Doc 9137
AN/898
Part 3

Airport Services Manual

Part 3
Wildlife Control and Reduction

Approved by the Secretary General
and published under his authority

Fourth Edition — 2012

International Civil Aviation Organization

Doc 9137
AN/898
Part 3

Airport Services Manual

Part 3
Wildlife Control and Reduction

Approved by the Secretary General
and published under his authority

Fourth Edition — 2012

International Civil Aviation Organization

Published in separate English, Arabic, Chinese, French, Russian
and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 University Street, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int.

Third edition 1991
Fourth edition 2012

Doc 9137, *Airport Services Manual,* Part 3 — *Wildlife Control and Reduction*
Order Number: 9137P3
ISBN 978-92-9231-929-8

AMENDMENTS

Amendments are announced in the supplements to the *Catalogue of ICAO Publications;* the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS		
No.	Date	Entered by

CORRIGENDA		
No.	Date	Entered by

FOREWORD

Previous editions of this manual focused on the control of birds on, and in the vicinity of, aerodromes. With the recognition that other forms of wildlife also present hazards to the operation of aircraft on, and in the vicinity of, aerodromes the provisions on bird hazard reduction in the fifth edition of Annex 14, Volume I — *Aerodrome Design and Operations* were expanded to include a broader focus on wildlife strike hazard reduction. Annex 14, Volume I, requires that action be taken to decrease the risk to aircraft operations by adopting measures to minimize the likelihood of collisions between wildlife and aircraft. Thus, the guidance provided in this fourth edition of the manual has been expanded to include both bird and wildlife control for the purpose of reducing the hazard of bird/wildlife strikes to aircraft. Airport authorities are encouraged to include both birds and wildlife in their airport bird/wildlife control programme.

This document was written on the assumption that birds and wildlife are a serious hazard to aircraft, and it attempts to outline what can and should be done to overcome this hazard. It is not the purpose of this document to discuss the relative importance of various hazards but to stress the importance of good organization and planning in the creation of a successful bird/wildlife control programme.

The prime purpose of this manual is to provide airport personnel with the information necessary to develop and implement an effective bird/wildlife control organization for their aerodrome. Because the risk of bird/wildlife strikes is different at each site, the management will also be different. The seriousness of a bird/wildlife hazard problem is affected by geographic location, attractiveness of the site to birds/wildlife, and air traffic density. This manual outlines organizational structures that will effectively deal with the problem of bird/wildlife control. A brief history in Chapter 1 describes the evolution of the problem and some examples of significant bird strikes.

The manual includes material dealing with the reasons why birds/wildlife occur at an aerodrome, the organization and composition of a national committee to combat potential bird/wildlife hazards to aircraft operations, and the modifications to be carried out at an aerodrome to remove the features which attract birds/wildlife.

The final updates to this fourth edition were reviewed by the world's bird/wildlife control experts from the International Bird Strike Committee, led by the United Kingdom Civil Aviation Authority. A list of selected publications containing material relevant to the subject of bird/wildlife control and reduction on, or in the vicinity of, an aerodrome is included at the end of the document.

When developing guidance material intended to be used by many States, it is difficult to use generic terms which will work for every State due to the variation in the organization of their airport authorities, flight control, etc. For convenience, the generic term "committee" is used throughout this document to designate (singly or collectively) who is to take certain action, and Chapters 2 and 3 provide guidance on the establishment of such committees. In addition, for the purpose of this document and for consistency with Annex 14, the terms "wildlife" and "wildlife strike" are intended to include aircraft strikes by birds, or bird strikes.

It is intended that the manual be kept up to date. Future editions will most likely be improved on the basis of experience gained and of comments and suggestions received from users of this manual. Therefore, readers are invited to send their views, comments and suggestions on this edition, in writing to:

The Secretary General of ICAO
International Civil Aviation Organization
999 University Street
Montréal, Quebec
Canada H3C 5H7

Table of Contents

Chapter 1

GENERAL

1.1 On 7 September 1908, while piloting the Wright Flyer, Orville Wright had what is believed to be the first collision between an aircraft and a bird, what is now known as a bird strike. Less than four years later, on 3 April 1912, at Long Beach, California, Calbraith Perry Rodgers, the first man to fly an aeroplane across the United States, became the first person to die as the result of a bird strike. His Wright Flyer became entangled with a gull that jammed the aircraft's controls, causing it to plunge out of control into approximately 1.5 m of sea water. The frail structures and power plants of the early aeroplanes meant that they were susceptible to bird strike damage. Fortunately, their slow speed gave pilots and birds/wildlife plenty of time to take any evasive action necessary.

1.2 Development of aircraft progressed to the point that they were robustly constructed and, consequently, more resistant to bird strike damage. Nevertheless, serious bird strikes did occur to such aircraft, usually involving the cockpit, the windshield and surrounding structure. Occasionally, injuries to flight crew did result from these bird strikes. During the 1950s, many metal, propeller-driven aeroplanes were gradually replaced by the faster and more efficient early jets; however, today, well into the 21st century, many propeller-driven aircraft are still in active flight operation.

1.3 Ironically, just at the dawn of jet passenger travel, two accidents involving propeller-driven airliners caused the aviation industry to more closely examine the danger that bird strikes pose to aircraft. Both occurrences involved a relatively new type of aircraft propulsion system, the turboprop. The first accident took place on 4 October 1960 at Boston's Logan International Airport. The aircraft, a Lockheed Electra L188, struck a flock of starlings (*Sturnus vulgaris*) just as it became airborne. The birds were ingested into three of the aircraft's four engines, causing the aircraft to lose power, stall and crash into the harbour. Of the seventy-two passengers and crew on board, sixty-two died. Two years later, on 23 November 1962, a Vickers Viscount struck a flock of Whistling Swans (*Cygnus columbianus*) over the State of Maryland, while flying at 6 000 feet. One of the horizontal stabilizers was penetrated by a swan, weakening the structure and causing it to separate from the aircraft which subsequently crashed and killed all on board. This crash resulted in the bird impact criteria for horizontal stabilizers being raised to eight kilograms (8 kg).
`

