes in snow and frost conditions. The paper claims that it is feasible to model and reliably predict mass mid winter movements of geese by integrated research in order to improve flying safety.

Eschenfelder, P. (2000). Jet engine certification standards. 2000 Bird Strike Committee-USA/Canada, 2nd Annual Meeting, Minneapolis, MN, University of Nebraska - Lincoln. from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1000&context=birdstrike2000 http://www.intbirdstrike.org/Amsterdam_Papers/IBSC25%20WPIE1.pdf.

The ability of modern jet engines to ingest birds and continue to operate is largely misunderstood or not contemplated at all in the aviation industry. Currently there is not one jet engine operating in the world that is certified to ingest one large bird (goose, swan, stork, pelican, vulture, etc) and continue to operate. Ingestion of smaller birds is on a sliding scale of small proportion. The effort to harmonize bird ingestion rules between the FAA and JAA has failed. Controversy erupted in recent certification meetings regarding the database being used to certify engines. Additionally, should

only rotating engine parts meet certain standards, or all engine parts exposed to impact meet standards? None of the work done by or papers presented to IBSC regarding bird ingestion are used in developing certification standards. Flightcrew members do not know, nor are they required to know, how fragile their engines are. Airport bird control personnel cannot appreciate the importance of their work unless they understand the small number of birds the engines can ingest and continue to operate. The industry needs education on the importance of strike avoidance due to the thin safety margin provided by engine ingestion standards.

Eschenfelder, P. (2000). Phoenix rio salado/tempe town lake. 25th IBSC meeting, Amsterdam. pp 333-337.

Phoenix, Arizona, is located in the southwestern United States in the northern Sonoran Desert. Seventy percent (70%) of avian feed in this area is associated with streams or rivers. A dry riverbed, the Salt River, runs through the valley, Valley of the Sun, in which Phoenix is located. The Salt River runs immediately adjacent to the Phoenix Sky Harbor Airport. Sky Harbor Airport is a busy commercial airport and hub for America West Airlines and Southwest Airlines. The cities of Phoenix and Tempe have engaged in a project, using mostly federal money, to create a lake and wetlands in this riverbed. A lake, Tempe Town Lake, was filled this summer, 1999. Two miles long it is located less than 2 miles from the end of the runways at Sky Harbor; aircraft pass over the lake at 650 feet AGL on approach to the airport. Additionally, wetlands construction in the Salt River bed would place wetlands within 300 feet of the new runway under construction at Sky Harbor Airport. The FAA has objected to this work. Although a mitigation plan has been proposed for Sky Harbor Airport, it has not yet been implemented. No mitigation is proposed by the City of Tempe for Tempe Town Lake, other than erecting signs, “Do not feed the birds”. The Phoenix area is wintering grounds to numerous species of duck, Canada geese and other birds. For the first time in recorded history seagulls have been observed in the Phoenix area. Informal communication received from one of the major carriers at Sky Harbor indicates that bird strikes have risen dramatically since Tempe Town Lake was filled.

Froneman, A. (2000). Towards the management of bird hazards on south african airports. 25th IBSC meeting, Amsterdam. pp 139-155.

Birds and aircraft have collided with serious consequences to both humans and animals almost from the beginning of aviation. The aviation industry throughout the world increasingly recognises that bird strikes have become a serious safety risk. Birds are attracted to airport grounds to feed or roost while they often also fly over the area from feeding or roosting sites. Air traffic in South Africa is increasing and it is essential to ensure that international air safety standards are maintained at South African airports. Little has been done in the past to co-ordinate the management of bird related safety risks at South African airports. In order to improve the situation, the Airports Company South Africa (ACSA) has entered into a unique strategic partnership with the Endangered Wildlife Trust (EWT), a nongovernmental organisation committed to the conservation of southern Africa’s biodiversity, to establish and operate an integrated national bird control program. The aim of the project is to minimise bird strikes and other interactions between wildlife and airport facilities at ACSA airports by applying environmentally-sensitive management techniques. Airport staff is involved in the monitoring of bird strikes and bird populations on or near airports in order to gain a better understanding of population dynamics. Emphasis is placed on proactive bird control measures involving ecological solutions such as habitat management. However, during the establishment phase of habitat alterations, more re-active bird control measures are used to scare birds away from high-risk areas on the airfield. During its first year of operation the project has made significant progress. One hundred and forty eight bird strikes were reported from 13 airports across the country. The data recorded have helped to narrow the problem down to specific species and to prioritise actions through analysing bird strike rates for the different airports. In addition to refining the

reporting system the project currently focuses on establishing appropriate environmentally sensitive bird control measures. Wildlife control committees have been established at ACSA airports and they form the basis of an improved bird strike reporting and bird control monitoring programme. The formation of a South African Airport Wildlife Working Group under the auspices of the partnership is envisaged to share information from a national and international level with all stakeholders.

Gordon, S.E. and Lyman, N. (2000). Flight control™ as a grazing repellent for canada geese at portland international airport. 25th IBSC meeting, Amsterdam. pp 265-281.

The anthraquinone formula marketed as Flight Control™ (FC) is advertised as a goose repellant with both an ultraviolet and post-ingestional repellency when applied to turf. Two studies have been conducted with FC, one at the National Wildlife Research Center in the U.S., and one at the Mumbay, India airport, but neither included the information necessary to determine if it is practical to use at Portland International Airport (PDX). The Port of Portland wanted to determine: 1) If FC is effective in deterring geese from grass. 2) Whether geese will avoid the entire project area or just the treated plots. 3) How long FC will last in our rainy climate. 4) If geese will avoid the test plots after the product has reduced in concentration. 5) Whether the product effects non-target species. 6) Whether FC will have any negative effect on treated grass. 7) If FC is a cost-effective way to reduce birdstrikes at PDX. A field with heavy goose activity was divided into five transects, which were monitored morning and afternoon for 13 weeks. Two test plots, which had goose activity 65 percent of monitoring events, were selected for application. The product was then sprayed using a mixture of one-half gallon FC, five gallons of water, and eight ounces of an agricultural sticker. This was applied at a rate of one-half gallon per acre. Monitoring continued twice a day with the following results. Geese were not observed in the treated areas for the first 10 days. After 10 days, geese were present in the treated plots five of the next 11 days, or 21 percent of monitoring events. Total post-treatment monitoring showed that goose activity in treated areas rose gradually each week, but continued to be lower than in control areas. Our test results showed that Flight Control could be used as a goose deterrent on turf with marked avoidance of treated areas. For airports with heavy rainfall, the effectiveness of the product may diminish after 10 days. We also found that geese did not avoid the entire project site, only the treated plots. In addition, goose activity in treated areas, after the product had decreased in concentration, was only slightly lower than in untreated areas. There were no observed effects to non-target birds, and no adverse effects on treated grass. In conclusion, Flight Control can be used to deter geese from specific areas for as long as the concentration of the material lasts. It did not, however, cause geese to learn to avoid the treated areas in our test. Research into making the chemical longer lasting would increase its cost-effectiveness.

Hagemeijer, W., Buurma, L., et al. (2000). Predicting strike hazards from bird data: towards a dutch bam as a model for a european bam? 25th IBSC meeting, Amsterdam. pp 139-152.

Jackson, V.S. and Allan, J.R. (2000). Nature reserves and aerodromes - resolving conflicts. 25th IBSC meeting, Amsterdam. pp 339-344.

In the U.K, local and national authority biodiversity action plans encourage, amongst other things, the creation of wetland regions, reedbeds and areas of open water in order to establish suitable habitats for a wide range of species of conservation concern. Nature reserves and restoration schemes for sand and gravel quarries which aim to fulfil the objectives of these action plans may cause an increase in birdstrike risk if located close to an aerodrome. It is possible for the UK Ministry of Defence or any civil airport to object outright to any planning proposals within 13 ilometres of the airfield for wildlife enhancement or other features such as landfills which may increase the birdstrike hazard. However, conflicts between conservation and the birdstrike hazard can often be resolved at an early stage by design modifications and development of management plans that control hazardous species whilst protecting those of

conservation importance. This paper discusses the areas of conflict and provides examples of how to manage areas for conservation without compromising flight safety.

Kelly, T.A., Merritt, R., et al. (2000). The avian hazard advisory system (ahas): operational use of weather radar for reducing bird strike risk in North America. 25th IBSC meeting, Amsterdam. 7 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPRS5.pdf.

The Avian Hazard Advisory System (AHAS) was developed to use NEXRAD weather radar data and National Weather Service (NWS) weather data to forecast and monitor bird activity. The monitoring of birds in near real time uses algorithms developed by Geo-Marine, Inc to isolate biological targets from weather. Removing the weather returns permits subsequent processing to retrieve information on bird strike risk to be fully automated. Development of additional algorithms to isolate specific classes of biological targets is underway. These new radar datasets are in Geographic Information System (GIS) format and are being used for improving bird strike risk models and for conservation and ecological applications.

Knauer, R.F., Ballinger, K.E., et al. (2000). Practical application techniques for flight control®, a new bird repellent for the aviation industry. 25th IBSC meeting, Amsterdam. pp 283-296.

Flight Control® is a product that has shown promise as a non-toxic, chemical bird repellent. Work conducted to date continues to confirm the effectiveness of Flight Control® to function as an effective bird repellent for turf and structural applications. This paper describes the product, how it works, application techniques and results of recent turf and structural field trials at three airports in the United States.

Krupka, R. (2000). Collisions of the czech air forces' aircraft with birds during 1993-1999. 25th IBSC meeting, Amsterdam. pp 159-168.

Our contribution deals with the situation within the Czech Air Force during 1993-1999, it means from the rise of the independent Czech Armed Forces after division of the former Czechoslovakia. Author compares an occurrence of collisions with regard to bird species, daytime and season, velocity and altitude of aircraft, flight phase and the range of damage. According to the short time of research and to the fact that not all collected data were full, this analyse hasn't a universal applicability. However, this study presents some data that are applicable to the last bit and can be useful for pre-flight planning of missions and training flights.

Küsters, E. (2000). Man-made wetlands and flight safety. 25th IBSC meeting, Amsterdam. pp 347-358.

Because of the destruction of natural wetlands that took place on a very large scale during this century, the importance of man-made wetlands is growing rapidly. Therefore the creation of new wetlands is appreciated by nature conservationists. Yet if those wetlands are created in the surroundings of airfields, they cause problems to flight safety because of their attractivity to birds. While bird numbers and their habits on natural wetlands do not change too much over the years and therefore the effects on flight safety can be calculated, man-made lakes in the beginning are in an oligotrophic state and therefore of little attractivity only. But because of the nutrient input with the rain and the groundwater, eutrophication takes place rapidly. As a consequence, bird numbers rise year by year, increasing the risk of birdstrikes. The development of a gravel mining area that meanwhile forms wetlands of more than three squarekilometers close to an airfield in southern Germany has been investigated for almost 20 years now, showing alarming results with respect to the increase in bird numbers. But there are ways of making those lakes less attractive.

Lensink, R., Poot, M.J.M., et al. (2000). Mathematical model, Preflight planning, Warning system, Avoidance, Low-level. 25th IBSC meeting, Amsterdam. pp 489-502.

Since the risk of bird strikes is the highest during take off and landing of aircrafts (i.e. the lower air layers), knowledge of bird densities, species composition and behavioural

aspects in the lower air layers on and in the vicinity of an airport is needed to estimate that risk. In combination with actual bird strike data, bird strike risk can be estimated and guidelines for measures can be provided, e.g. bird control or flight restrictions. In commission of the Royal Netherlands Air Force and the City of Eindhoven we registered the number of birds aloft on Eindhoven Airport between August 1998 and July 1999 using a visual technique. Observations were conducted during four days each month and lasted the full daylight period. Observations were carried out with binoculars in a fixed position, in a fixed volume covering a part of the runway and bordering fields (fixed volume count). The most numerous species were Swift, Starling, Carrion Crow, Wood Pigeon, Skylark, Jackdaw and Stock Dove. The daily average numbers of birds aloft ranged between 50-250 birds/km^3. Due to the variation within a day, peak numbers were 5-20 times higher. In general the intensity of movements was higher in the early morning and the late afternoon, mainly due to roosting and feeding flights. In summer Swifts dominated the scene. Most birds observed seemed to be resident. In autumn and spring a minority of the total number of flight movements concerned migratory movements. The results will be discussed in relation to species composition, behavioural aspects and the frequency of bird hits.

Leshem, Y. and Shamoun-Baranes, J. (2000). Flight safety, internet and education - a leading tool for global awareness
25th IBSC meeting, Amsterdam. pp 13-21.

The frequency of civil and military flight is expected to increase dramatically during the new millennium. In addition, air forces cooperate and perform training and missions together in different countries and even continents. Consequently, the transfer of knowledge regarding birds and flight safety must be developed between countries to broaden education and public awareness. Without a doubt, the Internet will become the most significant vehicle to achieve this goal. This article will discuss how during the last two decades, an education and public awareness campaign that accompanied all the activities within and outside the IAF played a significant role in our project, which significantly decreased the air collisions in the Israeli Air Force. Regional activity in the Middle East is being developed between the Turkish, Hellenic, Royal Jordanian, Israel and United States Air Forces, some of which were enemies until recently, to establish regionally coordinated bird and flight safety activities. This program can be a model for regional cooperation around the globe. The “Migrating Birds Know No Boundaries” website (**www.birds.org.il**) was developed and has proved to be a very successful tool for regional research and education. The site is being expanded to include the issue of flight safety. We propose that the IBSC adopts the Internet as the main tool for global exchange of information, education and awareness.

Manktelow, S. (2000). The effect of local weather conditions on bird-aircraft collisions at british airports. 25th IBSC meeting, Amsterdam. pp 317-329.

The majority of birdstrikes occur at or around airfields. Study into birdstrike prevention has focused on the control of bird numbers on airfields, and the success of control measures at this level has been mixed and difficult to assess. In order to properly assess the effectiveness of control measures it is necessary to have an understanding of the factors that contribute to birdstrikes and their relative importance. This study investigates the role of weather at and around the time of birdstrikes using birdstrike and meteorological data from nine British airports. Several variables were tested including wind speed and direction, rainfall, temperature, visibility and cloud cover. The results show that higher rainfall and temperature are associated with an increased chance of a birdstrike occurring and when studied in conjunction with bird behaviour would suggest that these conditions increase the number of birds on airfields. This supports research and observations from other workers in the field. Visibility was better at the time of birdstrikes indicating that poor visibility is not a major factor. Wind direction was a factor only for two of the airports studied. The other weather variables tested had no relationship to birdstrike frequency.

Matijaca, A.B.L. (2000). Air traffic safety concerning threat of collision of birds and aircraft, with regard to the situation in the republic of Croatia
25th IBSC meeting, Amsterdam. 10 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPPR3.pdf.

The collision of birds and aircraft is known as “bird strike” and it represents serious danger for air traffic. Therefore, all parties to air traffic must apply legal regulations, prescribed measures, recommendations and stated standards regarding control of appearance of birds in airports’ areas. On international level, air traffic bird strike regulations and recommendations may be found in ICAO Annexes. In the Republic of Croatia, aircraft safety protection rules are prescribed in Air Traffic Law Rules and in Airport Safety Statutes. As far as airport operators are concerned, their legal obligation is to avoid causes of damages. They have duty of care to ensure a safe operational environment for all airport users, what includes responsibility for hazards caused by flocks of uncontrolled birds unless all necessary measures for effective reduction of bird population or for scaring birds away from airport property are taken. Damage liability is very often stated in case of bird strike. It is the special legal and obligatory relation between parties involved in any particular case. Concerning protection of airport from possible damage situations, especially with regard to lessening or exoneration of liability, it is desirable to provide a safe environment in which an aircraft may move. It is indispensable for every airport to adopt determined procedures. The adoption of these procedures means that they must be applied at any time, because, in case of eventual legal procedure, it is necessary to prove their application before or in the moment of that actual bird strike. In the Republic of Croatia, all available actions and methods are undertaken regarding control of appearance of birds on and in the vicinity of airports. Bird control team – special national committee, must supervise these activities. In other words, it is indispensable to create special plans and programs and to start their realisation in order to achieve a complete persons and property protection. These programs may not function as isolated self-reliant acts. They must be in accordance with national air traffic safety policy, and they must be compatible with use of surrounding land programs for which the state and local self governing and governing bodies are in charge. Finally, the desired aim of these programs is to turn airports into safe areas on one side and into least suitable and least attractive places for birds on the other side. Thereby, the danger of eventual bird strike would be either eliminated, or at least significantly reduced.

Nikolaidis, E.D. (2000). Bird strikes in Greece 1997-1998 civil aviation. 25th IBSC meeting, Amsterdam. pp 1-11.

This paper gives a brief summary of the bird strikes in Greece (Civil Aviation). It presents the results of bird strikes statistical analysis for the years 1997 and 1998. The last analysis conducted for Civil Aviation in Greece covered the years 1980-1992. The paper contains the strike seasons, risk per airport, strike altitudes, phase of flight, light conditions, reporting operators, top ten manufacturers model, influence on flight. Finally this paper proposes actions for the near and distant future.

Oost, L., Verboom, J., et al. (2000). Larch-airport: a gis-based risk assessment model. 25th IBSC meeting, Amsterdam. 6 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPRS9.pdf.

There is a great need for a tool that makes risk assessment of bird strikes in the vicinity of airports possible. Such a tool must be based upon the landscape structure and knowledge of bird habitat preference and behaviour. The LARCH model (Landscape ecological Analysis and Rules for the Configuration of Habitat) has been developed to assess the biodiversity potential of fragmented landscapes by analysing the landscape from the perspective of a selection of indicator species. The model can be adapted to map movements of birds through the landscape, following this same principle: looking at the landscape from the perspective of a selection of species that are relevant for bird

strike problems. Detailed vegetation-cover maps become available from remote sensing. From these GIS maps, breeding, foraging and resting habitat can be mapped with LARCH for a selection of species. From the area and configuration, population size estimates can be derived. The algorithm can be calibrated using census data. In The Netherlands, such data are available. The model predictions can be tested using bird strike information in combination of flight frequency etc. Overlaying maps of bird core habitat with maps of airports and take-off and landing routes, it is possible to point out potential problem areas. LARCH-subroutines can determine where the take-off and landing routes lie in the vicinity of airports. To underline the necessity of risk assessment the case study of Eindhoven Airport will be presented. The dangers were researched the construction of an artificial lake could pose in the vicinity of Eindhoven Airport in The Netherlands. The research was especially focused on the danger of waterfowl near an airport. As a result of the research the planned artificial lake near Eindhoven Airport will not be constructed. This research was carried out without the use of models or GIS, but the procedure can be automatised as a module of the LARCH model. Then it can be applied to other airports with little extra effort and a minimum of field work. During the meeting of the IBSC the first results will be presented of adapting the LARCH model to situations near airports. It will take some time to transform the LARCH model in order to predict the movement patterns of birds in the landscape realisticly. Using the model, it will be possible to collect data of wildlife near airports in a more fundamental way. Furthermore it will be easier to compare the risks of different airports.

Ostrom, J.E. (2000). Chemical immobilization - one more wildlife management tool. 25th IBSC meeting, Amsterdam. 9 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPA11.pdf.

Airport Managers' options for lethally removing deer from within the Air Operations Area of an airport are severely limited due to public relations and safety concerns. The Minneapolis-St. Paul International Airport has successfully implemented a depredation program to lethally remove whitetailed deer using chemical immobilization with succinylcholine chloride followed by immediate euthanasia with a stunning device. This chemical immobilization program provides a safe, cost effective and lethal method for humanely removing deer from within the tight constraints of a large hub airport.

Patterson, B. (2000). Wildlife control at Vancouver international airport: introducing border collies. 25th IBSC meeting, Amsterdam. 7 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPA6.pdf.

Situated on an island located along a major Pacific Flyway, Vancouver International Airport (YVR) has developed a comprehensive wildlife management program in order to maintain a safe aircraft operating environment. YVR attracts a diverse range of birds, including ducks; gulls; herons; geese (Canada and Snow); sparrows; swallows; crows; starlings; owls; hawks; and eagles. The airport's Wildlife Management Program consists of a Habitat Management Program and a Wildlife Control Program which are both based on a database of knowledge the airport continues to build regarding the behaviour patterns of wildlife common to the airport. Operating 24-hours-per-day 365 days of the year, YVR's Wildlife Control Program annually moves close to one million birds from the aircraft operating area. Innovation and adaptability have been critical to the success of YVR's program. On foot, in trucks, or in their Zodiacs YVR's Wildlife Control Officers employ many tools in their trade, including: gas cannons; pyrotechnics (including Ruggieri pistols); live ammunition; night vision goggles; high power lights; sirens; nets and wires; traps; and wailers. In November 1999, YVR introduced two Border Collies to its wildlife control program. The introduction of these dogs was a carefully researched and orchestrated event, as the airport recognized that their success would be based on many key factors. Before any commitments were made to introduce the dogs, the airport conducted climate surveys of its staff, initiated site visits, consulted with local veterinarians and animal care specialists and held numerous

discussions with the dog trainer/supplier. The program the airport initiated based on this research included the development of a comprehensive dog handler training and certification program, the establishment of policies and procedures for the care and handling of the dogs, and a detailed communications plan. The airport has seen a drop in the use of pyrotechnics and as a consequence earned recognition from the community for reducing noise as a result. The goal of employing Border Collies in YVR's wildlife control program is to reduce the risk of bird strikes at the airport and observations to date indicate this is in fact happening. In the first quarter of 2000 bird counts on the airfield were down 40% from the same quarter in 1999 with the only change in control techniques being the use of the Border Collies Fleet and Sky. With only three full months of service experience with Fleet and Sky it is too early to make a complete objective assessment of the dogs' effectiveness, however preliminary results like these are very encouraging.

Pessoa, S., Sequeira, C., et al. (2000). Bird strike hazards as a factor in the site selection process and planning for the future new lisbon airport. 25th IBSC meeting, Amsterdam. pp 357-363.

The New Lisbon Airport site selection process was started in 1969. By 1998, 12 of the 14 original candidate sites had been rejected. The two remaining locations were Ota, NNE of Lisbon and N of the Tagus River and Rio Frio, SE of Lisbon and close to the estuaries of the Tagus and Sado Rivers (both natural reserves, one with Special Protection Zone status). NAER (Novo Aeroporto S.A., created in 1998 to conduct the new airport development process) set up a multi-criteria analysis of the 2 sites, to assess the technical, aeronautical, socio-economic, financial and environmental factors. Bird studies (carried out within the framework of the environmental studies and including fieldwork during May-October 1998) concluded that Rio Frio is close to bird migration routes and thus affected by a high level of migratory movements. An airport in Rio Frio would in all likelihood, be exposed to bird strike hazards against which no mitigation measures are, as yet, available. In another study, a mathematical model was developed to compare expected risks at the two locations. Despite its shortcomings, the model concluded that, at Rio Frio the risk would be moderate to high, whereas in Ota it would be low to moderate. The study also concluded that Rio Frio would always be affected by a high level of water bird traffic moving between the two nearby estuaries. NAER hired the third author, via ICAO, to review these reports and he concluded that, despite a lack of adequate data, the Ota location was preferable since a larger number of migratory and local flights of high - risk bird species can be expected in Rio Frio. When the environmental studies concluded that the Rio Frio option was "not sustainable" from an environmental point of view, the Portuguese Government decided to exclude it and, thus, approved the Ota location. It was subsequently also decided to carry out in-depth bird studies and NAER hired the third author, again via ICAO, to advise on the terms of reference for those studies.

Poot, M.J.M., Lensink, R., et al. (2000). Spatial patterns of bird movements on and around an airport, a case study on eindhoven airport - extra dimensions from the panorama-scan. 25th IBSC meeting, Amsterdam. 11 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPRS7.pdf.

In commission of the Royal Netherlands Air Force and the City of Eindhoven we registered the number of birds aloft on Eindhoven Airport between August 1998 and July 1999 by visual techniques using binoculars. Observations were conducted during four days each month and lasted the full daylight period. Two methods were used: observations in a fixed volume covering a part of the runway and bordering fields (fixed volume count) and observations in a radarlike way covering a much larger volume consisting of the total airport and surrounding landscape (horizon-scan). The focus of this paper is on the second technique. Since the risk of bird strike is highest during take off and landing (i.e. the lower air layers), it is important to know the density and species composition of birds that are flying near and over runways. Questions from the

perspective of bird strike risk and bird control are whether the numbers and species composition of birds flying over the runways show a relation with the surrounding landscape of the airport and whether bird flight routes occur in relation to landscape structures. Eindhoven Airport has an open landscape and is located in a forested area in the southeast of The Netherlands. As the panorama-scan covers a much wider area than the single runway of Eindhoven Airport (as in the case of the fixed volume scan) this visual technique gives the opportunity to compare and relate the numbers of birds aloft above as well as around the airport. In this paper we show that with this technique, besides reliable information on densities of birds aloft, at the same time detailed spatial and flight direction information is gathered which makes it possible to interpret the estimates of densities of birds aloft in an ecological context.

Richardson, W.J. and West, T. (2000). Serious birdstrike accidents to military aircraft: updated list and summary. 25th IBSC meeting, Amsterdam. pp 67-97.

A total of 286 serious bird-related accidents to military aircraft from 32 countries (1950-99 period) are listed here or in two earlier papers. Serious accidents are those where an aircraft was destroyed or people were killed. This paper lists 59 “new” birdstrike accidents from the 32 countries in 1950- 99, and provides more details for 110 accidents listed previously. The primary countries considered include most of those in Europe (east to Russia), Canada, U.S.A., Israel, Australia, and New Zealand. For most countries, accident data were provided or corroborated by military Flight Safety Offices, local birdstrike specialists, or aviation historians. Unofficial sources were also used extensively. Records are still incomplete to varying degrees, depending on country. Of these 286 serious bird-related accidents, at least 63 were fatal, with at least 141 deaths (137 on the aircraft; 4 on the ground). The 1990s were the most costly decade, with at least 68 bird-related fatalities. Countries with maximum known numbers of bird-related accidents in 1950-99 are Germany (60 aircraft from at least 8 countries), U.K. (47), and U.S.A. (46+). Most cases involved jet fighter or attack aircraft with one engine (at least 179 accidents) or two engines (40+), and jet trainers (34+). Among the other military aircraft lost since 1950 were seven 4-engined aircraft (three in the 1990s). Since 1950, many additional serious birdstrike accidents to military aircraft have been reported in Asia (especially India), and a few in Africa and South America. These reports, most unofficial and of uncertain reliability, are summarized briefly.

Rochard, B. (2000). The UK civil aviation authority’s approach to bird hazard risk assessment. 25th IBSC meeting, Amsterdam. pp 127-135.

The Civil Aviation Authority requires licensed aerodromes to implement safety management systems. Risk management is an essential part of safety management, in which risks are evaluated and, where necessary, strategies devised to reduce them to an acceptable level. All possible hazards are identified and their severity and probability assessed. By combining severity and probability, tolerability can be determined and the need for action to reduce the severity or probability determined. AWM and CAA have applied this methodology to the birdstrike hazard. Data from birdstrike accidents show that all aircraft types are vulnerable, and birds that alone or in flocks can cause catastrophic accidents visit virtually all aerodromes. Therefore, in the absence of mitigation, the risk level is un acceptable. Control action is necessary and the situation must be continuously kept under review to monitor the residual risk: bird hazard reduction is a ‘finger in the dike’ operation.

Ruhe, W. (2000). Asr - bird observation program at german airports. 25th IBSC meeting, Amsterdam. 9 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPRS3.pdf.

Bird counts, the basis of bird avoidance programs, provide excellent and detailed information about bird species, population sizes and their behaviour on and around airports. But, visual observation of birds is limited by astronomical and meteorological conditions, altitudes and distances and by their monitoring frequency. In order to

additionally obtain continuous and area covering information on bird activity in the closer vicinity of airports, the German Board of Bird Strike Prevention (DAVVL e.V.) started a program of bird radar detection at major airports in co-operation with the German Air Traffic Control Organisation (DFS GmbH), using a new generation of Airport Surveillance Radar (ASR-2000). Within a distance of 10 nm around the local radar sensor, echoes of moving targets have been video recorded and computer stored in quarter-hourly intervals. Bird migration in regional scale and bird activity on a local scale could be detected, which gives interesting insights into the daily and seasonal activity pattern of birds around the airports. The objective of the program, method and results as well as examples of the recordings will be presented.

Satheesan, S.M. and Satheesan, M. (2000). Serious vulture-hits to aircraft over the world. 25th IBSC meeting, Amsterdam. pp 113-126.

Between 1955 and 1999 more than 33 aircraft (27 military and other civil) were written off due to collisions with vultures, which had also caused loss of 21 lives in 11 of these aircrashes. These accidents had occurred in seven countries across the continents of Asia, Africa, Europe and North America. Seven species of vultures were responsible for these air accidents. India had lost about 70 million US Dollars every year between 1980 and 1994 due to vulture strikes (Satheesan 1994, 1996, 1998, 1999a). In other countries also writing off fighter aircraft had brought financial loss to the tune of 10 to 17 million US Dollars per accident. Of the 30 accidents where the altitude for collision of aircraft with vultures is known, 50% occurred below 200m and none above 1200m, and almost all of them outside aerodromes. This paper suggests ecologically sound and practical measures to contain vulture menace to aircraft from the Indian experience. Mass killing of vultures may lead to an ecological disaster, which will prove more costly than what vultureaircraft- strikes could bring about. A very important suggestion is also made as to how amendments to Section 9A of the Indian Aircraft Act 1934 and Rule 81B of the Indian Aircraft Rules 1937 can be made in order to combat the threat of vultures to civil and military aircraft over the world.

Servoss, W., Engeman, R.M., et al. (2000). "Wildlife hazard assessment for Phoenix Sky Harbor International Airport." International Biodeterioration & Biodegradation **45**(3-4): 111-127.

We examined wildlife abundance, distribution, and movement patterns at Phoenix Sky Harbor International Airport (PHX) and within an 8-km radius to assess current air-strike hazards, and to provide baseline information for projecting changes in air-strike hazards as land-use patterns around PHX change. We found that water sources at or near PHX especially induced wildlife movement patterns that put air traffic at risk. This was particularly true of the Salt River bed adjacent to the airport, which also is a natural flight corridor for birds. Compounding the problem, air traffic at PHX was the heaviest when bird abundance and activity was the greatest during migration and breeding. We feel that air strike hazards at PHX are likely to increase substantially as the Salt River bed is reclaimed to produce additional lakes and high quality riparian habitat. We offer recommendations to reduce the hazard levels currently found at PHX and to reduce additional hazards as the habitat around PHX is converted and produces more attractive wildlife habitat. Published by Elsevier Science Ltd.

Short, J.J., Kelley, M.E., et al. (2000). Birdstrike prevention: applying aero-science and bio-science. 25th IBSC meeting, Amsterdam. pp 463-485.

When birds and aircraft occupy the same airspace at the same time, bad things happen. Annual US military cost are estimated to exceed US$200 million per year, and costs to world-wide aviation have been estimated at US$3 - $4 billion per year. Much has been done in the past to improve the bird impact resistance of aircraft, and further improvements would be cost effective on some aircraft. However, the law of diminishing returns comes into play, and the penalties involved in creating a truly bird-proof aircraft can become unacceptably high. Several new approaches and technologies for reducing the number of damaging birdstrikes were presented in our

paper at the International Bird Strike Committee (IBSC) meeting #23 in London. Progress since IBSC 23 is described in this paper. Some of these new concepts are now mature enough to begin operational testing. These include using infrared and radar to detect birds, as well as audible radar and low-power, laser devices for controlling birds. Collectively, these promising new approaches can be expected to reduce birdstrike costs by at least half. Commercialization of these concepts will require a strong advocacy from the user communities. Some strategies and points of contact are provided.

Stone, E. (2000). "Separating the noise from the noise: A finding in support of the "Niche Hypothesis," that birds are influenced by human-induced noise in natural habitats." Anthrozoos **13**(4): 225-231.

Controlling for the confounding influence of physical disturbance, it was possible to test the hypothesis that ambient noise alone would play a role in structuring bird communities in riparian habitats in Boulder Colorado, USA. Point counts of birds were conducted in open spaca/minimally disturbed, residential, commercial and industrial neighborhoods. Within the same disturbance parameters and land use, species richness and PIF scores (a weighted value based on species' importance) consistently and significantly decreased as ambient noise increased. These results can be viewed as support for the "Niche Hypothesis" (Krause 1987, 1998), that wildlife species' acoustic niches are adversely affected by human-induced noise pollution. (C) 2001 International Society for Anthrozoology.

Thorpe, J. (2000). Are we winning the battle? 25th IBSC meeting, Amsterdam. 7 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WP0S7.pdf.

Entering the New Millennium air travel is rapidly expanding and it is perhaps timely to review progress being made in reducing the hazards caused by the conflict between birds and aircraft. The Paper reviews the major areas of Working Group activity and highlights those where progress is inhibited. A number of suggestions are made in order to improve future advancement and reduce risks.

van Belle, J., Maan, M., et al. (2000). Using radar to obtain a quantitative description of summer bird movements in the Dutch coastal area. 25th IBSC meeting, Amsterdam. 15 pp. from http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPRS2.pdf.

During 1999, several feasibility studies on the creation of an airfield at an artificial island in the North Sea were carried out. One of the decisive questions was whether such a location would cause an increase in the bird strike probability. In order to obtain reliable three-dimensional bird density distributions, we have carried out monthly radar observations from the piers of IJmuiden protruding 2 km into the North Sea. We used a search and tracking radar and could observe medium-sized birds at up to 7 km distance. The Dutch coastal area comprises both local bird movements and large-scale migration pathways. The last category consisted of broad front migration of birds crossing the coast on their way to or from Great Britain and leading line migration of birds following the coast, either over sea or over land. Since the different phenomena do not equally make up for differences between mainland and coastal areas, it is very important to differentiate between them. At any time of the year staging gulls appeared to be very abundant. Therefore, in this paper we will isolate their local flying activity from migratory movements. Since they may have any direction they are sometimes hard to distinguish from both migration patterns. During June and July very little large-scale movements were recorded, whereas non-migrating gulls proved to be very abundant at times. By considering the local and migratory movements quantitatively we attempt to assess the bird risk to potential aviation activities within the coastal zone.

Verbeek, M.T., Los, W., et al. (2000). Bird avoidance model (BAM) Europe
25th IBSC meeting, Amsterdam. pp 527-532.

Present day methods used to prevent birdstrikes en route are limited to military aviation and depend mainly on the interpretation of radar images. These so-called BIRDTAMS (Bird Notices to Airmen) already exist since the Sixties in a limited number of West European Air Forces, but show very poor potential for expansion and refinement, because radar observations are not species specific. They cannot meet civil requirements with respect to risk analysis. Further, other existing methods do reflect the current or historical avian threat to aircraft, but are incapable of predicting changes in this threat. In Europe, air traffic shows a remarkable growth and a threefold increase is expected over the next 15 years. Therefore, it is very important to obtain a dynamic real-time GIS-based model, which can predict changes in the times and altitudes of potential hazardous avian flight, based upon the physical and dynamical processes that drive this flight. An additional reason for establishing a European BAM besides the improvement of flight safety is the legal aspect. The Bird Protection Directive and the Fauna-Flora-Habitat Directive of the European Community prohibit low-level flying above bird sanctuaries to avoid disturbances. Actual information of these restricted areas is absolutely necessary to pilots. The European BAM aims at promoting a common European policy to the large problem of bird-aircraft collisions. This could provide the first step towards an international cooperation. The initiative to start with the development of a European Bird Avoidance Model (BAM) has come from the RNLAF in cooperation with the University of Amsterdam (UvA) and SOVON (Bird census work Netherlands). A proposal for a European project will be submitted to the European Community this fall. A number of European partners in the field of research are invited to participate in this project.

Vogt, P.F. (2000). Control of nuisance birds in the airport arena by fogging with rejex-it® tp-40/ws-40. 25th IBSC meeting, Amsterdam. pp 297-304.

Rejex-it® aerosols offer an efficient tool for the management of nuisance birds without harming target and non-target birds or other animals. It is not a pesticide, but a repellent based on methyl anthranilate (MA), a naturally occurring compound with reduced risk to the environment. As a proactive method it does not depend on birds to taste the repellent by eating treated food. Thermal fogging of Rejex-it® TP-40 or mechanical fogging of Rejex-it® WS-40 relies on the exposure of the birds to the aerosol. As such, thermal fogging has been applied with great success in many hangars, warehouses and baggage handling areas of TWA and American Airline, where roosting and nesting birds have been an ongoing problem. In open areas, such as the airfield at Homestead Reserve AFB or Laughlin AFB, a ULV fogger was very effective to repel the migrating swallows with TP-40. A new development is the automated, battery operated ULV fogger of HH Winkler, which was extremely successful in dispersing all birds from a roof top and a train station with extremely low quantities of WS-40 for up to 500 yards downwind. After several exposures to the fog the birds generally left the area completely and did not return. The automated fogging system inhibits any future re-infestation from new bird populations and assures a total bird free environment.

Wright, S. and Dolbeer, R. (2000). Wildlife strikes: A growing and costly problem for civil aviation in the USA. Proceedings of the 45th Annual Corporate Aviation Safety Seminar, San Antonio, Texas, US, USDA National Wildlife Research Center-Staff Publications. pp 35-52.

York, D.L., Cummings, J.L., et al. (2000). "Hazing and movements of Canada geese near Elmendorf Air Force Base in Anchorage, Alaska." International Biodeterioration & Biodegradation **45**(3-4): 103-110.

Bird strikes to aircraft are a serious economic and safety problem in the United States, annually causing millions of dollars in damage to civilian and military aircraft and the occasional loss of human life. We observed movements of 1236 neckbanded lesser Canada geese (Branta canadensis parvipes) to determine efficacy of hazing as a means to reduce goose presence at Elmendorf Air Force Base (EAFB), Anchorage,

Alaska from August to October 1997. Emphasis was on movements of geese onto EAFB with additional data collected at the other two major airports in the area, Anchorage International Airport (AIA) and Merrill Field Airport (MFA). Daily observations indicated the presence of 208 individual neckbanded geese on EAFB, and 20% returned more than once after being hazed from EAFB. We identified three staging areas, geese utilized prior to entering EAFB, and three post-hazing dispersal sites. Collared geese began moving onto EAFB 30-40 days post-molt with the largest proportions moving onto EAFB 70-90 days post-molt, We observed 75 neckbanded geese on AIA from seven molting sites, and 23% returned more than once after being hazed from AIA. We observed 141 neckbanded geese on MFA from 14 molting sites, and 21% returned more than once after being hazed from MFA. Our data indicated that as long as local goose populations increase, large numbers of Anchorage area geese are likely to enter one of the airports creating a variety of management problems. Hazed geese returning to airports multiple times present a special hazard to aircraft safety because they appear to have become habituated to non-lethal scare tactics. We recommend an integrated management approach to limit the Anchorage area goose population utilizing various control techniques which are acceptable to Anchorage residents while continuing the hazing program at area airports. (C) 2000 Elsevier Science Ltd. All rights reserved.