1.4 With the proliferation of jet aircraft and the increases in traffic that occurred throughout the 1960s and 1970s, modern jet-powered transport aeroplanes, with their greater speed, were seen to be at greater risk than their propeller-driven predecessors. Newer generations of aircraft continued to come into service, servicing ever increasing traffic needs and replacing older and less efficient aircraft. In many parts of the world, successful wildlife conservation has lead to increasing numbers of birds and other wildlife that are known to represent a risk to aviation. There is also increasing recognition that birds are not the only wildlife species to pose a threat to aviation safety. Some species of mammals and reptiles also pose a serious threat to aircraft safety. To adequately address the wildlife aircraft strike problem, wildlife/bird control on and around an airport should be expanded to include flying and terrestrial mammals and reptiles. Due to growing traffic, comprised of greater numbers of quieter aircraft, and the increase in wildlife populations, greater effort is required to control and monitor wildlife movements on and within the vicinity of airports. In addition, the cost of downtime for inspection and repair of aircraft following bird/wildlife damage or suspected bird/wildlife damage is significant. The additional costs and disruption as a result of aborted flights, rescheduling of aircraft passengers and air cargo, transfer of passengers to alternative means of transport, overnight accommodation at the expense of the aircraft operator and the deleterious effects on connecting flight schedules that can be significant and damaging to airline operating budgets and public goodwill (the passenger experience) are also major factors in the cost of a bird strike. It is apparent that data on bird/wildlife strikes need to be collected in order to better understand the dynamics of the bird/wildlife strike problem. The ICAO Bird Strike Information System (IBIS) is ideally suited to this task. A complete

description of IBIS can be found in the *Manual on the ICAO Bird Strike Information System (IBIS)* (Doc 9332). IBIS provides analyses of bird/wildlife strike reports received from States. An analysis of this data reveals that approximately ninety per cent (90%) of bird/wildlife strikes occur on or in the immediate vicinity of airports.

1.5 The analysis of bird/wildlife data in respect of bird strikes and observations and monitoring of bird/wildlife activities can reveal trends that will assist airport authorities to recognize areas of concern which should be addressed through a well-managed wildlife control programme. Bird/wildlife strike statistics can also be analysed to determine those times of year or day when bird/wildlife control is needed the most.

Chapter 2

ESTABLISHMENT OF A NATIONAL COMMITTEE

2.1 Annex 14, Volume I, requires the wildlife strike hazard on, or in the vicinity of, an aerodrome to be assessed through, among other things, the establishment of national procedures and an ongoing evaluation of wildlife hazards by competent personnel. The establishment of a national committee is ideally suited to addressing this task. Such committees have proven to be popular forums to gain and exchange information on research and development in airport wildlife control. Although the composition of a national committee may vary from State to State, it should include all stakeholders associated with or interested in the problem. It should be noted that national committees have very little authority in decision making and usually act as an information source for those in the aviation community.

2.2 A national committee should include governmental departments such as transport, defence, agriculture and environment as well as representatives from the major aircraft and airport operators, flight safety officials, pilot associations and airframe and engine manufacturers. Those who provide specialist bird/wildlife hazard training should also be invited to participate.

2.3 Since bird/wildlife strikes present a persistent problem, studies should take place to assess the hazard posed by wildlife on a case-by-case basis. Often this research may involve the review of current practices or the development of new initiatives, principally by airport operators or their contractors, but this should not be exclusively limited to them.

2.4 A well-thought-out mandate and guidelines will facilitate the development and implementation of a national aerodrome bird/wildlife control policy. Once the mandate is devised, the committee should meet at regular intervals to keep apprised of new developments or serious issues and to review the need for updating of policy.

2.5 Participation in regional and international committees, such as the International Bird Strike Committee (IBSC) and ICAO regional workshops on bird/wildlife hazard reduction, in addition to the Joint Birdstrike Committee USA/Canada, is recommended because they provide the ideal forum for States and stakeholders to gain knowledge and experience in implementing effective bird/wildlife control programmes.

2.6 National guidelines or regulations should be developed as a basis for the committee as well as for the direction of airport authorities, aircraft operators and other institutions. These guidelines may also provide the basis and mandate for developing special research and bird/wildlife control programmes.

Chapter 3

ROLES AND RESPONSIBILITIES WITHIN A BIRD/WILDLIFE STRIKE CONTROL PROGRAMME

3.1 GENERAL

Annex 14, Volume I, requires States to certify all aerodromes used for international operations, in accordance with the specifications contained within the Annex. As part of this certification process, aerodrome operators are required to develop an aerodrome manual which includes information on the aerodrome site, facilities, services, equipment, operating procedures and management, including a safety management system.

3.2 ROLE OF THE STATE CIVIL AVIATION AUTHORITY

3.2.1 The State civil aviation authority (CAA) or national aviation administration (NAA) should ensure that any procedures in the airport certification manual relating to bird/wildlife control are developed and implemented as part of the aerodrome safety management system (SMS).

3.2.2 Birds and other wildlife on, and in the vicinity of, the airport may represent a threat to aircraft safety. In some cases, this threat can be reduced by adapting the aircraft's schedule in favour of the wildlife, especially when the presence of wildlife is for a limited time. Reducing the presence of wildlife in aircraft flight paths can be achieved through ecological means such as habitat management or the dispersal or removal of hazardous wildlife. While the wildlife control programme will be airport-specific, the development of such nature and environmentally sensitive programmes should adhere to national environmental regulations.

3.2.3 States seeking assistance with the development of a wildlife control programme and the assessment of wildlife control issues may wish to contact the ICAO Secretariat as ICAO Technical Cooperation Programme experts are available to assist States in the development and implementation of bird/wildlife programmes and the assessment and identification of hazards and attractants associated with an airport.

3.3 ROLE OF THE AIRPORT OPERATOR

3.3.1 Because of the importance of bird/wildlife control, each airport operator has the responsibility to develop, implement and demonstrate an effective bird/wildlife strike and wildlife control programme at the airport, and this should be tailored to and commensurate with the size and level of complexity of the airport, taking account of the identification of the bird hazard and the risk assessment of that hazard.

3.3.2 Airport operators, where practicable, should implement a programme tailored to local conditions, with assistance from the national committee or other outside agencies, as required. Where practicable, the airport operator should appoint an airport bird/wildlife control coordinator who is responsible and accountable for the airport's bird/wildlife hazard control policy and the personnel engaged in bird/wildlife hazard control. This may include the formation of a local

airport bird/wildlife committee that will develop and implement the specific programme. It is imperative that personnel responsible for these tasks are able to demonstrate competence, are trained by qualified personnel and are provided with the appropriate resources and equipment to carry out their tasks.

3.4 ROLE OF THE AIRPORT BIRD/WILDLIFE STRIKE COMMITTEE AND THE AIRPORT BIRD/WILDLIFE STRIKE CONTROL COORDINATOR

3.4.1 The airport bird/wildlife strike committee should include those involved in bird/wildlife control, airport planning, maintenance and operations. It should also include air traffic services, flight operators, rescue and fire fighting services, security, duty managers, finance, etc. The committee should review strike data collected and observations of birds/wildlife, assess bird/wildlife risks and summarize trends in order to evaluate and determine what effective control measures should be implemented in order to manage the issues arising.