Zalakevicius, M. (2000). Wetlands and aviation: between protection and regulation. 25th IBSC meeting, Amsterdam. pp 365-373.

The paper focuses on the evaluation of the current situation of Lithuanian wetlands and the determination of their role in flight safety in civil and military aviation in the region. Lithuania is located on the edge of the last glacial cover, which has influenced the formation of the country's present hydrographic network. Wetlands are exceptionally important in providing birds with suitable habitats all the year round. In 1993, that Lithuania signed the Ramsar Convention, 5 main, the most rich in biodiversity, wetlands were designated national Ramsar sites. In addition, in 1994-1995, 9 areas were recognised as meeting the criteria of potential Ramsar sites. The process is not over yet, and new territories are waiting the designation and protection. 30 staging sites, important for migratory waterfowl, were designated in 1998. New staging and wintering grounds of birds in the region are recently expanding under global climate change. The only aspect of importance and value of wetlands seen and emphasised in Lithuania recently is that of habitat and bird protection. However, new bird strike problems related to wetland protection and biodiversity (birds in particular) conservation management are evident and becoming urgent. In the adjacent territories of the 4 main international civil airports and 3 huge military airports of the former soviet army, are wetlands, containing massive concentrations of waterfowl. Therefore, the risk of bird strikes is recently growing and extending throughout the seasons of the year, covering all the cycles of bird life. Conservation management and a wise use of wetlands as a rule are realised in a close coordination with the requirements imposed on environmental protection, agriculture, water management, fishery, and forestry rather than flight safety in aviation. Considering aviation safety requirements imposed on existing airports and those being built or reconstructed, wetland management must be adjusted to multiple aspects of various sectors including air transport and environment. Legislation, harmonisation, and compatibility of laws, legal acts, regulations, public information, as well as awareness promotion, etc. must play one of the most important roles in the matter.

Zalakevicius, M. (2000). Global climate change, bird migration and bird strike problems. 25th IBSC meeting, Amsterdam. pp 509-525.

The article analyses the dependency of different migratory processes on global climate change and the bird strike prevention problems possibly related to it. Climate change has a direct impact on the spring arrival of breeding birds and their autumnal departure. Of all the migration processes and their constituent parts, migratory take-off is the most

sensitive to climate change. Birds try to take-off under particularly favourable for the flight conditions. Thus, climate change is predicted to induce certain shifts in take-off periods, influence alterations in staging areas and the formation of bird accumulations therein, and eventually condition the number of to it. Climate migration waves, periods of their occurrence, migratory distances, and the characteristics of the species' migratory course. Migration control is based on the principle of the dynamic balance between environment, i.e. climate, and the inner endogenous programme, while global climate change affects both the endogenous programme, readiness for flight by changing migration waves, and environmental conditions. Thus, bird migration control may change only the ranges of the dynamic balance, what is essential for a practical use of migration controlling mechanisms, i.e. the structure of models and the expression of formulae. Under the impact of climate change, changes in migratory state, migratory routes, migration distances and directions, places of staging and wintering, as well as migration intensity occur. These changes have a direct influence on bird strike problem management: ways of solution, concrete measures, their effectiveness, etc.

Aas, C.K. (2000). Om kollisjoner mellom fugler og fly i 1999 sammenlignet med tidligere år. OsloPosten, 2000-08-02, UiO.

1999

[Anon] (1999). "Composite "bird strikes" examined using acoustic microscopy." Aircraft Engineering and Aerospace Technology **71**(5): 519-519.

Alge, T. (1999). Airport bird threat in North America from large flocking birds (geese)(as viewed by an engine manufacturer)–Part 1. 1999 Bird Strike Committee-USA/Canada, First Joint Annual Meeting, Vancouver, BC, University of Nebraska - Lincoln. pp 1-7.

Allan, J.R., Bell, J.C., et al. (1999). An assessment of the world-wide risk to aircraft from large flocking birds. 1999 Bird Strike Committee-USA/Canada, First Joint Annual Meeting., Vancover, BC, University of Nebraska - Lincoln. pp 29-35.

Bell, J.C. (1999). The effects of changes in the Northern Lapwing population on the bird strike hazard in the UK. 1999 Bird Strike Committee-USA/Canada, First Joint Annual Meeting, Vancouver, BC, University of Nebraska - Lincoln.

Bentz, P.-G. (1999). Spillepeng – Fåglarna har pippi på soptippar. 12-14 pp.

Bentz, P.-G. (1999). Planerade oljefällor/fördröjningsmagasin för mottag av ureabemängt dagvatten vid Jämtlands flygflottilj F 4, Östersund - Bedömning av risken för fågelkollisioner. Fort.verket. 8 pp.

Bentz, P.-G. (1999). Planerade oljefällor och infiltrationsmagasin för mottag av dagvatten vid Luleå – Kallax flygplats/Norrbottens flygflottilj F 21 – Bedömning av risken för fågelkollisioner. Fort.verket. 4 pp.

Bentz, P.-G. (1999). Planerad lagringsdamm för bevattning av gräsytor med ureabemängt dagvatten vid Skaraborgs flygflottilj F 7, Såtenäs – Bedömning av risken för fågelkollisioner. Fort.verket. 4 pp.

Bentz, P.-G. (1999). Planerad lagringsdamm för bevattning av gräsytor med ureabemängt dagvatten vid Skånska flygflottiljen F10, Ängelholm – Bedömning av risken för fågelkollisioner Fort.verket. 4 pp.

Bentz, P.-G. (1999). Planerad våtmark vid Västerås flygplats – Bedömning av risken för fågelkollisioner. Västerås flygplats. 3 pp.

Bruderer, B., Peter, D., et al. (1999). "Behaviour of migrating birds exposed to X-band radar and a bright light beam." Journal of Experimental Biology **202**(9): 1015-1022.

Radar studies on bird migration assume that the transmitted electromagnetic pulses do not alter the behaviour of the birds, in spite of some worrying reports of observed disturbance. This paper shows that, in the case of the X-band radar 'Superfledermaus', no relevant changes in flight behaviour occurred, while a strong light beam provoked important changes. Large sets of routine recordings of nocturnal bird migrants obtained using an X-band tracking radar provided no indication of differing flight behaviour between birds flying at low levels towards the radar, away from it or passing it sideways. Snitching the radar transmission on and off, while continuing to track selected bird targets using a passive infrared camera during the switch-off phases of the radar, showed no difference in the birds' behaviour with and without incident radar waves. Tracking single nocturnal migrants while switching on and off a strong searchlight mounted parallel to the radar antenna, however, induced pronounced reactions by the birds: (1) a wide variation of directional shifts averaging 8 degrees in the first and 15 degrees in the third 10 s interval after switch-on; (2) a mean reduction in flight speed of 2-3 m s(-1) (15-30 % of normal air speed); and (3) a slight increase in climbing rate. A calculated index of change declined with distance from the source, suggesting zero reaction beyond approximately 1 km. These results revive existing ideas of using light beams on aircraft to prevent bird strikes and provide arguments against the increasing use of light beams for advertising purposes.

Delaney, D.K., Grubb, T.G., et al. (1999). "Effects of helicopter noise on Mexican spotted owls." Journal of Wildlife Management **63**(1): 60-76.

Military helicopter training over the Lincoln National Forest (LNF) in southcentral New Mexico has been severely limited to protect nesting Mexican spotted owls (Strix occidentalis lucida). To evaluate nesting and nonnesting spotted owl responses to helicopter noise, we measured flush frequency, flush distance, alert behavior, response duration, prey delivery rates, female trips from the nest, and nest attentiveness during manipulated and nonmanipulated periods, 1995-96. Chain saws were included in our manipulations to increase experimental options and to facilitate comparative results. We analyzed stimulus events by measuring noise levels as unweighted one-third-octave band levels, applying frequency weighting to the resultant spectra, and calculating the sound exposure level for total sound energy (SEL) and the 0.5-sec equivalent maximum energy level (LEQ(max 0.5-sec)) for helicopters, and the 10-sec equivalent average energy level (LEQ(avg. 10-sec)) for chain saws. An owl-weighting (dBO) curve was estimated to emphasize the middle frequency range where strigiform owls have the highest hearing sensitivity. Manipulated and nonmanipulated nest sites did not differ in reproductive success (P = 0.59) or the number of young fledged (P = 0.12). As stimulus distance decreased, spotted owl flush frequency increased, regardless of stimulus type or season. We recorded no spotted owl flushes when noise stimuli were >105 m away. Spotted owls returned to predisturbance behavior within 10-15 min after a stimulus event. All adult flushes during the nesting season occurred after juveniles had left the nest. Spotted owl flush rates in response to helicopters did not differ between nonnesting (13.3%) and nesting seasons (13.6%; P = 0.34). Spotted owls did not flush when the SEL noise level for helicopters was less than or equal to 102 dBO (92 dBA) and the LEQ level for chain saws was less than or equal to 59 dBO (46 dBA). Chain saws were more disturbing to spotted owls than helicopter flights at comparable distances. Our data indicate a 105-m buffer zone for helicopter overflights on the LNF would minimize spotted owl flush response and any potential effects on nesting activity.

Dolbeer, R.A. (1999). Aerodrome bird hazard prevention: case study at John F. Kennedy International Airport. Proceedings of the International Seminar on Flight Safety and Birds in the Middle East, International Center for the Study of Bird Migration, Latrun, Israel. pp 157-166.

Linnell, M.A., Conover, M.R., et al. (1999). "Biases in bird strike statistics based on pilot reports." Journal of Wildlife Management **63**(3): 997-1003.

Collisions between birds and aircraft are a concern because they threaten human safety and result in costly repairs. Most data on bird strikes have been provided by pilots and may be incomplete or biased. To assess whether bird strike statistics derived from pilot reports are biased, we compared the number of pilot-reported bird strikes at a Hawaiian airport during 1900-94 to the number of bird strikes obtained from regular runway searches for dead birds. We documented 526 bird strikes, of which only 25% were reported by pilots. Pilot reporting rates (percentage of all strikes reported by pilots) varied by species involved, number of birds struck, season, time of day, location on the runway during the landing phase, and the bird's mass. Reporting rates were not, however, correlated to size of the bird. Pilot reporting rates were independent of wind speed, wind direction, and percent cloud cover, and reporting rates were similar during landings and takeoffs. We found that bird strike statistics derived from pilot reports were biased. A sole reliance on such data can lead to incorrect conclusions and may cause airports to select inappropriate measures and times to reduce bird strikes.

Lovell, C.D. and Dolbeer, R.A. (1999). "Validation of the United States Air Force bird avoidance model." Wildlife Society Bulletin **27**(1): 167-171.

Since 1986, bird strikes have caused 33 fatalities and nearly $500 million in damage to United States Air Force (USAF) aircraft. To reduce these losses, the USAF developed a Bird Avoidance Model (BAM) to evaluate low-level training routes for bird-strike hazards throughout the contiguous United States. The current BAM, developed during the 1980s, incorporates waterfowl and raptor species, which account for most (69%) of the damaging bird strikes to military aircraft flying low-level routes. Because changes have occurred to waterfowl and raptor populations throughout North America, there is speculation that the BAM (developed and currently run with historical waterfowl and raptor data) may not accurately predict current bird-strike hazards. Therefore, we compared bird-strike hazards predicted by the BAM for those low-level routes where waterfowl or raptor strikes occurred with a random selection of published low-level routes where waterfowl or raptor strikes were not reported. Mean predicted bird-strike hazards for both waterfowl and raptors were greater (P less than or equal to 0.02) for routes where strikes had occurred than for routes where strikes by these species had not occurred. Thus, the BAM predicted mean bird-strike hazards along low-level training routes for the military and, when properly used, can assist with flight planning to minimize strikes with waterfowl and raptors.

Mace, B.L., Bell, P.A., et al. (1999). "Aesthetic, affective, and cognitive effects of noise on natural landscape assessment." Society & Natural Resources **12**(3): 225-242.

Research has shown that helicopter noise from tourist flights is very common in some national parks and wilderness areas. At Grand Canyon National Park, aircraft noise has been found to be as high as 76 dB(A) with as many as 43 noise events in a 20-minute period. The present study examined the influence of 40 dB(A) ol 80 dB(A) helicopter noise on assessment of a popular Grand Canyon vista in a laboratory simulation. Participants (44 female and 36 male undergraduates) viewed 68 slides of scenic vistas and assessed them on naturalness, preference, and scenic beauty and evaluated dimensions of freedom, annoyance, solitude, and tranquility. Compared to a control condition of background natural sounds (e.g., birds, brooks), noise conditions negatively impacted all dependent measures. Although the effects were most pronounced at the 80-dB level, even the 40-dB helicopter noise negatively impacted all dependent variables. Results suggest that helicopter noise interferes with the quality of the visitor experience and even affects the perceived aesthetic quality of landscapes.

Mosbech, A. and Boertmann, D. (1999). "Distribution, abundance and reaction to aerial surveys of post-breeding King Eiders (Somateria spectabilis) in Western Greenland." Arctic **52**(2): 188-203.

Moulting and post-breeding king eiders in western Greenland were surveyed in late August and early September of 1993, 1994, and 1995. We counted all eiders observed during fixed-winged aircraft flights along coastlines and offshore transects. The coastline in the survey area is roughly 13 400 km long, and our flightlines totaled approximately 16 500 km. The areas optimal for the birds were covered fully several times; in less suitable areas, only a fraction of the coastline was covered. Using the largest count for coastlines covered more than once, we counted a total of 22 980 king eiders. Large numbers of king eiders were observed at a number of remote localities on the west coast of Disko Island and in southern Upernavik. At localities considered to have frequent human disturbance, few birds were observed. Highest densities were found along coasts with sandy or muddy areas at the shorelines. Overall we estimate that 30 000 to 40 000 king eiders reside in the coastal zone of western Greenland in late August. Even allowing for a high turnover rate, as different individuals may occupy the moulting areas during the extended period from July to October, this figure can account for only half of a 1950s estimate that 200 000 males and immatures were moulting in western Greenland.

Pochop, P.A., Cummings, J.L., et al. (1999). "Vegetation preferences of captive Canada geese at Elmendorf Air Force Base, Alaska." Wildlife Society Bulletin **27**(3): 734-740.

Bird-aircraft strikes represent a serious safety and economic problem in the United States. Canada geese (Branta canadensis) are frequently attracted to airfields because of the availability of preferred forage and large open areas. At Elmendorf Air Force Base, Alaska, we determined preferences of captive, wild-caught, lesser Canada geese (B. c. parvipes) for alternative vegetation types not normally planted at this airfield. We compared Canada goose preferences for Kentucky bluegrass (Poa pratensis), bluejoint reedgrass (Calamagrostis canadensis), beach wildrye (Elymus mollis), Baring hairgrass (Deschampsia beringensis), lupine (Lupinus nootkatensis), and flightline turf (a mix of smooth brome [Bromus sp.], dock [Rumex acerosella], and red fescue [Festuca rubra]). Geese preferred flightline turf over Kentucky bluegrass. Bering hairgrass was marginally less preferred than Kentucky bluegrass. Kentucky bluegrass was preferred over lupine, bluejoint reedgrass, and beach wildrye. We discuss vegetation management as an alternative goose control technique. Further evaluation of the least preferred vegetation types should be conducted in large flight pen and field plot studies.

Seamans, T.W., Dolbeer, R.A., et al. (1999). Does tall grass reduce bird numbers on airports?: Results of pen test with Canada geese and field trials at two airports, 1998. Proceedings Joint Meeting of Bird Strike Committee Canada and Bird Strike Committee USA, Vancouver, British Columbia, Canada, University of Nebraska - Lincoln. pp 160–170.

A suggested management plan to reduce bird numbers and bird-aircraft collisions at airports is to maintain grass 15-25 cm high. However, 3 studies conducted in the United States in 1998 indicated tall-grass management may not result in fewer birds. First, Canada geese (*Branta canadensis*), in a replicated experiment lasting 9 days in 6 pens in Ohio, showed no preference (P = 0.53) for short-grass (4-11 cm) over tall-grass (16-21 cm) plots. Second, we compared bird use of 8 tall- (23.3 $\pm$ 0.5 cm high, x $\pm$ SE) and 8 short- (14.3 $\pm$ 0.2) grass plots totaling 46 ha at Burke Lakefront Airport, Cleveland, Ohio on 15 days from 20 April-9 June. We found no difference (P = 0.40) in overall bird use of tall- and short-grass plots. Only 1 species, red-winged blackbirds (*Agelaius phoeniceus*), showed a preference (P = 0.001), with more birds (0.4 $\pm$ 0.8/ha/3-min observation) found in tall grass compared to short grass (0.1 $\pm$ 0.3). Finally, in a similar study at JFK International Airport in New York, bird observations were made on 2 unmowed (max. vegetation height of 48-130 cm) and 2 mowed (max. vegetation height of 15-25 cm) plots totaling 270 ha from 1 July-29 September. The number and species

of birds hazardous to aircraft were similar in unmowed and mowed plots. The results of these studies suggest tall grass may not be an effective means of reducing bird numbers on airports. Further research, especially studies that monitor bird use of various grass types and heights over multiple seasons, is necessary to determine habitat management strategies that will reduce the number of bird species of concern on airports in North America.

Stokes, J.B., Leese, D.J., et al. (1999). "Citizens get relief from recreational noise: The case in the skies from Hawaii." Noise Control Engineering Journal **47**(4): 142-146.

Due to the exponential growth of large-scale, commercial, fixed-wing aircraft and helicopter tourism in the state of Hawaii since the late 1980s, native wildlife habitat has been degraded, and hikers and others seeking tranquility in wilderness areas throughout the state have been greatly disturbed. Aviation activity results in an unacceptable degree of noise pollution over or near Hawaii Volcanoes National Park on the island of Hawaii, and Haleakala National Park on the island of Maul, The same is true of state lands with wilderness character such as the Na Pali Coast, Waimea Canyon, and Koke'e State parks on the island of Kauai and Kula, and Kahikinui State forests on the island of Maul, In all these locations, noise intrusions occur continuously throughout the day, often for sustained periods of over one hour. The problem is particularly acute at Haleakala, where sound is amplified due to the park's unique geologic configuration (a small erosional depression, high above the clouds) that concentrates and amplifies aviation noise. The: bulk of Haleakala and Hawaii Volcanoes National Parks are part of the federal wilderness system, Both parks are International Biosphere Reserves designated by the United Nations; aviation noise is inconsistent with such designation. (C) 1999 Institute of Noise Control Engineering. [S0736-2501(99)00404-X] Primary subject classification: 66.1; Secondary subject classification: 13.1.

Thompson, M.M. (1999). "Using a GIS to integrate seasonal raptor distributions into a bird avoidance model for aircraft." Journal of Raptor Research **33**(1): 53-58.