3.4.2 The airport bird/wildlife strike control coordinator (or equivalent) should coordinate the activities of the wildlife control programme with air traffic control (ATC) and other stakeholders. The coordinator's responsibilities should allow for the time required to be involved with observations, control and reporting. The wildlife coordinator at the site should also review strike reports, monitor daily activity records and maintenance reports to determine the requirements for short- and long-term management programmes, and this information should be passed to managers accountable for safety on a regular basis (recommended at least monthly).

3.5 THE IMPORTANCE OF REPORTING

3.5.1 An effective bird/wildlife control programme depends upon accurate and reliable reporting. Data may come from sightings, maintenance reports, strike reports and control activities. Reporting must involve pilots and aircraft operators primarily, plus airport ground operations staff, ATC and other aviation stakeholders (e.g. aircraft maintenance organizations). Reviewing and analysing this data will help identify problems at the airport and indicate the effectiveness of current bird/wildlife strike prevention methods.

3.5.2 It is recommended that the bird/wildlife strike reporting procedure should ideally be coordinated by a single office in order to ensure an appropriate and meaningful review taking into consideration all circumstances. This procedure should be familiar to all airport personnel and described in the aerodrome manual or associated airport wildlife hazard policy document. All strike reports should be directed to the bird/wildlife strike control coordinator who should forward them to the appropriate regulatory authority. However, local operating procedures may differ and such procedures should be clearly set out in the local bird/wildlife management documents and working instructions as appropriate.

3.5.3 Accurate and reliable record keeping and a comprehensive reporting procedure provided in an effective bird/wildlife management manual may assist the airport with claims of liability in the event of an aircraft incident resulting from a bird/wildlife strike. Accurate, reliable and internally audited record keeping and reporting can be used to demonstrate that an effective bird/wildlife control programme is in place and that airport management is aware of and takes action to reduce the number of strikes at and, where practicable, in the vicinity of the airport.

3.5.4 Annex 14, Volume I, requires States to assess the bird/wildlife strike hazard on, and in the vicinity of, an aerodrome through the establishment of a national procedure for recording and reporting bird/wildlife strikes to aircraft and the collection of information on the presence of birds/wildlife in the vicinity of the aerodrome which constitute a potential hazard to aircraft operations. The Annex also requires States to collect and forward bird/wildlife strike reports to ICAO for inclusion in the ICAO Bird Strike Information System (IBIS). The IBIS system consists of the reporting forms shown in Figures 3-1 and 3-2, computer storage of strike reports and analysis of strike data. Data collected by IBIS may be used by States that do not have computerized bird/wildlife strike data collection systems, to evaluate their efforts to control bird/wildlife strikes at airports with similar bird/wildlife ecology.

BIRD STRIKE REPORTING FORM

Send to:

Operator 01/02

Aircraft Make/Model 03/04

Engine Make/Model 05/06

Aircraft Registration 07

Date day ..... month ..... year 08

Local time 09
dawn ☐ A *day* ☐ B *dusk* ☐ C *night* ☐ D 10

Aerodrome Name 11/12

Runway Used 13

Location if En Route 14

Height AGL ..... *ft* 15

Speed (IAS) ..... *kt* 16

Phase of Flight 17

parked	☐ A	*en route*	☐ E
taxi	☐ B	*descent*	☐ F
take-off run	☐ C	*approach*	☐ G
climb	☐ D	*landing roll*	☐ H

Part(s) of Aircraft

	Struck		*Damaged*
radome	☐	18	☐
windshield	☐	19	☐
nose (excluding above)	☐	20	☐
engine no. 1	☐	21	☐
2	☐	22	☐
3	☐	23	☐
4	☐	24	☐
propeller	☐	25	☐
wing/rotor	☐	26	☐
fuselage	☐	27	☐
landing gear	☐	28	☐
tail	☐	29	☐
lights	☐	30	☐
other (specify)	☐	31	☐

Effect on Flight

none	☐ 32
aborted take-off	☐ 33
precautionary landing	☐ 34
engines shut down	☐ 35
other (specify)	☐ 36

Sky Condition 37

no cloud	☐ A
some cloud	☐ B
overcast	☐ C

Precipitation

fog	☐ 38
rain	☐ 39
snow	☐ 40

Bird Species* 41

Number of Birds

	Seen 42	*Struck* 43
1	☐ A	☐ A
2-10	☐ B	☐ B
11-100	☐ C	☐ C
more	☐ D	☐ D

Size of Bird 44

small	☐ S
medium	☐ M
large	☐ L

Pilot Warned of Birds 45
yes ☐ Y no ☐ X

Remarks *(describe damage, injuries and other pertinent information)* 46/47

.....

.....

.....

.....

Reported by .....
(Optional)

** Send all bird remains including feather fragments to:*

THIS INFORMATION IS REQUIRED FOR AVIATION SAFETY

Figure 3-1. Sample Form 1

SUPPLEMENTARY BIRD STRIKE REPORTING FORM
OPERATOR COSTS AND ENGINE DAMAGE INFORMATION

A. BASIC DATA

Operator 01/02

Aircraft Make/Model 03/04

Engine Make/Model..... 05/06

Aircraft Registration..... 07

Date of strike *day* ..... *month* ..... *year*..... 08

Aerodrome/Location if known..... 11/12/14

B. COST INFORMATION

Aircraft time out of service.....*hours* 52

Estimated cost of repairs or replacement *U.S.$ (in thousands)* 53

Estimated other costs
(e.g. loss of revenue, fuel, hotels) *U.S.$ (in thousands)* 54

C. SPECIAL INFORMATION ON ENGINE DAMAGE STRIKES

Engine position number	1	2	3	4
Reason for failure/shutdown	55	56	57	58
uncontained failure	☐ A	☐ A	☐ A	☐ A
fire	☐ B	☐ B	☐ B	☐ B
shutdown — vibration	☐ C	☐ C	☐ C	☐ C
shutdown — temperature	☐ D	☐ D	☐ D	☐ D
shutdown — fire warning	☐ E	☐ E	☐ E	☐ E
shutdown — other (specify)	☐ Y	☐ Y	☐ Y	☐ Y
shutdown — unknown	☐ Z	☐ Z	☐ Z	☐ Z
Estimated percentage of thrust loss*	____59	____60	____61	____62
Estimated number of birds ingested	____63	____64	____65	____66

Bird species..... 41

* These may be difficult to determine but even estimates are useful.

Send all bird remains including feather fragments to:

Reported by .....

Figure 3-2. Sample Form 2

3.5.5 The reporting of bird/wildlife strikes is best facilitated by utilizing a form such as the one shown in Figure 3-1. However, local variations in the contents of this form may be necessary in order to facilitate online and electronic airline flight safety recording, but the basis of these systems should encompass, at the very least, the data fields shown in the example form.