Ward, D.H., Stehn, R.A., et al. (1999). "Response of fall-staging brant and Canada geese to aircraft overflights in southwestern Alaska." Journal of Wildlife Management **63**(1): 373-381.

Because much of the information concerning disturbance of waterfowl by aircraft is anecdotal, we examined behavioral responses of Pacific brant (Branta bernicla nigricans) and Canada geese (B. canadensis taverneri) to experimental overflights during fall staging at Izembek Lagoon, Alaska. These data were used to develop predictive models of brant and Canada goose response to aircraft altitude, type, noise, and lateral distance from flocks. Overall, 75% of brant flocks and 9% of Canada goose flocks flew in response to overflights. Mean flight and alert responses of both species were greater for rotary-wing than for fixed-wing aircraft and for high-noise than for low-noise aircraft. Increased lateral distance between an aircraft and a flock was the most consistent predictive parameter associated with lower probability of a response by geese. Altitude was a less reliable predictor because of interaction effects with aircraft type and noise. Although mean response of brant and Canada geese generally was inversely proportional to aircraft altitude, greatest response occurred at intermediate (305-760 m) altitudes. At Izembek Lagoon and other areas where there are large concentrations of waterfowl, managers should consider lateral distance from the birds as the primary criterion for establishing local flight restrictions, especially for helicopters.

1998

Budgey, R. (1998). Three dimensional bird flock structure and its mplications for birdstrike tolerence in aircraft. 24th IBSC meeting, Stara Lesna, Slovakia 9pp. from http://www.int-birdstrike.org/Slovakia_Papers/IBSC24%20WP29.pdf.

The number of birds currently used in multiple impact certification is based on data from the historical birdstrike record. As bird populations and engine designs change, new test criteria are periodically required. In order to measure future risks from species rarely struck at present, and confirm the level of risk from species that have been struck frequently, it is necessary to supplement the historical record with direct measurement of the threat posed by flocking birds. We describe a method for filming bird flocks using a stereo pair of video cameras and determining the three dimensional structure of the. flock. By modeling the flocks and plotting the path of an aircraft component through them, it is possible to determine the probability of striking a given number of birds and we include some initial results from running the model. These data can then be used by regulators to inform the choice of bird numbers and weights in future certification testing requirements. We also try to describe a relationship between bird flock density and a biometric factor such as wingspan. If this relationship holds as more data are gathered, the model can then be extended to any species of bird.

Buurma, L.S. (1998). Prediction and detection of bird flights across the control zone of airports. 24th IBSC meeting, Stara Lesna, Slovakia 10 pp. from http://www.int-birdstrike.org/Slovakia_Papers/IBSC24%20WP22.pdf.

On the basis of West European military bird strike statistics it has been established that many hazardous bird strikes occur just outside the sphere of influence of aerodrome bird control (habitat management and bird scaring). Especially in wetland regions many birds cross the control zone of airports, often in predictable spatiotemporal patterns. Once an airport has been constructed at a location intensively flown over by birds, or when major developments creating bird activity are accomplished facts, nothing else remains than to develop warning systems for bird strike prevention. The statement of this paper is that nowadays more possibilities do exist than are utilised so far. A lot of ornithological knowledge has not yet been tailored for use in aviation. Modern geographical information systems and other forms of computer modelling offer, the possibility to integrate this knowledge into Bird Avoidance Models (SAM) at different scales (from airport or shooting range surroundings to the size of continents). Furthermore, it becomes obvious that there is an altitudinal gap between bird movement data from long-range surveillance radars, as used in some West European airforces, and the visual impressions of field observers in the lowest airlayer. Closing this gap by means of small 3-D (tracking) radars paralleled by adapted fieldwork will give birth to a wealth of new insights to be build into dynamic BAM's.

Conomy, J.T., Collazo, J.A., et al. (1998). "Dabbling duck behavior and aircraft activity in coastal North Carolina." Journal of Wildlife Management **62**(3): 1127-1134.

Requests to increase military aircraft activity in some training facilities in the United States have prompted the need to determine if waterfowl and other wildlife are adversely affected by aircraft disturbance. We quantified behavioral responses of wintering American black ducks (Anas rubripes), American wigeon (A. americana), gadwall (A, streptera), and American green-winged teal (A. crecca carolinensis) exposed to low-level flying military aircrafts; at Piney and Cedar islands, North Carolina, in 1991 and 1992. Waterfowl spent less than or equal to 1.4% of their time responding to aircraft, which included flying, swimming, and alert behaviors. Mean duration of responses by species ranged from 10 to 40 sec. Costs to each species were deemed low because disruptions represented a low percentage of their time-activity budgets, only a small proportion of birds reacted to disturbance (13/672; 2%), and the likelihood of resuming the activity disrupted by an aircraft disturbance event was high (64%). Recorded levels of aircraft disturbance (i.e., (x) over bar = 85.1 dBA) were not adversely affecting the time-activity budgets of selected waterfowl species wintering at Piney and Cedar islands.

Conomy, J.T., Dubovsky, J.A., et al. (1998). "Do black ducks and wood ducks habituate to aircraft disturbance?" Journal of Wildlife Management **62**(3): 1135-1142.

Requests to increase military aircraft activity in some training facilities in the United States have raised the need to determine if waterfowl and other wildlife are adversely affected by aircraft disturbance. We hypothesized that habituation was a possible proximate factor influencing the low proportion of free-ranging ducks reacting to military aircraft activities in a training range in coastal North Carolina during winters 1991 and 1992. To test this hypothesis, we subjected captive, wild-strain American black ducks (Anas rubripes) and wood ducks (Aix sponsa) to actual and simulated activities of jet aircraft. In the first experiment, we placed black ducks in an enclosure near the center of aircraft activities on Piney Island, a military aircraft target range in coastal North Carolina. The proportion of times black ducks reacted (e.g., alert posture, fleeing response) to visual and auditory aircraft activity decreased from 38 to 6% during the first 17 days of confinement. Response rates remained stable at 5.8% thereafter. In the second experiment, black ducks and wood ducks were exposed to 6 different recordings of jet noise. The proportion of times black ducks reacted to noise decreased ($P < 0.05$) from first day of exposure (25%) to last (i.e., day 4. 8%). Except for a 2% difference in comfort, we detected no differences ($P > 0.05$) in time-activity budgets of black ducks between pre-exposure to noise and 24 hr after first exposure. Unlike black ducks, wood duck responses to jet noise did not decrease uniformly among experimental groups following initial exposure to noise ($P = 0.01$). We conclude that initial exposure to aircraft noise elicits behavioral responses from black ducks and wood ducks. With continued exposure of aircraft noise, black ducks may become habituated. However, wood ducks did not exhibit the same pattern of response, suggesting that the ability of waterfowl to habituate to aircraft noise may be species specific.

Dolbeer, R.A. (1998). Evaluation of shooting and falconry to reduce bird strikes with aircraft at John F. Kennedy International Airport. International bird strike committee (IBSC 24/WP 13), Stara Lesna, Slovakia. pp 145-158.

Engelbart, D., Gorsdorf, U., et al. (1998). "Effects and observation of migrating birds on a boundary-layer windprofiler in Eastern Germany." Meteorologische Zeitschrift **7**(5): 280-287.

Boundary-layer windprofilers recently have become more and more a standard technique for measuring lower atmospheric wind profiles operationally. Although the availability of reasonable data is quite high, there are about 2 % of all profiles which show unrealistic large deviations compared with standard rawinsondes. This paper, on the one hand statistically investigates large deviations of measurements made by a 1290 Mhz windprofiler in Eastern Germany and proves on the other hand the association to events of strong bird migration by comparing measurements from a (ATC) tracking radar in Berlin, used by the German military to minimize birdstrikes on aircraft with an occurrence of large deviations in windprofiler-derived mean wind profiles compared to rawinsondes. It is shown that the deviations correspond to events of strong bird migration. Assuming typical bird migration values from literature, the effect of birds on mean wind profiles derived from windprofiler radar is investigated, too, and finally, an easy and immediate method to identify bird migration is given using a SNR threshold value in connection with a non-precipitation criterion.

Follestad, A. (1998). Flystøy og struts. NINA, Trondheim. 14 pp.

Gauthreaux, S.A. and Belser, C.G. (1998). "Displays of bird movements on the WSR-88D: Patterns and quantification." Weather and Forecasting **13**(2): 453-464.

The WSR-88D can readily detect birds in the atmosphere in both clear air and precipitation mode, and echo reflectivities of 30-35 dBZ may be realized during heavy migration events or when birds are departing a roosting site. This paper describes the appearance of birds on base reflectivity, base velocity, and velocity azimuth display wind profile products, and presents a calibration curve that relates decibel values of reflectivity to bird migration traffic rates. The recognition of bird displays in WSR-88D

products is essential for the accurate interpretation of data gathered by the radar and its use in the development of forecasts. The findings also document the importance of the WSR-88D as a remote sensing tool for biological studies of birds and insects in the atmosphere and the application of such information in the avoidance of bird-aircraft collisions.

Hahn, E. and Weitz, H. (1998). Bird strikes versus bird counts on airports - is there any correlation? 24th IBSC meeting, Stara Lesna, Slovakia. 6 pp. from http://www.int-birdstrike.org/Slovakia_Papers/IBSC24%20WP08.pdf.

On the basis of bird count programs on German airports we discuss the relation between counted birds res. species and the bird strikes and bird strike rates. Only for the number of birds counted and the bird strike rate We found a weak correlation. The behaviour of birds and measures to pre vent bird strike influence the correlation.

Horesh, Z. and Milo, Y. (1998). Using traps to control pigeon and crow populations in airfields. 24th IBSC meeting, Stara Lesna, Slovakia 11 pp. from http://www.int-birdstrike.org/Slovakia_Papers/IBSC24%20WP14.pdf.

The Columba livin is a common pigeon species that has adapted to a wide range of habitats and living conditions, and is highly resistant to varying climatic changes. In most places in the world it is non-migratory throughout most of the year, and because of its high reproductive rate (Goodwin and Derek, 1967), it has become a damage-causing nuisance. Efforts are being make worldwide to prevent or at least control that damage. In airfields, this bird presents a serious safety problem to both the structures and the airspace above them. The high acidity of the birds' secretions is particularly damaging to equipment. The hooded crow (Comas corone cornix) is also a species with a high reproductive rate which has adapted to a wide range of habitats, and in recent years it has become a pest in all parts of Israel; crow populations located in airfields pose a risk when planes take off and land. However, it should be noted that to date no crow-related incidents with planes have been reported in Israel, apparently as a result of the fact that crows are fast learners and their acquired knowledge has taught them to beware of planes. Airfields have two main attractions for crows: 1) The large number of eucalyptus trees planted around the bases, which provide them with places to roost, sleep and nest; 2) The food distributed to the guard dogs along the fences. Forest Ecological Solutions, Ltd. developed and implements mechanical traps to capture both species birds on a massive scale in populated areas. No toxic materials are used and no environmental residue is left. The method is environmentally friendly, and has been successfully applied in a continuing project at six Israel Air Force bases for four and a half consecutive years.

Il'ichev, V.D., Silaeva, O.L., et al. (1998). "Dynamics of aircraft noise in the Malinki wildlife protection area in spring and summer." Russian Journal of Ecology **29**(4): 226-229.

The noise level at the Malinki Biological Station (Russian Academy of Sciences) near Moscow was studied in spring and summer by the method of point estimates and ecological and acoustic analyses. Up to 200 airplanes cross its airspace every day; sometimes they fly as often as 30 airplanes per hour. Flights at low altitudes accounted for a noise level of 75-90 dB during 6 h per day. The noise level was unstable due to meteorological, ecological, and social conditions. To further clarify this issue, ecological studies, as well as the additional analysis of noise level and sources, are required.

Krausman, P.R., Wallace, M.C., et al. (1998). "Effects of jet aircraft on mountain sheep." Journal of Wildlife Management **62**(4): 1246-1254.

Military-designated air spaces have been established above national parks and monuments, wildlife refuges, wilderness areas, and Department of Defense lands. Each of these landscapes is managed differently, which has led to questions of compatibility between military aircraft and wildlife. We determined the influence of F-16 aircraft overflights on mountain sheep (Ovis canadensis nelsoni) from January 1990 to

May 1992 in the Desert National Wildlife Refuge, Nevada. We constructed a 320-ha enclosure and calibrated the area for sound pressure levels (i.e., noise) created by F-16 aircraft flying along the ridgeline of the mountains in the enclosure, approximately 125 m above ground level. In May 1990, we placed 12 mountain sheep from the surrounding area in the enclosure and monitored their behavior and use of habitats for 1 year to ensure they were familiar with the area before they were subjected to aircraft overflights. The habitat use and activity of the sheep in the enclosure were similar to free-ranging conspecifics. In May 1991, we instrumented 5 mountain sheep with heart-rate monitors and added them to the enclosure. During May 1991 to May 1992, F-16 aircraft flew over the enclosure 149 times during 3 1-month periods. We recorded heart rate and behavior of sheep 15 min preoverflight, during the overflight, and postoverflight. Heart rate increased above preflight levels in 21 of 149 overflights but returned to preflight levels within 120 sec. When F-16 aircraft flew over the enclosure, the noise levels created did not alter behavior or use of habitat, or increase heart rates to the detriment of the sheep in the enclosure.

Kusters, E. and van Raden, H. (1998). "On the influence of military shooting ranges on the birds of the Wadden Sea." Zeitschrift Fur Jagdwissenschaft **44**(4): 221-236.

The Wadden Sea of the North Sea which are home to high concentrations of waterfowl and shorebirds, especially during the migratory seasons are also the sires of several air-re-ground shooting ranges and ammunition test areas. Investigations were carried out in Konigshafen (island of Sylt) and in Meldorf Bay to find out if and in which way the military shooting causes disturbances to the birds and how negative effects can be minimized. The reactions of the birds to bombing and shooting air-to-ground missiles and machine guns from low flying planes covered a wide range from continuing feeding over alert behaviour to spontaneous flight. Reaction intensity depended on the sequence in which the weapons were fired (habituation if the shouting started with low noise level weapons) and particularly on the ride. A strong correlation between the birds' reactions and the ride were also observed in Meldorf Bay (Figs. 1-5). The most intensive reactions were observed when ammunition tests were conducted while shorebirds were sitting closely together in large flocks on their high tide roosts. Based on the results of the investigations, an attempt is made to provide a survey of the main parameters influencing the behaviour of a single bird (Fig. 6). Whether shooting or any other disturbance causes the bird to fly away or not depends on which one of the factors of the complex system that regulates the bird's behaviour has the strongest influence at that very moment.

Küsters, E. and Scheller, W. (1998). Birdstrikes with military aircraft and flight altitudes of raptors in Germany 24th IBSC meeting, Stara Lesna, Slovakia 8pp. from http://www.int-birdstrike.org/Slovakia_Papers/IBSC24%20WP26.pdf.

In Germany about 16% of the birdstrikes with known species were caused by raptors. Kestrels (almost exclusively recently fledged birds) were involved mainly in summer (July - Sept.), while soaring raptors caused two maxima. the first one from March to May, the second one from July to September. Most of the birdstrikes occurred in the 500 ft level, yet the absolute height maximum was 3500 ft. An observation program revealed that some species of soaring raptors regularly reach flight heights of 3000 m (approx. 10.000 ft) in spring (territorial behaviour). Flight altitude increases again in autumn before migration starts. Flight height is positively correlated with air temperature and quality of thermals, maximum height is reached around noon time. That means the risk of having a birdstrike with a buzzard or any other soaring raptor is highest at noon on days with good thermals in spring or in August/September.

Leshem, Y. and Ronen, N. (1998). Removing Hiriya garbage dump, Israel - A test case 24th IBSC meeting, Stara Lesna, Slovakia 7pp. from http://www.int-birdstrike.org/Slovakia_Papers/IBSC24%20WP15.pdf.

Contrary to the international rules of ICAO, the Hiriya garbage dump was established in 1952, located 4.5 kilometers from Ben Gurion International Airport, Israel. For more than 20 years, changing governments have not succeeded in executing decisions to remove such a site with the potential of a national flight safety disaster. Tens of thousands of gulls and other bird species use Hiriya for six months a year. This article analyzes the dangers and stages that have finally initiated the process of moving the dump to an alternative site.

Maier, J.A.K., Murphy, S.M., et al. (1998). "Responses of caribou to overflights by low-altitude jet aircraft." Journal of Wildlife Management **62**(2): 752-766.

Military training exercises have increased in Alaska in recent years, and the possible effects of low-altitude overflights on wildlife such as barren-ground caribou (Rangifer tarandus) have caused concern among northern residents and resource agencies. We evaluated the effects of overflights by low-altitude, subsonic jet aircraft by U.S. Air Force (USAF) A-10, F-15, and F-16 jets on daily activity and movements of free-ranging female caribou. This study was conducted on caribou of the Delta Caribou Herd in interior Alaska during each of 3 seasons in 1991: late winter, postcalving, and insect harassment. Noise levels experienced by caribou were measured with Animal Noise Monitors (ANMs) attached to radiocollars. Caribou subjected to overflights in late winter interrupted resting bouts and consequently engaged in a greater number of resting bouts than caribou not subjected to overflights (P = 0.05). Caribou subjected to overflights during postcalving were more active (P = 0.03) and moved farther (P = 0.01) than did caribou not subjected to overflights. Caribou subjected to overflights during the insect season responded by becoming more active (P = 0.01). Responses of caribou to aircraft were mild in late winter, intermediate in the insect season, and strongest during postcalving. We conclude that females with young exhibit the most sensitive response to aircraft disturbance. Accordingly, military training exercises should be curtailed in areas where caribou are concentrated during calving and postcalving.

Montemaggiori, A. (1998). The importance of bird monitoring at airports: the case of fiumicino, rome. 24th IBSC meeting, Stara Lesna, Slovakia 11 pp. from http://www.int-birdstrike.org/Slovakia_Papers/IBSC24%20WP17.pdf.

According to a simple but effective methodology adopted and tested at Fiumicino Airport (Rome) since 1989, to monitor bird community and scaring devices, the information gathered during the period 1989-90 and the period 1995-96 were compared. The obtained results show a decrease in the presence of Gulls (Larus cachirmans and Larus ridibundus) of more than 80%; Starlings (Sturnus vulgaris) decreased of 74% and Lapwings (Vanellus vanellus) of 24,2%. These results strongly highlight the importance of a Continuous monitoring effort of the avian community at airports, in order to better calibrate and implement the bird-avoidance strategy, and to check the obtained results.

Satheesan, S.M. (1998). Sound and light can control bird activity at indian airports. 24th IBSC meeting, Stara Lesna, Slovakia 3pp. from http://www.int-birdstrike.org/Slovakia_Papers/IBSC24%20WP19.pdf.

Judicious use of combined sound and light showed promise in reducing bird activity at some airports in India. The 'Patrol' model of Scarecrow, a hand-held bio-accoustic bird - scaring machine made in the United Kingdom producing distress calls of birds, used in conjunction with crackers and cartridges scared away several species of problem birds at some aerodromes and vast sanitary landfills in and around Delhi. Some birds such as Pariah kites got attracted and some repelled but subsequent use of crackers and bird fright cartridges drove away most of the birds from the area. Bright light and powerful sound produced close to the flock of birds gave desired result in chasing them away.