3.5.6 To implement a reporting system, an office in the national administration of the State should be charged with the responsibility of distributing the reporting forms and collecting and editing the completed forms before forwarding them to ICAO. The IBIS reporting form has been designed for reproduction by States, but it should be noted that the addresses to which the form is to be returned in each State, as well as the State address to which bird/wildlife remains should be sent, need to be shown.

Chapter 4

ORGANIZATION OF AN AIRPORT BIRD/WILDLIFE STRIKE CONTROL PROGRAMME

4.1 GENERAL

A programme to reduce the risks associated with bird/wildlife strikes is referred to in Annex 14, Volume I, Section 9.4, “Wildlife strike hazard reduction”. An airport should implement a bird/wildlife strike prevention programme in order to reduce the risks presented by birds and wildlife at the airport and in its vicinity. The scale and details of this programme will vary from airport to airport, but all programmes should contain basic information as described below.

4.2 CONTROL PROGRAMME

A bird/wildlife strike control programme should describe the following elements:

a) assignment of personnel:

   1) a manager who is accountable for developing and implementing the bird/wildlife strike prevention programme;

   2) a coordinator who should oversee the daily activities and analyse the collected data and carry out risk assessments in order to develop and implement the bird/wildlife strike prevention programme;

   3) trained and competent staff who should detect and record the presence of birds/wildlife and assess the bird/wildlife hazard and expel hazardous birds/wildlife. It is recommended that the training of staff engaged in bird control activities include an element of ornithological knowledge, to enable aerodrome bird control staff to make reliable and accurate identifications of birds both from observations and post bird strike during the collection and analysis of bird remains. A facility by which stakeholders can obtain a scientific analysis (feather or DNA) taken from snarge or an unidentifiable carcass following a strike should also be described in the control programme;

b) a process to report, collect and record data on struck and living birds/wildlife;

c) a process to analyse the data and assess the bird/wildlife hazard in order to develop mitigation, proactive and reactive measures. This should include a risk assessment methodology;

d) a process of habitat and land management both on the airport and in its vicinity in order to reduce the attractiveness of the area to birds/wildlife. Where applicable and relevant, this should include effective grass management techniques and, where applicable, a long/tall grass policy for “on-airfield” areas;

e) a process to expel or remove hazardous birds/wildlife, including by lethal means where appropriate;

f) a process for liaison with non-airport agencies and local landowners, etc., to ensure the airport operator is aware of developments that may contribute to creating additional bird hazards in the

infrastructure, vegetation, land use and activities in the airport vicinity (crop harvesting, seed planting, ploughing, establishment of land or water features, hunting, etc., that might attract birds/wildlife); and

g) a process to have regular meetings with all stakeholders of the airport's bird/wildlife strike prevention committee.

4.3. COLLECTING, REPORTING AND RECORDING DATA ON BIRD/WILDLIFE STRIKES AND OBSERVED BIRDS/WILDLIFE

4.3.1 Bird/wildlife detection is necessary and this is best done using mobile patrols with trained, competent and well-equipped staff who are dedicated to the task. Portable equipment is less prone to habituation and should be chosen to deal with the species being targeted.

4.3.2 A record of all wildlife activity or "bird/wildlife log" should be maintained. The log should detail the number, species and location of birds/wildlife seen. It should also contain the action taken to disperse birds/wildlife and the results of this action. The log should be completed at least every 30 minutes during daylight hours and then analysed to identify which species represent a hazard at which times of the day or year, or under which weather conditions, etc. This, combined with strike records, will provide the basis for predicting when certain species may be present to cause a problem. In general, airports will be well served by documenting all activities that are undertaken to reduce the presence of birds/wildlife.

4.3.3 All bird/wildlife strikes must be reported to the airport. It should be a requirement for all staff to report bird/wildlife strikes because it is only by full reporting that an accurate assessment of the real risk is possible. Overall risk does not necessarily stem from the pure total of bird/wildlife strikes. The risk is clearly greater if large flocking birds or large terrestrial mammals are involved than compared with small individual birds. Airport staff should record all details in a consistent manner and airline and other staff should also be encouraged to report all details.

4.3.4 Recent developments in DNA sequencing have led to the use of standardized molecular markers for species-level identification. This work is being conducted through the Consortium for the Barcode of Life which is located in the National Museum of Natural History, Smithsonian Institution, Washington, D.C., United States. The main aim of the consortium is to create and develop a reference barcode database. It is anticipated that all species will be identifiable through the use of the technique which uses a short gene sequence from a standardized region of the genome as a diagnostic "biomarker." Once a sufficient number of species have been identified using the technique, it will be possible to identify the species involved in bird/wildlife strikes to aircraft using samples of genetic material left at the point of impact. The remains of bird/wildlife strikes should be identified to species level to ensure the airport has the most accurate information possible on the types of birds/wildlife being struck.

4.4 RISK ASSESSMENT

4.4.1 With a good set of bird/wildlife strike data the airport should conduct a risk assessment using strike data for each species and update these regularly. This will assist in prioritizing efforts and directing them to the highest risks. A risk assessment should take into account the numbers struck for each species and the severity of damage arising from those strikes. Action should clearly be targeted on those species which occur with the highest frequency and create the greatest damage.

4.4.2 The risk assessment methodology set out by the International Birdstrike Committee is recommended guidance, along with other documentation from States. See the links provided in the appendix to this document for reference.

4.5 MANAGEMENT OF INFRASTRUCTURE, VEGETATION AND LAND USE

4.5.1 Airports should systematically review features on, and in the vicinity of, the airport that attract birds/wildlife. A management plan should be developed to reduce the attractiveness of these features and to decrease the number of hazardous birds/wildlife present or to deny them physical access to these areas.

4.5.2 Airport development should be designed such that it will not be attractive to hazardous birds/wildlife and no attraction will be created during construction. This may include denying resting, roosting and feeding opportunities for hazardous birds/wildlife.

4.5.3 A complete perimeter fence of adequate height is the prime method of preventing hazardous wildlife, other than birds, from gaining access to the airfield areas. Fences and gates should be left closed and regularly checked. No food sources should be available to animals on the airport.