Sparling, D.W., Vann, S., et al. (1998). "Blood changes in mallards exposed to white phosphorus." Environmental Toxicology and Chemistry **17**(12): 2521-2529.

White phosphorus (P-4) has been extensively used by the military for various purposes, including marking artillery impacts and as an obscurant. Target practice in an Alaskan tidal marsh during the last 4 decades has deposited large amounts of P-4 particles in sediments and water, which have resulted in die-offs of several waterfowl species. Because the toxicity of P-4 in birds has not been well documented and because it is quickly excreted or metabolized in living animals, we sought to determine the effects of experimental dosing on blood characteristics in game farm mallards (Anas platyrhynchos). In two experiments, one employing single doses of 5.4 mg P-4 per kilogram body weight in corn oil and the other using daily repeated doses of pelletized P-4 at either 0.5 or 1.0 mg/kg, there were significant changes in aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase (LDH), inorganic P, hematocrit, and hemoglobin. Other indications of exposure included changes in uric acid, creatinine, and total protein, which were consistent with reported liver and kidney damage due to this contaminant. Changes in white blood cells included a greater frequency of thrombocytes and fewer lymphocytes in dosed birds compared to controls. A biomarker of exposure based on LDH activity and hemoglobin is proposed.

Thorpe, J. (1998). The implications of recent serious birdstrike accidents and multiple engine ingestions. 24th IBSC meeting, Stara Lesna, Slovakia 11 pp. from http://www.int-birdstrike.org/Slovakia_Papers/IBSC24%20WP03.pdf.

The paper provides details of three recent accidents to multi-engined aircraft due to birds resulting in the death of 58 people. These were to four-engined military aircraft having implications for the airline world. The paper also examines 10 years of data from incidents where UK registered airliners suffered ingestion in more than one engine. Analysis of the 73 cases (1.7% of 4268 reported birdstrikes) shows that the rate for this type of incident varies from 3 per million flights on twin engined airlines to 8 on three-engined airliners and 5 on four-engined. In one case, on the latter, all four engines had to be changed. The strike rate is significant in safety terms. Gulls (Larus spp) were involved in 47% of the incidents followed by Lapwings (Vanellus vanellus) with 15%, i.e. 'controllable' species. These percentages are similar to those for all birdstrike incidents. Bird population data shows that the UK inland wintering population of both small and large gulls has risen steadily during the last 40 years, thus increasing the likelihood of such incidents. The threat from small birds e.g. starlings (Sturnus vulgaris), to turboprop aircraft, cannot be overlooked. Comparison with data from all bird strikes revealed that multi-engined strikes were more likely at dawn and dusk, but less likely during the day, possibly when flocks of birds were more easily seen by airport staff. The majority (76%) of incidents were at a height that was compatible with the aircraft being on or within the airport boundary. The paper concludes that the current level of risk can be reduced by the more rigorous application of established bird control measures on airports using proven technology supported by scientific assessment of the effectiveness of new technologies in order to reduce the likelihood of bird/aircraft encounters. With the CAA and FAA's declared intention of improving aviation safety during the next decade, bird hazards are one of the areas of risk.

Trimper, P.G., Standen, N.M., et al. (1998). "Effects of low-level jet aircraft noise on the behaviour of nesting osprey." Journal of Applied Ecology **35**(1): 122-130.

1. Nesting osprey Pandion haliaetus L. were exposed to controlled low-level CF-18 jet aircraft overflights along the Naskaupi River, Labrador, Canada, during 1995, Jet aircraft flew near five nests at distances ranging from 2.5 nautical miles (nm) to directly overhead at speeds of 400 -440 knots. 2. Maximum noise levels (L1) and other noise metrics were influenced by many factors including topography, distance, altitude, wind speed and direction. 3. Based on 240 h of observations from blinds, we recorded osprey nest attendance and egg exposure during 139 individual overflights. Similar observations were completed at two control nests. Overflights as low as 30 m above

ground occurred during incubation, nestling and prefledging only when observers were present. 4. Osprey behaviour did not differ significantly (P = 0.126) between pre- and post-overflight periods. Despite L1 values occasionally exceeding 100 decibels, adult osprey did not appear agitated or startled when overflown. 5. Osprey were attentive to and occasionally flushed from nests when float planes, other osprey or raptors entered territories, and when observers were entering or exiting blinds.

Wright, S.E., Dolbeer, R.A., et al. (1998). Deer on airports: an accident waiting to happen. Proceedings of the Vertebrate Pest Conference, Univ. of Calif., Davis. pp 90-95.

Aas, C.K. (1998). Civil aircraft bird strike statistics 1990-1996 from six highly trafficked Norwegian airports. Fly/fugl-kontoret. Fly/fugl-kontoret. 12 pp.

Aas, C.K. (1998). Measures to prevent birdstrikes at Norwegian airports. Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo. 2 pp.

1997

Auran, J.A. (1997). "Sjøfugl og fiskegarnproblematikken ved Vinge/Skatval." Trøndersk Natur **24**(1): 19-21.

Belant, J.L. (1997). "Gulls in urban environments: landscape-level management to reduce conflict." Landscape and Urban Planning **38**(3-4): 245-258.

Populations of several species of gulls (Larus spp.) have increased dramatically throughout coastal areas of North America and Europe during the past several decades. These increases have been attributed generally to protection from human disturbance, reduction in environmental contaminants, availability of anthropogenic food, and the ability of gulls to adapt to human-altered environments. Gull abundance in urban areas has resulted in numerous conflicts with people including hazards to aircraft, transmission of pathogens and parasites through contamination of water sources, damage to buildings from nesting material and defecation, and general nuisance. Various architectural and habitat management approaches presently are available to reduce gull/human conflicts. For example, gull use of putrescible-waste landfills may be reduced by covering refuse, diverting anthropogenic food to covered compost facilities, erecting wire grids over exposed refuse, and manipulation of turf height in leafing areas. Nesting on roofs can be alleviated through modifications of roofing substrate, reducing the number of roof structures present, and placement of overhead wires. Also, attractiveness of airports to gulls can be reduced through drainage of temporary water and by decreasing the availability of prey and leafing sites through habitat management. Architectural design and characteristics of adjacent habitat should be considered during the planning stages of new facilities in areas where use by gulls is likely. Although control activities can be effective at the site where the gull problem occurs, uncoordinated management efforts may cause relocation of the problems to surrounding areas. Also, site-specific management will rarely solve the problem across a larger scale (e.g., city-wide). A working group comprised of the respective city or county planning commission, affected businesses and other government agencies, private citizens, and wildlife professionals could be formed to provide overall direction for gull management. This working group would define the extent and nature of the problem, develop an appropriate management strategy incorporating ecology of the nuisance species, and conduct periodic assessments of program efficacy. An integrated, landscape-level management approach is necessary to ensure an overall reduction in conflict between gulls and people in urban environments. (C) 1997 U.S. Government. Published by Elsevier Science B.V.

Chilvers, B.L., Ryan, C.J., et al. (1997). "Factors affecting pilot-reported bird-strike rates at Christchurch International Airport, New Zealand." New Zealand Journal of Zoology **24**(1): 1-7.

Pilots' reports of their aircraft striking birds or having near misses at Christchurch International Airport from 1981 to 1993 were analysed to identify factors influencing the rate of such incidents. A preliminary analysis indicated that reporting of near misses was not influenced by recent bird strike incidents, which suggested that the data were reasonably robust to variation in pilot awareness of the problem. A total of 362 strikes was reported during the survey period, most commonly involving sparrows and gulls. Pilots were more likely to report near misses if the birds were large (e.g., gulls Larus spp., spur-winged plover Vanellus miles novaehollandiae, white-backed magpies Gymnorhina spp., and Australasian harrier Circus approximans) than if they were small (e.g., sparrows Passer domesticus and finches Carduelis spp.). The risk of an aircraft being struck varied both diurnally and seasonally, being highest at 0800-1000 h and in April. Birds seemed better able to avoid Boeing 737s than the quieter Boeing 767s and Whisper Jets. Bird-strike rates increased progressively in the early and mid 1980s, but this increase appears to have been halted through an intensive bird management programme in place since 1987 and restrictions on agricultural activity and urban refuse near the airport. However, quarterly bird-strike rates have been significantly more variable since 1987; the reason for this is unclear. A preliminary cost/benefit analysis of this management programme is presented.

Gabrey, S.W. (1997). "Bird and small mammal abundance at four types of waste-management facilities in northeast Ohio." Landscape and Urban Planning **37**(3-4): 223-233.

Location of waste-management facilities in urban and suburban areas is increasingly controversial for a variety of reasons. Because traditional putrescible-waste landfills often attract large numbers of gulls (Larus spp.) and other birds, they can present a significant risk to air-traffic safety when located near airports. The Federal Aviation Administration (FAA) provides recommendations for the location of putrescible-waste landfills and other waste-management facilities near airports because of the potential for bird-aircraft collisions. To extend the life of traditional putrescible-waste landfills, many communities are turning to non-traditional waste-management facilities such as yard-waste compost facilities, construction and demolition landfills, and trash-transfer stations. These types of facilities may present potential bird-strike risks, and may attract nuisance birds such as starlings (Sturnus vulgaris) and rock doves (Columba livia), and nuisance mammals such as Norway rats (Rattus norvegicus). Objective data are needed on bird and mammal use of these facilities for wildlife biologists to advise regulatory agencies and local governments on the siting and management of these facilities. From May 1993 to April 1994, we compared bird species and numbers at five non-traditional waste-management facilities of three types in northeastern Ohio with species and numbers at a vacant lot (control site) and at a major putrescible-waste landfill. We also surveyed small mammal species and numbers at two compost facilities, a vacant lot, and a small wooded lot. Bird abundance at the five facilities was no different than, or less than, at the vacant lot. About 350 times more birds were seen per observation at the putrescible-waste landfill than at the other five waste-management facilities. Bird use of these non-traditional waste-management facilities appears to be influenced much more by the type of habitat or land-use surrounding the facility than by the waste itself. Fewer small mammals were caught at the compost facilities than at the vacant lot and wooded area. Thus, these non-traditional waste-management facilities do not appear to attract birds or small mammals at higher than background levels and would not pose a significant nuisance problem to the community or be a hazard to aircraft if located near airports.

Grubb, T.G. and Bowerman, W.W. (1997). "Variations in breeding bald eagle responses to jets, light planes and helicopters." Journal of Raptor Research **31**(3): 213-222.

Holm, C. (1997). "Disturbance of dark-bellied brent geese by helicopters in a spring staging area." Dansk Orn. Foren. Tidsskr. **91**: 69-73.

Thorpe, J. (1997). The implications of recent serious bird strike accidents and multiple engine ingestions. International Workshop on New Technologies for Bird Strike Prevention, Boston, US.

The paper provides details of three recent accidents to multi-engined aircraft due to birds resulting in the death of 58 people. These were to four-engined military aircraft having implications for the airline world. The paper also examines 10 years of data from incidents where UK registered airliners suffered ingestion in more than one engine. Analysis of the 73 cases (1.7% of 4268 reported birdstrikes) shows that the rate for this type of incident varies from 3 per million flights on twin engined airlines to 8 on three-engined airliners and 5 on four-engined. In one case, on the latter, all four engines had to be changed. The strike rate is significant in safety terms. Gulls (Larus spp) were involved in 47% of the incidents followed by Lapwings (Vanellus vanellus) with 15%, i.e. 'controllable' species. These percentages are similar to those for all birdstrike incidents. Bird population data shows that the UK inland wintering population of both small and large gulls has risen steadily during the last 40 years, thus increasing the likelihood of such incidents. The threat from small birds e.g. starlings (Sturnus vulgaris), to turboprop aircraft, cannot be overlooked. Comparison with data from all bird strikes revealed that multi-engined strikes were more likely at dawn and dusk, but less likely during the day, possibly when flocks of birds were more easily seen by airport staff. The majority (76%) of incidents were at a height that was compatible with the aircraft being on or within the airport boundary. The paper concludes that the current level of risk can be reduced by the more rigorous application of established bird control measures on airports using proven technology supported by scientific assessment of the effectiveness of new technologies in order to reduce the likelihood of bird/aircraft encounters. With the CAA and FAA's declared intention of improving aviation safety during the next decade, bird hazards are one of the areas of risk.

Aas, C.K. (1997). Evaluering av skremmemetoder mot fugler på Stavanger lufthavn, Sola, i 1996. Fly/fugl-kontoret, Naturhistorisk museum, Universitetet i Oslo, Oslo. 11 pp.

1996

Berntsen, F., Langvatn, R., et al. (1996). Reinens reaksjon på lavtflygende luftfartøy. **390**. SINTEF, NINA, Trondheim. 22 pp.

Buurma, L.S. (1996). Bird movements around airports: a critical issue in the specification of avoidance systemsa. 23th IBSC meeting, London. pp 543-554.

Côté, S.D. (1996). "Mountain goat responses to helicopter disturbance." Wildlife Society Bulletin **24**: 681-685.

Deacon, N. (1996). Airfield bird control - applying the principles. 23th IBSC meeting, London. pp 319-325.

Dolbeer, R.A. and Arrington, D.P. (1996). Can albatrosses and aircraft coexist on Midway atoll? 23th IBSC meeting, London. pp 327-335.

Fleming, W.J., Dubovsky, J., et al. (1996). An assessment of the effects of aircraft activities on waterfowl at Piey Island, North Carolina. The North Carolina Cooperative Fish and Wildlife Research unit, North Carolina State University.

Gabrey, S.W. and Dolbeer, R.A. (1996). "Rainfall effects on bird-aircraft collisions at two United States airports." Wildlife Society Bulletin **24**(2): 272-275.

We examined the influence of rainfall on bird-aircraft collisions at 2 major United States airports. Presence of standing water from rainfall did not increase the probability of bird-aircraft collisions at John F. Kennedy international Airport during April-October, 1986-1990. However, at O'Hare international Airport there was evidence that standing

water increased collision rates. During April-October 1992-1994, collision rates were higher 1 day after greater than or equal to 2.54 cm rain than at other times. Although this analysis showed no clear-cut influence of rainfall on bird-aircraft collisions, airport operations personnel, as precautionary measures, should continue efforts to remove standing water and deter bird use of puddles. Detailed long-term data on daily bird-aircraft collisions, rainfall, and bird use of standing water are needed from other airports so that a more comprehensive and generalized analysis of collisions in relation to rainfall can be made.

Hahn, E. (1996). Falconry and bird control of a military airfield and waste disposal site. 23th IBSC meeting, London. pp 347-351.

Horton, N. and Milsom, T. (1996). Bird strike statistics can be meaningful: The CSL analysis. 23th IBSC meeting, London. pp 91-.

Jacobi, V. (1996). Study of bird behaviour to bird strike preventioin. 23th IBSC meeting, London. pp 337-343.

Kelly, T.C., Murphy, J., et al. (1996). Ecological disturbance and bird hazard control. 23th IBSC meeting, London. pp 287-289.

Kempf, N. and Huppop, O. (1996). "The effects of aircraft noise on wildlife: A review and comment." Journal Fur Ornithologie **137**(1): 101-113.

The discussion of noise effects involves physical, physiological, and psychological aspects making an evaluation quite difficult. In humans the effects of noise range from discomfort to severe, irreversible damage. In laboratory animals only strong and long lasting noise causes physiological changes that can affect health. These findings are only partly applicable to wild animal. Field studies have to deal carefully with (1) methodological difficulties in measuring sound pressure levels, (2) interspecific differences of auditory sensitivity, and (3) problems in interpreting behavioural reactions in the field. Non-standardized methods of observations and analysis make a comparison of the results found in the literature almost impossible. Especially the noise of aircraft can scarcely be assessed separately from its optical appearance. Optical or acoustical stimuli taken separately have only minor effects with the optical stimulus evoking the stronger reaction; even soundless paragliders can cause panic flights. In general, noise plays a minor role as a disturbance factor, but in combination with optical stimuli can trigger a reaction. Sonic booms and jet aircraft noise sometimes cause startle responses, which mostly do not result in severe consequences. Apparently, animals can adapt to high noise exposures. When animals react to aircraft noise, it is often due to previous experience associating the noise with an aircraft. Aside from a few accidents caused by panic flights, negative consequences of aircraft noise per se on individuals and populations are not proven. In contrast aircraft traffic in general can cause a variety of damages. Concerning the effects of noise on wildlife, many questions remain.

Larkin, R.P. (1996). Effects of military noise on wildlife: a literature review. USACERL.

Linnell, M.A., Conover, M.R., et al. (1996). "Analysis of bird strikes at a tropical airport." Journal of Wildlife Management **60**(4): 935-945.

Bird-aircraft collisions (bird strikes) are a major problem worldwide because they threaten passenger safety and result in costly repairs and lost revenue for the commercial air carrier. From 1990 to 1994, we conducted runway sweeps at Lihue Airport on Kauai, Hawaii searching for avian remains from bird-aircraft collisions. Three species of granivorous birds, 2 owl species, and the Pacific golden-plover (Pluvialis fulva) composed >80% of the bird strikes. Ninety-one percent of the strikes involved solitary birds; 9% involved >1 bird. Bird strikes were positively correlated with mean

monthly rainfall, perhaps due to increased seed production along runways during the rainy months, resulting in increased bird use in hazardous areas. Bird strike rates were also higher when winds were from a southwesterly direction and lower when cloud cover was 100%. Larger, faster commercial air carriers exhibited higher strike rates than military or general aviation types, with engine ingestions being most common, followed by strikes on the windshield and nose. Ingestions resulted in losses >$1.5 million in damage. Damage was caused by species ranging in mass from 13-1,300 g. More bird strikes occurred during landings than takeoffs with strikes unevenly distributed along the runway. During the landing phase, more bird strikes than expected occurred at the point of touchdown, whereas most strikes occurred in the mid-portion of the runway during takeoffs.

Nebain, V. (1996). An on-board bird reconition device for the prevention of bird strikes. 23th IBSC meeting, London. pp 555-564.

Richardson, W.J. (1996). Serious birdstrike-related accidents to military aircraft of europe and israel: list and analysis of circumstances. 23th IBSC meeting, London. pp 33-56.

This paper lists and summarizes the circumstances of 168 accidents in which military aircraft were destroyed or damaged beyond repair as a result of encounters with birds. At least 34 aircrew and 3 civilians on the ground were killed in these accidents. The analysis includes data from 21 countries: 14 in western and central Europe, 4 in eastern Europe, Israel, and Canadian and U.S. forces in Europe. Data were available for 15-46 years within the 1950-95 period, depending on the country. This paper excludes additional known accidents and fatalities in countries for which only fragmentary data were available. Of the 168 accidents considered, 45 were in the U.K. and Ireland, 18 in Scandinavia, 57 in western and central Europe, 11 in southern Europe (no data for Spanish forces), 21 in eastern Europe (data very incomplete), and 7 in Israel. At least nine European military aircraft were lost to birdstrikes outside Europe and Israel. Most aircraft lost were jet fighter and attack aircraft (88 before 1980; 55 from 1980 to date), single-engined trainers (12), or twin-engined bombers (7). Two 4-engine aircraft, a Victor tanker and Nimrod patrol aircraft, were lost in the U.K. The largest numbers of accidents (45 before 1980; 33 more recent) were during low-level (≤1000 feet AGL) cruise flight, mainly at high speeds. The second most common category involved aircraft at or near aerodromes (34 before 1980; 24 more recent), mainly at low altitude and low speed. Most losses involved engine ingestions and/or windscreen penetrations. Gulls, followed distantly by buzzards (hawks), ducks, pigeons and corvids, were the birds most commonly identified as being responsible for the accidents, with some notable regional differences. Additional accident data from other years and other countries are sought to provide a basis for a more comprehensive and representative list and analysis at a future date.