4.5.4 Vegetation composition (grass) should be kept at a height that is considered unattractive to hazardous birds/wildlife, while accepting that this may not be applicable in arid locations. The attractiveness of vegetation is a balance between food presence, food accessibility and protection against predators:

a) earthworms, insects, rodents and other animals are present in and on the soil and in the vegetation. The vegetation itself and its seed are food for plant and seed eaters;

b) food accessibility depends on vegetation height and density. Long, dense vegetation will inhibit most hazardous birds/wildlife from moving around, detecting and accessing the food;

c) birds/wildlife safeguard themselves from predators by hiding and/or fleeing. Long, dense vegetation is preferred as a hiding place by agoraphobian species. These species avoid the open space of the runway and short vegetation. On the other hand, claustrophobic species avoid long, dense vegetation and prefer to stay in the open space of the runway and short vegetation where they have a wide view to see predators well in advance to enable them to flee on time; and

d) birds/wildlife feeding on seeds will avoid the airport if its vegetation is mowed during the flowering season. When these flowers attract insects that are attracting aerial feeders (for example swallows, swifts and bee-eaters), the vegetation should be cut before the flowering season in order to maximize deterrence of local wildlife species, and the height and species composition of the vegetation should be managed to minimize food sources.

4.5.5 Agricultural crops, where possible, should be discouraged from the airfield environment since agricultural crops and related activities (ploughing, mowing) will provide food for hazardous birds/wildlife.

4.5.6 Water bodies in many parts of the world can be a particular hazard because they can be very attractive to birds. It may be possible for these to be modified by netting them to exclude birds, fencing them to deny access to birds that walk in, have the sides steepened or made less attractive in other ways. Refuse/garbage dumps can also be very attractive to birds and can cause bird flyways to cross the airport. Preventing food sources from being available either through management or netting/fencing of the facility can be effective to deter birds and other wildlife.

4.6 EXPELLING BIRDS/WILDLIFE

In case hazardous birds/wildlife are still attracted to the airport after the proactive measures of 4.5 have been implemented, it may be necessary to expel them by either trapping or using lethal methods if other techniques have not proved successful and there is a continuing risk of collision with aircraft. If firearms and chemicals are used, they will need to be utilized within national regulations.

4.7 OFF-AIRPORT BIRDS

4.7.1 Birds that are not present on the airport but overfly the airport or its approaches and climb-out areas may also come into conflict with aircraft. Off-airfield monitoring of bird species and behaviour should occur and should include species, flightlines, seasonal patterns, time of day, etc.

4.7.2 Any significant bird/wildlife attractants within a defined radius (the exact distance will be dependent upon local or State regulations) centred on the aerodrome reference point (ARP) should be assessed and a management plan developed to reduce their attractiveness to birds/wildlife. While it is understood by leading bird/wildlife experts that an ARP might not always be centred exactly on the geographic centre of an aerodrome, typically a 13 km (or 7 NM) circle is considered a large enough area for an effective wildlife management plan. However, as necessary, action should also be taken when the bird/wildlife attractants are outside the 13 km circle if the airport operator has any influence on planning and development issues.

4.7.3 In accordance with the recommendations of Annex 14, Volume I, Chapter 9, 9.4.5, for any new off-airfield developments being proposed that may attract birds or flightlines across the airport, it is important that the airport operator be consulted and involved in the planning process to ensure that its interests are represented.

4.8 INTEGRATED APPROACH

An integrated approach is needed to coordinate the relevant organization's activities on the airport and ensure communication takes place between them. It is especially important that quick communication is possible between those involved in bird/wildlife dispersal and air traffic control. Upon receipt of notice of a specific wildlife threat, air traffic control should issue appropriate warnings to aircraft operating on, and in the vicinity of, the airport. Aircraft operators should also be part of such an integrated approach by being prepared to implement the guidance in Chapter 5 upon receipt of the warning of a specific threat.

4.9 STAFF TRAINING

4.9.1 Airport wildlife control personnel should receive formal training prior to their initial engagement as wildlife controllers. Staff need to be trained, competent and equipped for detection and dispersal tasks. Each State, indeed each airport operator within a State, may have varying wildlife management requirements due to varying ecosystems, topography, geographic location, habitat, hazard, risk and resources. Detailed and specific instructions therefore cannot be given due to these variables, and the following therefore provides only general guidelines. States should prepare and distribute, with the cooperation of their national wildlife control committee, guidelines for the training of airport personnel involved in airport wildlife control. Airports should include procedures for the training of staff involved in wildlife control in their wildlife management programmes.

4.9.2 Training administered to any person for the purpose of conducting airport wildlife control should be documented and records retained for a sufficient period as directed by the airport's wildlife control programme or as necessary to satisfy periodic reviews, internal audits and competence checks.

4.9.3 Training of airport wildlife control personnel should be conducted by qualified airport wildlife control personnel or specialists with proven experience in this field. These organizations, agencies and individuals should also be invited to attend meetings of and engage with national wildlife strike committees. The minimum qualifications for personnel appointed to provide training in wildlife management at the airport should ultimately be determined by the airport operator, but they should, at a minimum, be able to demonstrate proven competence in the field of work and produce evidence that they have completed a formal course of instruction, including "training the trainer", and/or a CV

which demonstrates an equivalent level of relevant experience in the field. However it is recognized by many States that training staff require a higher level of training, combined with professional experience. The United States Federal Aviation Administration (FAA), for example, in Advisory Circular (AC) 150/5200-36A (link provided in the appendix to this document) describes the qualifications for wildlife biologists conducting wildlife hazard assessments and training curriculums for airport personnel involved in controlling wildlife hazards on airports.

4.9.4 Formal courses in wildlife/bird hazard management may be available from universities, military establishments, government entities, various educational institutions and commercial agencies and organizations.

4.9.5 Successful completion of an airport wildlife training course should be demonstrated by taking a written and/or practical test and attaining an agreed pass score. A written certification should be provided to those who pass the test. If a published training procedure is not provided by the trainer, the certificate should attest to the subject areas the trainee has successfully completed.

4.9.6 Different airports may require different levels and types of initial and ongoing training due to the nature of the specific wildlife hazards in the local area and due to the size and complexity of the airport operations, including the type of aircraft and frequency of air traffic movements. At a minimum, initial training should address the following general areas:

a) an understanding of the nature and extent of the aviation wildlife management problem and local hazard identification;

b) an understanding of the national and local regulations, standards and guidance material related to airport wildlife management programmes (use of best-practice models);

c) an appreciation of the local wildlife ecology and biology, including (where applicable) the importance of good airfield grass management policies (also known as “tall” or “long grass”) and the benefits to wildlife control they can deliver;

d) the importance of accurate wildlife observation and identification, including the use of field guides;

e) local and national laws and regulations relating to rare and endangered species and species of special concern, and the airport operator’s policies relating to them;

f) policies and procedures concerning collection and identification of wildlife strike remains;

g) long-term (passive) control measures, including on- and off-airport habitat management, identification of wildlife attractions, vegetation policies, aeronautical NAVAID protection, and drainage system and water body management practicalities;

h) short-term (active) tactical measures, using well-established, effective wildlife removal, dispersal and control techniques;

i) documentation of wildlife activities, control measures and reporting procedures (the airport wildlife management plan);

j) firearms and field safety, including the use of personal protective equipment; and

k) wildlife strike risk assessment and risk management principles and how they integrate with the airport’s safety management system.