Rochard, B. (1996). Airfield bird control - setting the standards. 23th IBSC meeting, London. pp 311-318.

Savereno, A.J., Savereno, L.A., et al. (1996). "Avian behavior and mortality at power lines in coastal South Carolina." Wildlife Society Bulletin **24**(4): 636-648.

We compared avian behavior and mortality associated with two 115-kV transmission lines on the central South Carolina coast during 3,392 hours of observation from May 1991 through May 1994. One line was marked with 30-cm-diameter yellow aviation markers. The second line was unmarked, but was similar in most other aspects. We conducted ground searches (n = 445) beneath each line year-round to document avian mortality due to power-line collisions. At marked lines, birds that approached at line height changed behavior more at unmarked lines ($P < 0.001$), and fewer crossed between static and conductor wires. Collision rate was 53% lower at marked than unmarked lines. Among collisions at both sites, 82% of birds collided with static wires. Based on observed collisions and carcass recoveries, wading birds particularly

appeared to be at risk. We concluded that aviation markers were effective at increasing line visibility and reducing collisions and recommend marking static wires of power lines in potentially sensitive areas.

Shaw, E.A.G. (1996). "Noise environments outdoors and the effects of community noise exposure." Noise Control Engineering Journal **44**(3): 109-119.
Man-made noise, especially transportation noise, creates acoustical environments that are vastly different from those associated with pristine habitats, During the past 25 years, the day-night average sound level, has gained substantial acceptance as a measure of community noise exposure, During the same period, the effects of various levels of noise exposure on human activities and health have been widely studied, Data from many social surveys have been brought together and analyzed to clarify the relationship between noise exposure and the prevalence of annoyance which provides a broad indication of the impact of intrusive noise on human communities, Criteria and guidelines based on such studies are now widely used in urban planning and their effectiveness is enhanced by new standards that characterize sound propagation outdoors, Regulations that control motor vehicle noise at the source have, as yet, produced only limited benefits, while highway barriers provide some relief from excessive exposure to traffic noise. In recent years, there have been impressive reductions in the noise emissions from commercial aircraft and notable improvements in the control of airport noise, Finally, the potential effects of noise on wildlife, especially endangered species, now come under close scrutiny when noise-generating projects are planned in sensitive environments.

Short, J.J., Kelley, M.E., et al. (1996). Recent reasearch into reducing birdstrike hazards. 23th IBSC meeting, London. pp 381-407.

Speelman, R.J., Kelley, M.E., et al. (1996). Establishing and validating aircraft birdsrike resistance requirements. 23th IBSC meeting, London. pp 627-637.

Takac, A. (1996). "Birds as a hazard for a safe air traffic." SIGURNOST **38**(3): 195-202.
Since the beginning of aviation birds have been recognized as a potential hazard to safe operation of aircraft. The problem increased as aircraft has become faster and with the introduction of turbine-engined aeroplanes. Damage caused by birds to aircraft usually results from impact of a bird, or a number of birds, on the airframe or engines and can be very costly. In some cases bird strike can result in a loss of human lives in aircraft crashes. In order to reduce potential hazard to the civil aviation, it is essential to prepare and implement a bird control programme. International and national aviation regulating bodies have prepared advisory documents that guide airport operators in methods of reducing the risk of bird hazards through programs of bird strike control. The only way of reducing the risk of bird strikes beyond the boundaries of an airport for the time being is radar monitoring and detection of birds and their movements and a warning to the pilot by air traffic control to avoid areas where significant bird movements have been detected, which has already been done experimentally in several countries. Due to the increase in aircraft speed in the future, and the dynamic growth of air transport, it is expected that the potential hazard from bird strikes will rise in the future, although some structural improvements in airframe design might reduce potential damage to aircraft.

Tianhao, W. (1996). Bird strike prevention in China. 23th IBSC meeting, London. pp 135-139.

Vassilakis, K. (1996). Bird strikes in Greece. 23th IBSC meeting, London. pp 139-159.

Weisenberger, M.E., Krausman, P.R., et al. (1996). "Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates." Journal of Wildlife Management **60**(1): 52-61.

Many landscapes underlying military designated air spaces have been established as national parks, wildlife refuges, or wilderness areas. The juxtaposition of public, wilderness, and military uses has led to questions of compatibility between aircraft and wildlife. We evaluated the effects of simulated low-altitude jet aircraft noise on the behavior and heart rate of captive desert mule deer (Odocoileus hemionus crooki) (n = 6) and mountain sheep (Ovis canadensis mexicana) (n = 5). We measured heart rate and behavior related to the number of simulated overflights per day (range = 1-7) and noise levels (range = 92-112 decibels [dB]) that animals were exposed to. We compared heart rates and behavior of mountain sheep and desert mule deer before, during, and after simulated overflights (n = 112 overflights/season) during 3 seasons. The heart rates of ungulates increased related to dB levels during simulated overflights (P less than or equal to 0.05), but they returned to pre-disturbance levels in 60-180 seconds. Animal behavior also changed during overflights but returned to pre-disturbance conditions in <252 seconds (P less than or equal to 0.005) All animal responses decreased with increased exposure suggesting that they habituated to simulated sound levels of low-altitude aircraft.

Aas, C.K. (1996). Some characteristics of bird strikes to military aircraft in Norway 1985-1995. Proceedings of 23rd International Bird Strike Committee, London. pp 71-79.

1995

Alfiya, H. (1995). "Surveillance-radar data on nocturnal bird migration over Israel, 1989-1993." Israel Journal of Zoology **41**(3): 517-522.

The circular-scanning approach radar at the Ben-Gurion International Airport has been a major tool in studying nocturnal migration over Israel during 1989-1993. Nocturnal migration was studied by photographs of the radar screen. Each photo was a continuous 10-min exposure, taken every half hour, from nightfall to dawn. The photographs allowed determination of direction, magnitude, schedule, and velocity of migration. Comparison of results from five years of observations showed that the diurnal and seasonal schedule of nocturnal migration, as well as the variation in direction during the night, exhibit a pattern that repeats itself yearly.

Buurma, L.S. (1995). "Long-range surveillance radars as indicators of bird numbers aloft." Israel Journal of Zoology **41**(3): 221-236.

Radars filter and select bird echoes within their beam in several ways. Long-range surveillance radars miss many birds behind the radar horizon. Moreover, the spatial behavior of the birds varies, thus further reducing detectability. Disentangling these effects requires empirical knowledge of the radar and general insight into the bird movements. A rough classification of bird echoes on the basis of direction, speed, and echo-type is necessary to quantify the total broad-front migration cohort by cohort. The extremely flat Dutch countryside and an ideal stacked beam S-band radar equipped with a sophisticated bird extraction system provided the database for the calculation of proportions of birds missed under typical migratory conditions. This improved the use of radar as an indicator of flight safety risk as well as a research tool for unravelling navigational strategies of migrants in the North Sea area. The key issue appears to be the selection of altitude and track direction in relation to landscape, wind, and flight phase.

Conover, M.R., Pitt, W.C., et al. (1995). "Review of Human Injuries, Illnesses, and Economic-Losses Caused by Wildlife in the United-States." Wildlife Society Bulletin **23**(3): 407-414.

Ilichev, V.D. (1995). "Natural and technogenic noise - possibility of ecological comparison by level." Izvestiya Akademii Nauk Seriya Biologicheskaya(3): 351-360.

The levels of motor transport and aviation noise were compared with the ecological noise (singing of birds) in five survey grounds located in the Moscow District and South Urals represented by different landscape zones and forests. For comparison equivalent

sound records were used, which were measured using an integrating sound level meter or calculated from tables on the basis of per second measurement of the sound levels using a standard sound level meter with correcting scale A for 30 min, It was shown that the noisiness of the studied bird habitats is mostly due to the sounds of medium intensity generated by motor transport and aviation, as well as to the voices of birds during the period of reproduction and to meteorological noise, The main range of noisiness embraced 40 to 80 dB, with some oscillations beyond these limits, Comparison of these data. with the technogenic noisiness of the urban environment has shown predominance of high-intensity components in the urban environment as compared with the natural environment.

Ilichev, V.D., Kamenskii, I.I., et al. (1995). "Ecological and technogenous factors of noise pollution of natural habitats of birds." Russian Journal of Ecology **26**(5): 345-348.

Noise pollution caused by transport was compared with that of natural origin at five experimental plots in Central Russia and the Southern Ural Region by means of standard and modified methods. Bird songs were registered as an ecological factor. A priority increment of technogenous factors was revealed for the territories around motor, aircraft, and railroad sources. It was shown with reference to the chaffinch that bird songs are deformed under conditions of technogenous noise pollution.

Luick, B.R. and White, R.G. (1995). Computer simulation model for jet aircraft disturbance of free ranging caribou. **AL/OE/MN-1994-001**. Armstrong Laboratory, Fairbanks Alaska. 48 pp.

Milsom, T.P. and Horton, N. (1995). Birdstrike. In an assessment of the hazard on UK civil aerodromes 1976-1990. Central Science Laboratory, York.

Aas, C.K. (1995). Rapport fra Fly/fugl-kontoret etter F-16 havari 4. mai 1995 ved Moss, Østfold. Fly/fugl-kontoret. 3 pp.

Aas, C.K. (1995). Uttalelse om fuglelivet på Ørsta-Volda lufthamn og tiltak for å redusere kollisjonsrisikoen mellom fugler og fly på flyplassen. Fly/fugl-kontoret. 5 pp.

Aas, C.K. (1995). Søppeldeponiet i Rådalen, avvisningsnettet og dets effekt på antall fugler - rapport fra perioden 20. juni 1994 til 1. mars 1995. Fly/fugl-kontoret. 3 pp.

1994

Andersen, R., Linnell, J.D.C., et al. (1994). Militær aktivitets innvirkning på hjortevilt. **316**. NINA, Trondheim. 22 pp.

Bleich, V.C., Bowyer, R.T., et al. (1994). "Mountain sheep Ovis canadensis and helicopter surveys: Ramifications for the conservation of large mammals." Biological Conservation **70**(1): 1-7.

Mountain sheep Ovis canadensis respond dramatically to helicopter disturbance. Significantly more animals abandoned sampling blocks and moved farther during helicopter surveys than on nonsurvey days throughout the year. Likewise, mountain sheep changed the vegetation type they occurred in more often after than before helicopter surveys; however, this difference was only significant during spring. Mountain sheep did not habituate or become sensitized to repeated helicopter overflights: time since capture was not related to their movements. The negative influence of the helicopter was extreme and may override variables that might otherwise be correlated with movement patterns of mountain sheep: this outcome also may hold for other ungulates. Further, sampling with helicopters may result in the violation of fundamental assumptions of population estimators routinely employed in conservation efforts for large mammals. The consequences of disturbing mountain sheep, such as altering use of habitat, increasing susceptibility to predation, or increasing nutritional stress, need additional study. These factors all have ramifications

for the conservation of mountain sheep and other large mammals disturbed by helicopter sampling.

Bowles, A.E., Knobler, M., et al. (1994). Effects of simulated sonic booms on the hatchability of White leghorn chicken eggs.

Buckley, P.A. and Mccarthy, M.G. (1994). "Insects, vegetation, and the control of Laughing Gulls (Larus atricilla) at Kennedy international airport, New-York-City." Journal of Applied Ecology **31**(2): 291-302.

1. In response to a purported 'bird-strike problem' at J.F. Kennedy International Airport in New York City, we examined short (5 cm) and long (45 cm) grass heights as gull deterrents, in a randomized-block experiment. 2. Vegetative cover, numbers of adult insects and of larval beetles (suspected on-airport food of the gulls) were sampled in the six-block, 36-plot study area, as well as gut contents of adult and downy young gulls in the immediately adjacent colony in the Jamaica Bay Wildlife Refuge. 3. We found that (i) Oriental beetle larvae were the most numerous and concentrated in one experimental block; (ii) beetle larvae numbers were uncorrelated with grass height; (iii) adult beetles were also uncorrelated with grass height; (iv) laughing gulls were distributed across blocks irrespective of percentage cover; (v) within blocks, laughing gulls were selecting short grass and avoiding long grass plots; (vi) laughing gull numbers were positively associated with numbers of Oriental beetle larvae; (vii) adult laughing gulls on the airport were eating lower-nutrition food of terrestrial origin (74-83% adult beetles, mostly Oriental plus green June and ground beetles); (viii) on the other hand, gull chicks in the adjacent breeding colony were being fed more easily digested, higher-protein food of marine origin (86-88% fishes, crustacea and molluscs); (ix) laughing gulls on the airport were taking their adult beetles only in short-grass plots, ignoring large numbers in adjacent long grass; (x) during the summer, on-airport gulls shifted from performing largely maintenance activities on pavement to feeding actively for beetles on newly mown short grass, the change coinciding with adult beetle emergence; (xi) standing water on the airport attracted significantly more gulls than dry areas all summer long. 4. We recommend a series of ecologically compatible, but aggressive habitat management actions for controlling laughing gulls on Kennedy Airport by rendering the airport unattractive to them, notably by implementing an airport-wide programme of long-grass encouragement, draining standing water and improving runoff in water-collecting areas, and controlling beetles. 5. We conclude by outlining the necessity for airport-wide bird, vegetation and habitat management programmes fully integrated into airport operation and planning activities.

Caccamise, D.F., Dasch, J.J., et al. (1994). Management of bird strike hazards at airports: a habitat approch. 22th IBSC meeting, vienna. pp 285-306.

Chamorro, M. and Clavero, J. (1994). Falconry for bird control on airdromes (the Spanish experience after 26 years). 22th IBSC meeting, Vienna. pp 397-407.

Dekker, A. (1994). Airfield bird counts, a management tool in the prevention of on-airfield birdstrikes. 22th IBSC meeting, Vienna. pp 343-360.

Dolbeer, R.A. and Bucknal, J.L. (1994). Shooting gulls reduces strikes with aircraft at John F. Kennedy international airport, 1991-1993. 22th IBSC meeting, Vienna. pp 375-396.

Gabrey, S.W., Belant, J.L., et al. (1994). "Bird and Rodent Abundance at Yard-Waste Compost Facilities in Northern Ohio." Wildlife Society Bulletin **22**(2): 288-295.

Godin, A. (1994). "Birds at airports." Prevention and Control of Wildlife Damage **1**: 1-4.

Horesh, Z. and Milo, Y. (1994). Using traps to control pigeon populations in airfields. 22th IBSC meeting, Vienna. pp 367-374.

Langvatn, R. (1994). Rein og flystøy, . N. Høyesterett**:** 17 pp.

Leptich, D.J., Beck, D.G., et al. (1994). "Aircraft-based Loran-C and gps accuracy for wildlife research on inland study sites." Wildlife Society Bulletin **22**(4): 561-565.

Lischak, W. (1994). Bird control and reduction. 22th IBSC meeting, Vienna. pp 93-94.

Miller, M.W. (1994). "Route selection to minimize helicopter disturbance of molting Pacific Black Brant - a simulation." Arctic **47**(4): 341-349.

I used a previously described simulation model to assess the effects of helicopter activity on approximately 18 000 molting Pacific black brant (Branta bernicla nigricans) near Teshekpuk Lake, Alaska. Bell 206 and Bell 412 helicopters were simulated flying across the molting grounds along six flight lines at various altitudes and frequencies between two airfields. The model determined the behavioral and energetic responses of every bird encountered by the aircraft during an overflight, then calculated the weight of these birds at the end of wing molt. Body condition of the brant, reflected in weight loss, was used to quantify the impact of helicopter disturbance. The number of birds in each of five risk categories was determined for each route, altitude, helicopter type, and overflight frequency. Flight lines and overflight patterns that minimized disturbance to the molting population were identified. Slightly altering the direct route between the two airfields resulted in up to 91% fewer birds experiencing heavy weight loss. Flying either helicopter type around the southern edge of the molting grounds caused the least disturbance; flying parallel to the coast, 1.6 km inland, caused the most. The Bell 412 caused up to 15% more weight loss than did the smaller helicopter. Weight loss along a given flight line can be reduced by 1) flying at altitudes greater than 1065 m altitude, 2) flying only when most brant are in their second week of molt, 3) minimizing flight frequency, and 4) avoiding use of the larger Bell 412 when possible.

Miller, M.W., Jensen, K.C., et al. (1994). "A simulation-model of helicopter disturbance of molting Pacific Black Brant." Ecological Modelling **73**(3-4): 293-309.

We describe a simulation model designed to study the effects of helicopter disturbance on molting Pacific black brant near Teshekpuk Lake, Alaska. Locations of 18 118 brant were digitized into the model based on 10 years of population survey data. Bell 206 and Bell 412 helicopters were simulated flying across the molting grounds along two routes between two airfields. The model determined the behavioral and energetic response of birds encountered by the aircraft during an overflight. Altitude and frequency of overflights were held constant during a simulated 28-day molting period, but were varied among simulations. The model provided the degree of weight loss these birds experienced due to helicopter disturbance. The effects of overflights on brant were classified into five risk categories based on weight. For both routes, the number of flocks and birds in each category was determined for each altitude, aircraft type, and overflight frequency. Simulation results indicated that the model can be used to identify flight-line modifications that result in significantly decreased disturbance to the birds.

Murphy, S.M., White, R.G., et al. (1994). Behavioral effects of jet aircraft on caribou in Alaska. International Congress on Noise as a Public Helth Problem. 479-486 pp. 6.

Pilo, B., Kumar, A., et al. (1994). Anti-bird collision strobe lights: field experiments on Indian birds. 22th IBSC meeting, Vienna. pp 69-72.

Ray, A., Wu, M.K., et al. (1994). "Damage-mitigating control of mechanical systems .1. Conceptual development and model formulation." Journal of Dynamic Systems Measurement and Control-Transactions of the Asme **116**(3): 437-447.

A major goal in the control of complex mechanical systems such as advanced aircraft, spacecraft, and power plants is to achieve high performance with increased reliability availability, component durability, and maintainability. The current state-of-the-art of control systems synthesis focuses on improving performance and diagnostic capabilities under constraints that often do not adequately represent the dynamic properties of the materials. The reason is that the traditional design is based upon the assumption of conventional materials with invariant characteristics. In view of high performance requirements and availability of improved materials, the lack of appropriate knowledge about the properties of these materials will lead to either less than achievable performance due to overly conservative design, or over-straining of the structure leading to unexpected failures and drastic reduction of the service life. The key idea of the research reported in this paper is that a significant improvement in service life can be achieved by a small reduction in the system dynamic performance. This requires augmentation of the current system-theoretic techniques for synthesis of decision and control laws with governing equations and inequality constraints that would model the properties of the materials for the purpose of damage representation and failure prognosis. The major challenge in this research is to characterize the damage generation process in a continuous-time setting, and then utilize this information for synthesizing algorithms of robust control diagnostics, and risk assessment in complex mechanical systems. Damage mitigation for control of mechanical systems is reported in the two-part paper. The concept of damage mitigation is introduced and a continuous-time model of fatigue damage dynamics is formulated in this paper which is the first part. The second part which is a companion paper presents the synthesis of the open-loop control policy and the results of simulation experiments for transient operations of a reusable rocket engine.

Satheesan, S.M. (1994). "Data on migratory birds from bird-aircraft strike incidents in India." Ostrich **65**(2): 247-248.

Seubert, J.L. (1994). Assessing the implementation of wildlife hazard management programs at civil airports. 22th IBSC meeting, Vienna. pp 275-284.

Steffen, R. (1994). Anti-bird collision (ABC) light system to prevent bird strike in aviation; cost - cause - solution. 22th IBSC meeting, Vienna. pp 63-68.

Stenman, O. and Helikamo, H. (1994). Bird strike prevention at Helsinki - Vantaa airport. 22th IBSC meeting, Vienna. pp 467-470.

Yashon, J. (1994). Bird strike deterrence and threat management at Ben Gurion international airport, Israel. 22th IBSC meeting, Vienna. pp 317-320.

Zalakevicius, M. (1994). Bird strike analysis in Lithuania. 22 IBSC meeting Vienna. pp 189-196.

Aas, C.K. (1994). "Trekkfuglene kommer - er du klar??" Flytrygging(10): 6-7.

1993

DeFusco, R.P. (1993). "Modeling bird hazards to aircraft - A GIS application study." Photogrammetric Engineering and Remote Sensing **59**(10): 1481.

Dolbeer, R.A., Belant, J.L., et al. (1993). "Shooting gulls reduces strikes with aircraft at John F. Kennedy International Airport." Wildlife Society Bulletin **21**(4): 442-450.

Ingold, P., Huber, B., et al. (1993). "Tourism and sport in the Alps - a serious problem for wildlife." Revue Suisse De Zoologie **100**(3): 529-545.

The paper deals with the question to what extent increasing tourist and leisure activities are a serious problem for wildlife. It presents the project "Tourismus und Wild" carried out between 1990 and 1993. The aim of the project is to measure the effects of different forms of tourism and leisure activities (hiking, paragliding etc.) as a basis for optimizing the relationship between tourism/recreation and wildlife. The studies were carried out on chamois, ibex, alpine marmots and ptarmigan in several areas of the Swiss alps differing in their amount of tourist and leisure activities: a) in the same area in the course of the day and on different days; b) in different sections of an area and in different areas. Several examples from the current study are used for illustration. Hikers and alpine marmots: the example shows that hiking can have a stronger effect than would be expected from the greatly reduced flight distances of the animals. It shows as well that it matters whether hikers keep to the path and whether they are accompanied by a dog or not. Hikers and chamois: moderate hiking activity on a path leading across a preferred grazing area of male chamois influences their use of the area in the course of the day. When hikers are present the chamois avoid the attractive grazing areas. Hikers and ptarmigan: By measuring heart-rate it was shown that bradycardia (decrease in frequency) occurs when a person is approaching the nest. Bradycardia is a subtle indicator for stimuli to which incubating hends in the context of predator avoidance. Paragliders and chamois: in areas which so far have been rarely used by paragliders experimental flights provoked strong reactions (escape to the woods at great distances). The development of the responses is followed up. It is not yet possible to present definite results on the behaviour of animals in areas where paragliding has been carried out for a long time. Criteria are listed to clarify the question as to when certain events have to be considered as a "serious problem": reduced survival and/or reproduction rate (even if a direct proof is lacking, as long as there is a strong indication from the analysis of the behaviour); habitat loss; effects on further elements of the habitat (e.g. damage to the vegetation due to overgrazing). There is an urgent need to solve the problem of "flying objects (particularly paragliders) and wildlife". In collaboration with the federal office for the environment and the groups concerned (e.g. paragliding association) it is planned to work out measures to limit the effect on wildlife.

Krausman, P.R., Wallace, M., et al. (1993). Effects of simulated aircraft noise on heart rate and behaviour of desert Ungulates. Armstrong laboratory. 70 pp.

Krausman, P.R., Wallace, M.C., et al. (1993). The effect of low-altitude aircraft on mountain sheep heart rate and behaviour. Armstrong laboratory. 134 pp.

Murphy, S.M., White, R.G., et al. (1993). Behavioural effects of jet aircraft on caribou in Alaska. 6th int. Congr. "Noise and Man `93. 8 pp. 3.

Watson, J.W. (1993). "Responses of nesting bald eagles to helicopter surveys." Wildlife Society Bulletin **21**(2): 171-177.

Aas, C.K. (1993). Årsrapport 1992 - Fly/fugl-kontoret. Zoologisk Museum, Universitetet i Oslo. 10 pp.

Aas, C.K. (1993). Kollisjoner mellom fly og fugl på Sola i perioden 1990-1992. Fly/fugl-kontoret. 5 pp.

Aas, C.K. (1993). Kollisjoner mellom sivile fly og fugl i 1992. Fly/fugl-kontoret. 5 pp.

Aas, C.K. (1993). "Beware birds! Trekkfuglene er tilbake igjen!" Flytrygging(12): 4-5.

1992

Biryukov, V.Y. and Lapinskis, Z. (1992). Biotechnical devices of bird scaring. 21th IBSC meeting, Jerusalem. pp 109-117.

Braid, R.B. (1992). "Incorporation of public participation in environmental analyses of low-altitude flying operations." The Environmental professional **14**: 60-69.

Hamersock, D.M. (1992). Ultrasonics as a method of bird control. Wright Lab., Wright-Patterson AFB, OH (USA).

The potential users of ultrasonic bird repelling devices (UBRDs) are many and include: all branches of the military, airfield managers, biologists, pest control/maintenance employees, government agencies (the Federal Aviation Administration, the US Department of Agriculture), agri-/aquaculturalists, aircraft manufacturers, and homeowners. A literature search conducted to find reports addressing the efficacy of UBRDs revealed several substantial efforts. This report compiles and presents the results of the literature search. Avian hearing physiology, ultrasonic sound characteristics, and the physical effects of ultrasonics on biological systems are addressed. Avian hearing physiology, ultrasonic sound characteristics, and the physical effects of ultrasonics on biological systems are addressed.

Harrington, F.H. and Veitch, A.M. (1992). "Calving success of woodland caribou exposed to low-level jet fighter overflights." Arctic **45**(3): 213-218.

Effects on woodland caribou (Rangifer tarandus caribou) of low-level military jet training at Canadian Forces Base - Goose Bay (Labrador) were studied during the 1986-88 training seasons. Calf survival was periodically monitored during 1987 and 1988 in a sample of 15 females wearing satellite-tracked radiocollars. During 1987, each female's exposure to low-level overflights was experimentally manipulated on a daily basis. In 1988, daily exposure was determined by analyzing jet flight tracks following the low-level flying season. Calf survival was monitored by survey flights every 3-4 weeks. A calf survival index, the number of survey periods (maximum = 4) that a cow was accompanied by a calf, was negatively correlated with the female's exposure to low-level jet overflights during the calving and immediate post-calving period and again during the period of insect harassment during summer. No significant relationship between calf survival and exposure to low-level flying was seen during the pre-calving period, during the late post-calving period prior to insect harassment, and during fall.

Aas, C.K. (1992). Ornitologisk befaring ved Fornebu, Sola og Flesland flyplasser høsten 1991. Luftfartsverkets og Luftforsvarets Fly/fugl-kontor, Oslo. 10 pp.

Aas, C.K. (1992). "Elgen - blant lover og regler… og fly! ." Flytrygging(4): 15-16.

1991

Bowles, A.E., Tabachnick, B., et al. (1991). Review of the effects of aircraft overflights on wildlife. **2**. National Park Service, Denver, Colorado.

Ellis, D.H., Ellis, C.H., et al. (1991). "Raptor responses to low-level jet aircraft and sonic booms." Environmental Pollution **74**: 53-83.

Gauthreaux, S.A. (1991). "The flight behavior of migrating birds in changing wind fields - radar and visual analyses." American Zoologist **31**(1): 187-204.

This paper examines the influence of atmospheric structure and motion (principally winds aloft) on the flight behavior and altitudinal distribution of migrating song-birds. Bird migration data that I gathered using surveillance radars operated by the United States National Weather Service and the Federal Aviation Administration and a vertically directed fixed-beam marine radar mounted on a mobile laboratory are

analyzed in relation to winds aloft. Migrating birds appear to fly at altitudes where winds will minimize the cost of transport and assist movements in seasonally appropriate directions. When migratory flights occur at altitudes that are higher than usual, a significant correlation exists between the altitude of densest migration and the altitude of most favorable wind. Lower altitudes may be favored over slightly more favorable winds at much higher altitudes. Radar data on the flight behavior of migrating birds in the vicinity of frontal systems is also examined. The flight strategies of migrants (fly over the front, change the direction of flight, or land and terminate the flight) differ depending on season and the "thickness" of the front. Recent migration studies that are related to atmospheric structure and motion are summarized and related to atmospheric processes operating simultaneously at vastly different spatial and temporal scales.

Harrington, F.H. and Veitch, A.M. (1991). "Short-term impacts of low-level jet fighter training on caribou in Labrador." Arctic **44**: 318-327.

Haykin, S., Stehwien, W., et al. (1991). "Classification of radar clutter in an air-traffic-control environment." Proceedings of the IEEE **79**(6): 742-772.

This paper may be viewed as the culmination of a radar clutter classification research program that has spanned over 15 years. In particular, we present the results of an experimental study aimed at the classification of radar clutter encountered on ground-based coherent scanning radar systems used for air traffic control. The clutter signals of interest are primarily those due to birds as well as clouds and weather systems. These two sources of radar returns represent potential hazards to aircraft safety. The aim of the clutter classifier is therefore to vector aircraft around such areas. The clutter classification presented herein is based on a set of features derived from a sequence of reflection coefficients computed using Burg's multisegment algorithm. These features contain two types of information, namely, signal strength, and Doppler. Two feature classifiers were evaluated experimentally: 1 A parametric Bayes classifier, assuming that the features are distributed according to the multivariate Gaussian distribution. 2 A neural network classifier that makes no such assumptions. Training of the neural network classifier is achieved using the popular back-propagation algorithm. The classification is performed using real-life radar data contained in a single resolution cell and collected during the course of a single antenna scan.

Langvatn, R. and Andersen, R. (1991). Støy og forstyrrelser, -metodikk til registrering av hjortedyrs reaksjon på militær aktivitet. NINA, Trondheim. 51 pp.

Machalek, M.J. and Taylor, R.J. (1991). "A bird-aircraft strike hazard expert system (Bashes)." AI Applications **5**(3): 1-8.

Bird-aircraft strikes have been a problem since the beginning of aviation. An expert system was developed to warn military pilots of locations with high concentrations of birds in the airspace. The study area covered parts of Utah and Nevada. The Great Salt Lake is central to this area containing many waterfowl management areas and duck clubs. Sanitary landfills along the east side of the lake attract many species of gulls. The program, written in the object-oriented language Smalltalk/V, is graphical in nature and contains a user-friendly interface. All relevant information is extracted from the user at the beginning of a run. Several sets of data are accessed, each with its own set of rules, to determine hazardous areas. The final product is a map of the study area with high bird-strike hazard areas indicated in red. While our goal was to make biological data available quickly and easily to non-biologists, BASHES may find another use in allowing research biologists to explore the dependence of bird movement patterns on date, time, and weather conditions.

Stockwell, C.A., Bateman, G.C., et al. (1991). "Conflicts in national-parks - a case-study of helicopters and Bighorn sheep time budgets at the Grand-Canyon." Biological Conservation **56**(3): 317-328.

Wildlife in numerous national parks of the United States experience frequent overflights by aircraft. Such activities may disturb wildlife populations. We analysed time budgets for desert bighorn sheep Ovis canadensis nelsoni in the presence and absence of helicopter overflights at Grand Canyon National Park (GCNP) to determine the extent to which food intake may be impaired. Bighorn were sensitive to disturbance during winter (43% reduction in foraging efficiency) but not during spring (no significant effect). This seasonal difference may have arisen because the sheep were farther from helicopters during the spring after they had migrated to lower elevations. Further analyses indicated a disturbance distance threshold of 250-450 m. The conservation implications of these results are discussed.

Aas, C.K. (1991). "Fra fuglefronten." Flytrygging(1): 11.

Aas, C.K. (1991). "Høyt flyr de og mange er de! ." Flytrygging(2): 19-20.

1990

[Anon] (1990). The Green booklet : some measures used in different countries for reduction of bird strike risk around airports. Helsinki, Bird Strike Committee Europe, Aerodrome Working Group.

Bentz, P.-G. (1990). Måkefuglers forekomst ved avfallsdeponiet i Rådalen, Bergen, sett i forhold til planlagt flytting av deponiet til Skeisåsen og sikkerhets- messige konsekvenser for flytrafikken vedBergen lufthavn/Flesland. Luftfartsverkets og Luftforsvarets fly/fugl-kontor, Oslo. 19 pp.

Bentz, P.-G. (1990). "Ser du trekkfuglene? Meld fra!" Flytrygging(1): 10.

Bentz, P.-G. (1990). "Snösparvar i transit på flygplatser." Fauna och flora **85**: 1-9.

Bentz, P.-G. and Brom, T.G. (1990). The Convair accident in the Skagerak 1989 – A presentation of the identification work on feather remains found in the wreckage. Proc. Bird Strike Comm. Europe 20th Meet., Valtion, Helsinki. pp 363-371

Bleich, V.C., Bowyer, R.T., et al. (1990). "Responses of mountain sheep to helicopter surveys." California Fish and Game **76**(4): 197-204.

Effects of helicopter surveys on distribution and movements of desert-dwelling mountain sheep, Ovis canadensis , were studied in San Bernardino County, California during April and June 1988. Adult males and females with radio collars moved about 2.5 times farther the day following a helicopter survey than on the previous day. Further, 35-52% of these animals changed polygons (8-83 km super(2)) following sampling from a helicopter, whereas only 11% did so on the day prior to the survey. Likewise, some animals left the study area following surveys. Sampling intensity (0.8 min/km super(2) vs. 2.0 min/km super(2)) had little effect on movement of mountain sheep. Similarly, terrain type (steep vs. rolling) did not influence movement of female mountain sheep following helicopter surveys. Movement by mountain sheep during a helicopter survey may violate fundamental assumptions of several population estimators.

Bowles, A.E., Book, C., et al. (1990). Effects of low-altitude overflights on Domestic turkey poluts. USAF, Wright-Patterson AFB, AL/ OEBN Noise Effects Branch.

Brown, A.L. (1990). "Measuring the effect of aircraft noise on sea birds." Environment International **16**(4-6): 587-592.

Doran, H.J., Cross, T.F., et al. (1990). "Electrophoretic identification of bird species involved in collisions with aircraft." Comparative Biochemistry and Physiology B-Biochemistry & Molecular Biology **97**(1): 171-175.

Helkamo, H. and Stenman, O. (1990). Some measurements used in different countries for reduction of bird strike risk around airports. BSCE 20. Bird strike committee Europe. Aerodrome Working Group, Helsinki. pp 1-75.

Milsom, T.P. (1990). "Lapwings Vanellus vanellus on aerodromes and the birdstrike hazard." Ibis **132**: 218-231.

Olsson, O. and Gabrielsen, G.W. (1990). Effects of helicopters on a large and remote colony of Brunnich's Guillemots (*Uria lovia*) on Svalbard. Norsk Polarinstitutt, Tromsø, Norway.

1989

Andersen, D.E., Rongstad, O.J., et al. (1989). "Response of nesting red-tailed hawks to helicopter overflights." Condor **91**(2): 296-299.

Low-level helicopter overflights of 35 Red-tailed Hawk (Buteo jamaicensis) nests were conducted at two study areas in southeastern and east-central Colorado in 1984 and 1985. Red-tailed Hawks nesting where low-level air traffic was nonexistent prior to 1983 exhibited stronger avoidance behavior than did hawks nesting where helicopter activity had occurred since the late 1950s. Nine (53%) of 17 birds in the first study area flushed from the nest while only one (8%) of 12 birds in the second study area flushed. Age of nestlings at the time an overflight occurred did not influence avoidance behavior, and overflights did not appear to influence nesting success at either study area. These results are consistent with the hypothesis that Red-tailed Hawks habituate to low-level air traffic during the nesting period.

Awbrey, F.T. and Bowles, A.E. (1989). The effects of aircraft noise and sonic booms on raptors: A preliminary model and a synthesis of the literature on disturbance. US Air Force, Air Force Systems Comand, Wright-Patterson Air Force Base, VS.

Bentz, P.-G. (1989). "Viltloven – et problem for flytrafikken?" Flytrygging(5): 8.

Bentz, P.-G. (1989). "Se opp for trekkfuglene! Faren ikke over! ." Flytrygging(3): 5-6.

Bentz, P.-G. (1989). "Bedre med en fugl i handa, enn..... ." Flytrygging(1): 9-10.

Lamp, R.E. (1989). Monitoring the effects of military air operations at Fallon Naval Air Station on the biota of Nevada. Nevada Department of Wildlife.

Quigley, H.B. and Crawshaw, P.G. (1989). "Use of ultralight aircraft in wildlife radio telemetry." Wildlife Society Bulletin **17**(3): 330-334.

Ward, D. and Stehn, R. (1989). Response of brant and other geese to aircraft disturbances at Izembek lagoon, Alaska. USFWS Alaska Fish and Wildlife Research Center, Anchorage. 241 pp.

1988

Asherin, D.A. and Gladwin, D.N. (1988). Effects of aircraft noise and sonic booms on fish and wildlife: A research needs workshop. National Ecology Research Center, US Fish and Wildlife Service. ESL-TR-88-64 pp.

Baughn, T.V. and Graham, L.W. (1988). "Simulation of a bird-strike Impact on aircraft canopy material." Journal of Aircraft **25**(7): 659-664.

Bentz, P.-G. (1988). "Kollisjoner mellom fugler og militært fly i Norge 1988. ." Flytrygging(7): 5-10.

Bentz, P.-G. (1988). "Oppdyrking av områder på norske flystasjoner – Noen viktige momenter for kontrakter mellom forpaktere og flystasjoner." Flytrygging(5): 7-8.

Bentz, P.-G. (1988). "Advarsel! Elg i trafikkområdet! ." Flytrygging(3): 97-99.

Bentz, P.-G. (1988). "Bruk av varselskrikanlegg. ." Flytrygging(3): 96.

Bentz, P.-G. (1988). "Bird Strike Committee Europe-møtet i Madrid." Flytrygging(2): 102-103.

Fjeld, P.E., Gabrielsen, G.W., et al. (1988). Noise from helicopters and its effects on a colony of Brunnich's Guillemonts (*Uria lomvia*) on Svalbard. Norsk Polarinstitutt, Tromsø, Norway.

Gladwin, D.N., Manci, K.M., et al. (1988). Effects of aircraft noise and sonic booms on domestic animals and wildlife: bibliographic abstracts. U.S. Fish and Wildl. Serv. National Ecology Research Center, Ft. Collins. 78 pp.

Manci, K.M., Gladwin, D.N., et al. (1988). Effects of aircraft noise and sonic booms on domsetic animals and wildlife: a literature synthesis. U.S. Fish and Wildl. Serv. National Ecology research Center, Ft. Collins, CO. 88 pp.

Miller, F.L., Gunn, A., et al. (1988). "Nuring by Muskox calves before, during, and after Helicopter Overflights." Arctic **41**(3): 231-235.