4.9.7 Additionally, wildlife control personnel should be fully aware of the conditions and terms of the operations of the airport's airside environment. Where this is not relevant, the wildlife control personnel should receive appropriate training, including:

a) airport airside driver training including airport familiarization, air traffic control communications, signs and marking, navigation aids, airport operations and safety, and other matters the local airport authority deems appropriate; and

b) aircraft familiarization, including aircraft identification, aircraft engine design and the impact of wildlife strikes on aircraft systems.

4.9.8 Airport wildlife control personnel must, as part of the airport operator's integrated approach to a safety management system, maintain competence in their role. This may be achieved by annual refresher training or another system of monitoring, accomplished "in-house" or using an external training provider. The airport operator should determine which method is most suitable. If a maintenance of competence scheme or refresher training is not available, airport wildlife control personnel should re-qualify within a period of no longer than three years.

4.9.9 In addition to the training in 4.9.6 and 4.9.7, the maintenance of competence should include:

a) review of firearms safety;

b) changes in the local environment;

c) changes in the risk management policy;

d) recent wildlife events at the airport;

e) improvements in active and passive measures; and

f) any other matters that the airport operator deems appropriate.

Chapter 5

AIRCRAFT OPERATORS

5.1 Aircraft operators should be given specific, timely and reliable information which will allow them to adapt their flight schedules in order to ensure the safety of their aircraft, just as they would do to mitigate other hazards such as wind shear, icing and volcanic ash.

5.2 Aircraft operators should inform air traffic control about observed birds/wildlife, either struck or living. If birds/wildlife are observed in the flight path, aircraft operators may choose to request bird/wildlife dispersal and consider adapting their flight operations by changing the route, timing and/or speed where this is possible within the parameters dictated by the air traffic control authorities. Aircraft operations personnel should also coordinate with airport operators and air traffic control to offer alternative departure and arrival options on unaffected runways should a wildlife/bird threat be present on the airport.

5.3 Examples of modified procedures for aircraft arriving at and departing airports with hazardous birds/wildlife on the airport or in its vicinity are:

a) Jets could depart the airport on the ICAO noise abatement departure profile (NADP 1) and turboprops could depart at best angle-of-climb speed until above 3 000 feet. Because 95 per cent of bird strikes occur below 3 000 feet these procedures would ensure that aircraft climb above 3 000 feet as rapidly as possible, while maintaining a relatively slow airspeed, which may decrease the damage in the event of a bird strike.

b) Arriving aircraft should remain above 3 000 feet until necessary to descend directly for landing. This may require coordination with air traffic control and modification of local air traffic procedures.

c) When airspeed is reduced in areas of high bird concentration, the slower speeds reduce the kinetic energy of a collision and reduce the likelihood of damage caused by a bird strike.

d) Pilots of jet aircraft that encounter a flock of birds on approach close to the runway may find that the safest course of action is to continue through the flock and land. An attempted go-around will require high engine rotation speed which will increase the likelihood of engine damage by ingestion. Any such procedures are determined by the airline’s standard operating procedures in coordination with local air traffic procedures.

5.4 It is recommended that all aircraft operators be required to file the appropriate bird strike report form in the event that they experience a bird/wildlife strike. Wildlife hazards observed (both in the air and on the ground) by aircraft operators should also be reported on the appropriate safety form, including near-miss occurrences.

Chapter 6

ASSESSMENT OF THE RISK OF BIRD/WILDLIFE STRIKES

6.1 Before discussing the assessment of the risk of bird/wildlife strikes, it is important to ensure that consistent terminology is used. The words “hazard” and “risk” are often used interchangeably in normal conversation but they have specific meanings in the science of risk analysis:

a) A hazard is defined as a situation that, in certain circumstances, can lead to an event that results in harm. In this context, a hazard is the presence of certain birds/wildlife on or near an aerodrome.

b) Risk is the probability that the harmful event will occur, multiplied by the severity of the harm that could result. In this context it is the probability of a bird/wildlife strike by a particular group of birds/wildlife multiplied by the severity of damage to the aircraft that results.

Risk = (probability of an event) × (severity of harm) and so for bird/wildlife strikes:

Risk = (probability of a strike) × (severity of damage caused).

6.2 It is therefore possible to have a large number of large birds/wildlife close to an airport (a significant hazard) which results in a very low risk if the birds/wildlife never move onto the airfield or fly across the operational airspace. It is also possible to have a large number of small wildlife (typically weighing less than 120 g or 4 oz) that are regularly struck by aircraft but which result in a low risk because of their size and weight, meaning that the level of harm resulting from the strikes is always very low (except when colliding with dense flocks).

6.3 Any assessment of risk therefore needs to estimate the probability that a strike will occur and the likely level of harm that will result. Estimation of harm is relatively straightforward because analysis of various bird/wildlife strike databases around the world shows that there is a consistent relationship between bird/wildlife mass and the level of damage to aircraft. Strikes involving flocks of birds (even small species) are also more likely to result in damage to the aircraft than strikes with single birds. Thus the larger the bird/wildlife and the greater its tendency to be struck in groups, the greater the risk.

6.4 It is more difficult, however, to estimate the likely strike frequency of a particular population of bird or other wildlife because their behaviour cannot be predicted with certainty. There are a number of possible approaches to estimating strike probability, which vary in sophistication and in the level of skills and experience needed to apply them.

6.5 The most common form of risk assessment involves the categorization of both strike probability and likely severity into a number of arbitrary levels, usually low, medium and high. Again, this is easily done for strike severity using the mass of the birds/wildlife involved, with a correction for their tendency to occur in groups. Assigning birds/wildlife to a category for strike probability is more difficult and requires some specialist knowledge of the behaviour of the species involved and how that behaviour is influenced by the environment around the airport concerned. Some airports may have staff that are sufficiently experienced in bird/wildlife behaviour to allow them to undertake this work. Otherwise, contracting the services of bird/wildlife strike prevention specialists or local ornithologists may be necessary.

6.6 A typical option for risk assessment may involve a numerical approach that uses the number of strikes encountered with different species over the recent past as a measure of the probability of likely future strikes. For this process to work reliably the airport’s records must indicate that the majority of strikes that occurred at the airport have

been reported, that reporting has been consistent from year to year and that the bird/wildlife species involved have been identified correctly. If these three requirements have not been met, it is better to use one of the more generic risk assessments described above. One such numerical approach involves taking the mean number of strikes recorded for each species in the past five years and using this to assign the species concerned to one of five frequency categories. The mass of the species is then used as a measure of likely severity and the species are assigned to one of five severity categories. The boundaries of these categories can be set by the airport or regulator concerned. The frequency and severity measures are then combined into a 5 x 5 risk matrix (see Figure 6-1) with the different cells of the matrix designated as one of three risk levels.

SEVERITY	PROBABILITY				
	Very high	High	Moderate	Low	Very low
Very high	3	3	3	2	2
Moderate	3	3	3	2	2
High	3	3	2	1	1
Low	2	2	1	1	1
Very low	1	1	1	1	1

Figure 6-1. A 5 × 5 risk assessment matrix

6.7 The three risk levels require different responses from airport managers as follows.

a) *Risk level 3.* Risk from this species is currently very high. Additional management actions should be implemented for this species as soon as possible.

b) *Risk level 2.* Risk from this species merits further review of available options and action if appropriate. Current risk management for this species should be reviewed and additional steps taken if appropriate.

c) *Risk level 1.* Risk from this species is currently low. No further action is required beyond the risk management measures currently in place.

6.8 It is also accepted that there may be local variations to this matrix, such as:

a) *Green (Level 1).* No further action is required.

b) *Amber (Level 2).* The current residual risk requires a review of available options and possible action.

c) *Red (Level 3).* The current residual risk requires further action to reduce it.

In other words, the actions and assessment need to fit with the reality of what can realistically be achieved within the legislation available and the resources at the airport's disposal. It should be noted that where the risk assessment in a Level 3 indicates "unacceptable" there may be very little the airport can do about managing this risk to entirely remove it, for example, due to the coastal location of the airport, or where the airport is surrounded by conservation areas and the airport operator is unable to access and influence the wildlife hazards due to constraints placed upon the airport by local wildlife legislation.

6.9 The risk assessment matrix may also need to be adapted to cater for the risk posed by multiple strikes, whereby this risk would need to be raised to a high level.

6.10 All of the above techniques are designed to assess the total risk of a bird/wildlife strike at an airport. This is effectively the airport operator's risk exposure. In order to assess the risk to an airline or an individual passenger flying to or from an airport, some account of movement rate needs to be incorporated into the risk assessment. The simplest approach to this is to express strike frequency per aircraft movement or, more conventionally, as strikes per 10 000 aircraft movements. As with the techniques described above, the sophistication with which this strike rate can be interpreted depends upon the level of detailed information available concerning the bird/wildlife strikes that are encountered. If information is limited to the total number of strikes per year then the strike rate per 10 000 movements may simply be categorized as low, medium or high. If bird/wildlife strikes are reliably reported and identified and there is a sufficient data set, then it may be possible to treat the strike rate for an individual species as a measure of strike probability. However, it should be borne in mind that the severity depends on the mass of the species and the flocking behaviour.

6.11 Whatever risk assessment technique is chosen, it is essential that the findings are followed up by effective risk management. For those risks that are judged very high (Level 3), a list of available actions should be developed, in consultation with bird/wildlife management experts where necessary, and the costs and benefits of the various options assessed before a decision is reached on which options to select. It is equally important that the effectiveness of these options is evaluated at appropriate intervals after they are implemented. Repeating the risk assessment process annually to determine if the risk is falling to an acceptable level is recommended.

6.12 At the same time for those risks judged low (Level 1), the actions in place should not ease and should continue at the same intensity and frequency.

6.13 Finally, it is essential that the entire process be properly documented in order to show that the airport operator concerned is acting with due diligence in managing the bird/wildlife risk on and around its property.

6.14 A more thorough discussion of the assessment of risk can be found in ICAO's *Safety Management Manual (SMM)* (Doc 9859).

Chapter 7

HABITAT MANAGEMENT AND SITE MODIFICATION

7.1 GENERAL

7.1.1 Birds and other wildlife occur on airport property for a variety of reasons, mainly food, water and shelter.

7.1.2 Modifications to the airport's habitat/environment to eliminate or exclude food, water and shelter can limit the attractiveness of an airport to birds and other wildlife. Habitat management provides the foundation for an airport's bird/wildlife hazard management programme because it offers ecologically based, long-term measures for reducing the number of hazardous birds/wildlife at the airport. If direct action against birds/wildlife is chronically necessary, it is usually because habitat management has not yet been fully implemented or further measures are not cost-effective.

7.1.3 Before undertaking activities to manage the environment, it is important to first carry out an ecological survey of the airport and surrounding area to identify sources of food, water and shelter attractive to wildlife on and in the vicinity of the airport. This way, the environmental management plan is able to deal with specific conditions or habitats that are attracting wildlife. A standardized reporting system that documents wildlife species, numbers and location on the airport, as well as strike events, can provide the foundation for an ecological survey. From this ecological survey, prioritization of activities or projects within the plan may then occur. There are many wildlife attractants that an environment management plan can control.

7.2 FOOD

7.2.1 It is difficult to remove all food sources for birds and other wildlife on airports. Because grass is the common vegetation on most airports, grassland management has an important influence on food available to birds.

7.2.2 Wildlife may enter airport lands in order to feed on seeds, vegetation, invertebrates or rodents and other small mammals in grasslands or agricultural crops; on fruits in trees and shrubs; or on exposed food waste from catering services or restaurants. These sources of food are especially attractive to a variety of birds. Agricultural measures like mowing, harvesting and ploughing will attract birds because of the disturbance and exposure of seeds, invertebrates and rodents. Although it is impossible to remove all food sources on airports, the following are suggested measures that can be taken to mitigate the problem:

a) *Agriculture.* Cultivation of airport lands will, no matter what the crop type, attract birds at some part of the life cycle of the crop. Therefore, it is recommended that airport lands not be used for agriculture.

b) *Food waste.* Airports should require wildlife-proof storage of food waste, prohibit bird/wildlife feeding and promote good sanitation and litter control programmes.

c) *Waste management facilities (refuse collection, landfill sites and/or garbage dumps).* Refuse dumps that accept putrescible (organic) wastes are highly attractive to various bird and mammal species that are hazardous to aviation. It is important to bring about national and local legislation in order to prohibit or restrict the establishment of new sites that accept putrescible wastes close to airports and, ideally, national legislation to provide for the closure of existing dumps that are attracting wildlife hazardous to aviation. However, in reality, this will be very difficult to achieve without new State legislation. Generally It

is desirable that sites be no closer than a 13 km circle centred on the ARP and, in some cases, further — where studies of flightlines of birds attracted to these sites prove them problematic for the airport. If a refuse site in the vicinity of an airport cannot be closed, it likely will be necessary to try to influence the operators to provide control measures at the site to reduce its attractiveness to wildlife. However, this cannot be determined unless a formal assessment of the site is carried out to establish the type of waste and the wildlife species attracted to the locale. Such control could include fencing, netting or overhead wires to prevent access to the active surface and active dispersal of birds using pyrotechnics or other dispersal techniques. Fully enclosed waste-transfer facilities and sites which take only inorganic refuse such as construction and demolition waste generally will not attract hazardous wildlife.