Smith, D.G., Ellis, D.H., et al. (1988). Raptors and aircraft. Proceedings of the Southwest Raptor Management Symposium, Washington, D.C., National Wildlife Federation. pp 360-367.

1987

Bentz, P.-G. (1987). "Advarsel: Våren er på vei – og trekkfuglene!" Flytrygging(3): 12-13.

Bentz, P.-G. (1987). "Fly/fugl-problematikken." Flytrygging(1): 6-10.

Gladwin, D.N., Asherin, D.A., et al. (1987). Effects of aircraft noise and sonic booms on fish and wildlife: results of a survey of U.S. Fish and Wildlife Service Endangered Species and Ecological Service Field Offices, Refuges, Hatcheries, and Research Centers. U.S. Fish and Wildlife Serv., National Ecology Research Center, Fort Collins, CO. 24 pp.

Stockwell, C.A. and Bateman, G.C. (1987). The impact of helicopter overflights on the foraging behavior of desert bighorn sheep (Ovis canadensis nelsoni) at Grand Canyon National Park. 39 pp.

1986

Becker, J. (1986). The use of radar for bird strike prevention in Germany. 18th IBSC meeting, Copenhagen. 11 pp. from http://www.int-birdstrike.org/Copenhagen_Papers/IBSC18%20WP5.pdf.

Bentz, P.-G. (1986). "Kollisjon mellom fly og vandrefalk!" Oriolus **15**: 33.

Briot, J.L. (1986). Last French experiments concerning bird-strike hazards reduction (1981 - 1986). 18th IBSC meeting, Copenhagen. 7 pp. from http://www.int-birdstrike.org/Copenhagen_Papers/IBSC18%20WP18.pdf.

DeFusco, R.P., Larkin, R.P., et al. (1986). Bird hazard warning using next generation weather radar. 18th IBSC meeting, Copenhagen. 14 pp. from http://www.int-birdstrike.org/Copenhagen_Papers/IBSC18%20WP7.pdf.

Efanov, B. (1986). Increase of efficiency of the mobile bio-acustic sytem for scaring birds within the airport area. 18th IBSC meeting, Copenhagen. 6 pp. from http://www.int-birdstrike.org/Copenhagen_Papers/IBSC18%20WP32.pdf.

Fleischner, T.L. and Weisberg, S. (1986). Effects of jet aircraft activity on Bald eagles in the vicinity of Bellingham International Airport. Bellingham, WA, DEVCO Aviation Consultants.

Krausman, P.R., Leopold, B.D., et al. (1986). "Desert mule deer response to aircraft." Wildlife Society Bulletin **14**: 68-70.

Miller, F.L., Gunn, A., et al. (1986). "Nursing by muskox calves before, during, and after helicopter overflights." Arctic **41**(3): 231-235.

Ward, D.H., Taylor, E.J., et al. (1986). Behavior of Pacific black brant and other geese in response to aircraft overflights and other disturbances at Izembek Lagoon, Alaska. 68 pp.

1985

Bentz, P.-G. (1985). "Foreløpig birdstrike-oversikt 1980-84, Del 1." Flytrygging(1): 45-48.

Bentz, P.-G. (1985). The Snow Bunting hazard to aircraft at Andøya Airport in northern Norway. Proc.17th Meet. Bird Strike Comm. Europe, Rome 1984. 10 pp.

Bentz, P.-G. (1985). "Peregrine Falco peregrinus with prey killed by aircraft." Fauna norv. Ser. C, Cinclus **8**: 64.

Guam, A., Miller, F.L., et al. (1985). Behavioural responses of barren-ground caribou cows and calves to helicopters on the Beverly herd calving ground, Northwest Territories. Caribou and human activity. 1st North American Caribou Workshop, Whitehorse, Yukon 1983.

Gunn, A., Miller, F.L., et al. (1985). Behavioral responses of barren ground caribou cows and calves to helicopters on the Beverly Herd calving ground. Nortwest Territories. 10-14 pp.

Hodge, P.E. (1985). "The birds are back." Flying Safety **41**(10): 6-10.

In the past, there have been several forums for discussing bird problems, such as the US Fish and Wildlife Workshop on Wildlife Hazards to Aircraft and the Federal Aviation Administration's Wildlife Hazards to Aircraft Conference and Training Workshop. Although military aspects of birds hazards were discussed briefly at these workshops, there has not been a meeting to deal strictly with the unique considerations of military flying operations. Recently, however, the Airforce's Bird/Aircraft Strike Hazard conference at Vandenberg AFB, CA to discuss all aspects of BASH reduction at military installations. Two of the objectives of this conference were to present specific guidance on how to conduct a base level program and to identify the type of help bases can get from other agencies to resolve their bird problems.Although military aspects of birds hazards were discussed briefly at these workshops, there has not been a meeting to deal strictly with the unique considerations of military flying operations. Recently, however, the Airforce's Bird/Aircraft Strike Hazard conference at Vandenberg AFB, CA to discuss all aspects of BASH reduction at military installations. Two of the objectives of this conference were to present specific guidance on how to conduct a base level program and to identify the type of help bases can get from other agencies to resolve their bird problems.

Valkenburg, P. and Davis, J.L. (1985). The reaction of caribou to aircraft: a comparison of two herds. 1th North American Caribou Workshop, Whitehorse Yukon. pp 7-9.

1984

Black, B.B., Collopy, M.W., et al. (1984). Effect of low-level military training flights on wading bird colonies in Florida. **7**. Florida Cooperative Fish and Wildlife Research Unit, School of Forestry and Resource Conservation, University of Florida, Gainesville. 190 pp.

Dahl, H. (1984). The bird strike situation and its ecological background in the Copenhagen Airport, Kastrup, Directorate Of Civil Aviation Copenhagen (Denmark)

The paper contains a description of the measures taken at Copenhagen Airport to reduce the bird strike problem during the last 20 years. Apart from shooting and otherwise scaring away the birds, the ecological countermeasures are described. The measures at the island include spraying of the nests in the colony with an emulsion of oil and water with the result that the colony production of young birds has diminished. Further, it includes killing of the birds by use of alfa-chloralosis contained in tablets and put into dead herrings placed in the gulls' nests. The result has been a reduction from about 37,000 pairs of herring gulls to less than 10,000 pairs of herring gulls breeding on the island. Approximately 100,000 US dollars are used every year to finance the different actions against the birds. The use of long grass has caused an increase in mice and as a result hereof an increase in kestrels involved in bird strikes.

Hild, J. (1984). Falconry as a bird deterrent on airports. 17th IBSC meeting, Rome.

Jacoby, V.E. (1984). Possibility to use precision approach radars for bird strike prevention. 17th IBSC meeting, Rome. 11 pp. from http://www.int-birdstrike.org/Rome_Papers/IBSC17%20WP7.pdf.

Korschgen, C.E., Green, W.L., et al. (1984). "Use of radar with a stationary antenna to estimate birds in a low-level flight corridor." J. Field Ornithol. **55**(3): 369-375.

1983

Bentz, P.-G. (1983). "Nå er det trekkfugltider." Flytrygging(1): 81-82.

Bentz, P.-G. (1983). Bird concentration areas and migration patterns in Norway. **1**. Luftfartsverket (publ.), Oslo. RAC 6-1-1, 6-1-2, 6-2-1, 6-2-2, 6-2-3.

Krausman, P.R. and Hervert, J.J. (1983). "Mountain sheep responses to airial surveys." Wildlife Society Bulletin **11**(4): 372-375.

1982

Bashore, T.L. and Bellis, E.D. (1982). "Deer on Pennsylvanian airfields: Problems and means of control." Wildlife Society Bulletin **10**(4): 386-388.

Bentz, P.-G. (1982). "Trane forårsaket flystyrt i Buskerud. ." Fauna **35**: 25-28.

Fancy, S.G. (1982). "Reaction of bison to arial surveys in interior Alaska." Canadian Field Naturalist **96**(91).

Hild, J. (1982). "Die Konkurrenz im Luftraum: Gezieltes Biotop-Management Kann das Risiko von Vogelunfaellen Vermindern." Umschau **82**(12): 383-384.

Bird hazards induce high flight safety risks and aircraft damages in international civil and military aviation. Technical provisions on aircraft are possible only partialy. adarornithological methods made it possible to develop a warning and forecasting system especially for military low level flights. Methods of ecological biotop-

management serve as a basis for birdstrike-prevention procedures on airdromes, airfields and their surroundings.

Laty, M. (1982). Birds on airports. The reason for their presence. 16th IBSC meeting, Moscow. 5 pp. from http://www.int-birdstrike.org/Moscow_Papers/IBSC16%20WP9.pdf.

1981

Burger, J. (1981). "Behavioral responses of Herring gulls Larus argentatus to aircraft noise." Environ. Pollut. Ser. A.
24(3): 177-184.

The behavior of nesting and loafing L. argentatus was compared when the birds were exposed to supersonic transport, subsonic aircraft and normal colony noises at Jamaica Bay National Recreational Area. When supersonic transports flew over, significantly more nesting gulls flew from their nests, and they engaged in more fights when they landed compared with the other conditions. Many eggs were broken during these fights, and subsequently eggs were eaten by intruders. At the end of the incubation period there were lower mean clutch sizes in dense sections of the colony. For loafing gulls, significantly more birds flushed when planes flew over compared with immediately before and after such plane noises.

Miller, F.L. and Gunn, A. (1981). "Play by Peary caribou calves before, during , and after helicopter harassment." Canadian Journal of Zoology **59**: 823-827.

Short, J.J. (1981). Development of a predictive bird avoidance model for low-level operations. 15th IBSC meeting, Brussels. 20 pp. from http://www.int-birdstrike.org/Brussels_Papers/IBSC15%20WP18.pdf.

1980 og tidlegare

Avery, M.L., Springer, P.F., et al. (1980). Avian mortality at man-made structures: an annotated bibliography (revised). U.S. Fish and Wildlife Servive. Biological Services Program, National Power Plant Team. 152 pp.

Compilation of 1,042 references through February 1980, including 189 not in the original publication (Avery et al. 1978). Includes subject, taxonomic, and geographic indexes. This revised version of the 1978 bibliography contains 189 new international annotations for a total of 1,042 entries. Citations are other ed according to subjects, kinds of birds, and locations. "The majority of the reports include the number of individuals and species killed, with some observations of weather conditions at the time of the incident, bird behavior near the structure, or comments on the attraction of birds to lights."

Brough, T. and Bridgman, C.J. (1980). "An evaluation of long grass as a bird deterrent on British airfields." Journal of Applied Ecology **17**(2): 243-253.

Gunn, A. and Miller, F.L. (1980). Responses of Peary caribou cow-calf pairs to helicopter harassment in the Canadian high arctic. 2nd International Reiindeer/Caribou Symposium. pp 497-507.

Miller, F.L. and Gunn, A. (1980). "Behavioral responses of muskox herds to stimulation of cargo slinging by helicopter, Northwest Territories." Canadian Field Naturalist **94**(1): 52-60.

Thingstad, P.G. (1980). "Fly/fugl-problematikken ved Værnes flystasjon." Flytrygging(1): 1-28.

Kushlan, J.A. (1979). "Effects of helicopter censuses on wading bird colonies." Journal of Wildlife Management **43**: 756-760.

MacArthur, R.A., Johnston, R.H., et al. (1979). "Factors influencing heart rate in free-ranging bighorn sheep: a physiological approach to study of wildlife harassment." Canadian Journal of Zoology **57**: 2010-2021.

Miller, F.L. and Gunn, A. (1979). "Responses of Peary caribou and muskoxen to helicopter harassment." Can. Wildl. Serv. Occas. **40**.

Verheijen, F.J. (1979). Effects of light and light beams on birds. 14th IBSC meeting, The Hague. 7 pp. from http://www.int-birdstrike.org/The_Hague_Papers/IBSC14%20WP10.pdf.

Avery, M.L., Springer, P.F., et al. (1978). Avian mortality at man-made structures: an annotated bibliography. U.S. Fish and Wildlife Service, Biological Services Program, National Power Plant Team. 108 pp.

Annotated bibiliography of 853 references pertaining to bird mortality due to collision and electrocution at man-made structures such as power transmission lines, radio and TV towers, lighthouses, cooling towers, buildings, and airport ceilometers. Includes subject, taxonomic, and geographic indexes. This bibliography on avian mortality and human-made structures contains 853 international entries. Citations are other ed according to subjects, kinds of birds, and locations. "The majority of the reports include the number of individuals and species killed, with some observations of weather conditions at the time of the incident, bird behavior near the structure, or comments on the attraction of birds to lights."

Crowley, R.W. (1978). "A case study of the effects of an airport on land values." Journal of Transportation Economics and Policy **7**(May).

Dunnett, G.M. (1977). "Obsevations on the effects of low-flying aircraft at seabird colonies on the coast of Aberdeenshire, Scotland." Biological Conservation **12**: 55-63.

Miller, F.L. and Gunn, A. (1977). A preliminary study of some observable responses by Peary caribou to helicopter induced harassment, Prince of Wales Island, Northwest Territories, July-August 1976. **79**. Canadian Wildlife Service. 23 pp.

Plan, J.B. and Tull, C.E. (1977). A study of wintering and nesting gyrfalcons on the Yukon North Slope during 1975 with emphasis on their behaviour during experimental overflights by helicopters. **35**. 90 pp.

Blokpoel, H. (1976). Bird hazards to aircraft: problems and prevention of bird/aircraft collisions. Ottawa, Clarke, Irwin & company ltd.

Blokpoel, H. and Hatch, D.R.M. (1976). "Snow geese, disturbed by aircraft, crash into power lines." Canadian Field Naturalist **90**(2): 195.

On 8 May 1974, several thousand snow and blue geese were feeding in a stubble field in Manitoba, Canada, when a low-flying aircraft caused them to take wing. In the "chaotic" rush into the air, 25-75 birds were killed or injured by striking power lines that bordered one side of the field. It is not known whether death resulted from collision or electrocution.

Calef, G.W., DeBock, E.A., et al. (1976). "The reaction of barren-ground caribou to aircraft." Arctic **29**(4): 201-212.

Carrier, W.D. and Melquist, W.E. (1976). "The use of a rotor-winged aircraft in conducting nesting surveys of ospreys in northern Idaho." Raptor Research **10**: 77-83.

Luz, G.A. and Smith, J.B. (1976). "Reactions of pronghorn antelope to helicopter overflight." J. Acoust. Soc. Am. **59**: 1514-1515.

Larkin, R.P., Torre-Bueno, J.R., et al. (1975). "Reactions of migrating birds to lights and aircraft." Proceedings of the National Academy of Science **72**(6): 1994-1996.

Gollop, M.A., Goldsberry, J.R., et al. (1974). Aircraft disturbance to molting sea ducks, Herschel Island, Yukon Territory, August 1972. **14**.

Gunn, W.W.H. and Livingston, J.A. (1974). Disturbance to birds by gas compressor noise simulators, aircraft, and human activity in the MacKenzie Valley and the North Slope. Arctic Gas Biological Report. **14**.

Jakobi, V.E. (1974). Biologicheskie osnovy predotvrashchenija stolkhovenij samoletov s ptitsami. Moskva.

Langhelle, G. (1974). Om fly/fugl problemet på Lista flystasjon : en økologisk/faunistisk undersøkelse på Lista flystasjon. Bergen, Zoologisk museum.

Lenarz, M. (1974). The reaction of Dall sheep to an FH-1100 helicopter. **23**. Renewable Resources Consulting Services, Ltd. and Canadian Arctic Gas Study Ltd.

McCourt, K.H. and Horstman, L.P. (1974). The reaction of barrenground caribou to aircraft. The Reaction of Some Mammals to Aircraft and Compressor Station Noise Disturbance. R. D. Jakimchuk, Renewable Resources Consulting Services Ltd., Can. Arctic Gas Study Ltd. Biol. Rpt. **23**.

Röed, Å.E. (1974). Some viewpoints on bird collisions in civil aviation. Stockholm, FFA.

Schweinsburg, R.E. (1974). Disturbance effects of aircraft to waterfowl on north slope lakes, June, 1972. **14**. 48 pp.

Ward, J. and Sharp, P.L. (1974). Effects of aircraft disturbance on moulting sea ducks at Herschel Island, Yukon Territory, August 8 1973. Studies on Terrestrial Bird Populations, moulting Sea Ducks and bird Productivity in the Western Arctic, 1973. Arctic Gas biological Report Series. W. W. Gunn, W. J. Richardson, R. E. Schweinsburg and T. D. Wright. **29**.

Blokpoel, H. (1973). "Bird migration forecasts for military air operations." Canadian Wildlife Service Occasional Paper **16**: 1-18.

Klein, D.R. (1973). The reaction of some northern mammals to aircraft disturbance. 11th Int. Cong. Game Biol., Stockholm, Sweden, Nat. Swedish Environ. Prot. Board. pp 377-383.

Lid, G. (1973). The bird-strike problem in Norway. 8th IBSC meeting, Paris. 12 pp. from http://www.int-birdstrike.org/Paris_Papers/IBSC08%20WP11_3.pdf.

Cottereau, P. (1972). The effects of sonic boom from aircraft on wildlife and animal husbandry. Academic Press, New York, New York. 63-79 pp.

Møllen, G.U. (1971). The use of distress calls for scaring of birds on airfields in Norway. 6th IBSC meeting, Copenhagen. 16 pp. from http://www.int-birdstrike.org/Copenhagen_Papers/IBSC06%20WP3.pdf.

Hild, J., Keil, W., et al. (1969). Research projects of the Committee of the Federal Republic of Germany for the Prevention of Bird Strike Hazards to Aircraft. Ottawa, National Research Council of Canada.

Vosburgh, J. (1966). Deathtraps in the flyways. Birds in our lives. A. Stefferud, U.S. Department of Interior, Fish and Wildlife Service, Bureau of Sports Fisheries and Wildlife.

Green, J.C. (1963). "Destruction of birdlife in Minnesota - Sept. 1963. Notes on kills at Duluth on September 18/19." Flicker **35**(4): 112-113.
Reports finding 111 individuals of 20 species (nearly all vireos and warblers) at base of airport ceilometer and WDSM-TV tower; Ovenbird and Bay-breasted Warbler were most abundant species.

[Anon] (1954). "Disaster in migration." **18**(4): 104-105.
On 7 October 1954, a "rain" of small birds at several spots in the Southeast occurred. In Charleston, South Carolina, about 100 dead birds of 24 species were identified, and in Winston-Salem, North Carolina, 190 birds of 21 species were collected from near the respective airport ceilometers. Most of these birds were warblers. The catastrophe was attributed to a combination of "tumbling temperatures, overcast skies, ... stabbing beacons," and a cross-wind associated with a cold front.

Laskey, A.R. (1951). "Another disaster to migrating birds at the Nashville airport." Migrant **22**(4): 57-60.

Aronoff, A. (1949). "The September migration tragedy." Linnaean Newsletter **3**(1): 1-2.
Mortality at the Empire State Building (over 200 birds, 30 species) on the night of 10 September 1948 is discussed, and a species list is provided. Also discussed are kills at a Nashville, Tennessee, airport ceilometer involving 248 birds of 35 species; at a Philadelphia, Pennsylvania, building (at least 11 species); and at a 450-foot tower in Baltimore, Maryland. A list of casualties from the Nashville incident is included.

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