7.3 WATER

Surface water is often highly attractive to birds. Exposed water should be eliminated or minimized to the greatest extent possible on airport property as follows:

a) *Depressions and water bodies*. Pits or depressions that fill with water after rains should be levelled and drained. Larger water bodies, such as storm-water retention lagoons, can be covered with wires or netting to inhibit birds from landing. Larger water bodies that cannot be eliminated should have a perimeter road so that bird/wildlife-control personnel can quickly access all parts of the water body to disperse birds. Water bodies and ditches should have steep slopes to discourage wading birds from feeding in shallow water.

b) *Drainage ditches*. When drainage ditches clog up with vegetation or eroded soil and the flow of water is impeded, insect and other aquatic life flourish, thereby attracting birds if remaining unnetted. In order to address such issues, culverting the ditches is recommended. Clearing the ditches at regular intervals is important. They should be graded so that the water will run off as rapidly as possible. Grass and other vegetation should be cut on the sloping banks. Where practicable, the water attractant can be eliminated by replacing ditches with buried drain pipes.

7.4 SHELTER

7.4.1 Birds and other wildlife often seek shelter and breeding sites on airport property in such places as the structural beams of hangars and bridges, in nooks of jetways and other structures, and in trees and shrubs. Some birds, such as gulls and waterfowl, seek the open spaces on airport property for safety while resting. These areas give the birds a clear view of their surroundings in all directions. Deer and other mammals will seek shelter in dense stands of trees and shrubs. The following measures can be taken to deter birds and other wildlife from seeking shelter and breeding sites on airport property:

a) *Structures*. Architects should consult biologists during the design phase of buildings, hangars, bridges and other structures at airports to minimize exposed areas that birds can use for perching and nesting. When perching sites are present in older structures (such as rafter and girded areas in hangars, warehouses and under bridges) access to these sites can often be eliminated with netting. Anti-perching devices, such as spikes, can be installed on ledges, roof peaks, rafters, signs, posts and other roosting and perching areas to keep certain birds from using them. Changing the angle of building ledges to 45 degrees or more will deter birds. However, it is emphasized that incorporating bird exclusion or deterrence into the design of structures is the most effective, long-term solution.

b) *Abandoned structures*. All unnecessary or abandoned posts, fences and other structures that can be used as perches by raptors and other birds should be removed from airport property. Piles of

construction debris and discarded equipment, unmowed fence rows and other unmanaged areas are not only aesthetically unpleasing but typically provide excellent cover for rodents and other wildlife. These areas should be eliminated at airports.

c) *Trees and shrubs.* Much care must be taken when selecting and spacing plants for airport landscaping. Avoid plants that produce fruits and seeds desired by wildlife. Also avoid the creation of areas of dense cover for roosting by flocking species of birds. Thinning the canopy of trees or selectively removing trees to increase their spacing can help eliminate bird roosts that form in trees on airports.

d) *Ground vegetation.* Because vegetative ground cover (typically grass) is usually the dominant habitat on an airport, the management of an airport's airside ground cover to minimize its attractiveness to wildlife is a critical activity. However, management of ground vegetation requires expert knowledge about the local ecological conditions because of variations in soil types, rainfall patterns, temperature profiles and wildlife, resulting in site-specific vegetation. The following are suggested methods of reducing wildlife attraction to airport ground cover:

1) Studies in Europe have indicated that maintaining a monoculture of tall or long (150 mm to 200 m high) dense grass can discourage gulls, lapwings and similar birds from landing and feeding on soil invertebrates. However, studies and observations in North America, parts of Africa and Asia indicate that tall grass does not discourage certain large birds such as geese, herons and egrets. Tall, dense grass interferes with visibility and locomotion of the smaller birds. Although rodent populations may increase in tall grass, the density and height of the grass may be managed by effective cutting and clearing methods (also known as "bottoming out") in order to discourage raptors and rodents from feeding. Maintenance of tall, dense stands of grass may require special mowing equipment and other activities to prevent thatch build-up and to keep the grass uniformly tall and free of weeds.

2) When seeds are the most important food source, the vegetation should be mowed during the flowering season. In case these flowers attract insects that, when airborne, attract swallows and other aerial feeders, the vegetation should be mowed before the flowering season.

3) Short grass (less than 150 mm) may result in fewer rodents compared to tall grass because of reduced cover and increased disturbance caused by frequency of mowing. However, raptors may be attracted to short grass because any rodents still present are more exposed than in taller grass. Mowing activities may attract birds to feed by exposing invertebrates and rodents. The height of the vegetation and the timing and frequency of mowing on an airport should be oriented to minimizing hazardous wildlife and not to any other horticultural benefits which may arise from the ground cover.

4) A promising approach to reducing wildlife attraction to airport ground cover, regardless of the height, is the use of vegetation that is undesirable or mildly toxic to wildlife. For example, there are varieties of fescue grass that contain fungal endophytes unpalatable to some grazing birds, mammals and insects. Other ground cover, such as *Wedelia* or Bermuda Grass, may be appropriate for subtropical airfields.

5) Until more research is completed, no general guidelines on grass height or vegetation type for airside ground cover will be made. Consult with professional biologists and horticulturists to develop a vegetation type and mowing regime appropriate for the growing conditions and wildlife at the location. The main principles to follow are to use a vegetation cover and mowing regime that do not result in a build-up of rodent numbers or the production of seeds, forage or invertebrates desired by wildlife.

Chapter 8

REPELLENT TECHNIQUES

8.1 GENERAL

8.1.1 Repellent and harassment techniques should be used to keep hazardous wildlife away from specific areas on or near an airport. The long-term cost-effectiveness of repelling hazardous wildlife does not compare favourably with habitat modification or exclusion techniques. Wildlife will return as long as the attractant is accessible. However, habitat modification and exclusion techniques will never rid an airport of all hazardous wildlife. Repellent techniques are a key ingredient of any wildlife hazard management plan.

8.1.2 Repellents work by affecting the animal's senses through chemical, auditory or visual means. Habituation or acclimation of birds and mammals to most mechanical repellent techniques is a major problem. When used repeatedly, without added reinforcement, wildlife soon learn that the repellents or techniques are harmless and the repellents or techniques are ignored.

8.1.3 When using repellents, four critical factors should be remembered:

a) there is no single solution to all problems;

b) there is no standard protocol or set of procedures that is best for all situations. Repelling wildlife is an art and a science. Motivated, trained and suitably equipped personnel who understand the wildlife on the airport are critical for the successful use of repellents;

c) each wildlife species is unique and will often respond differently to various repellent techniques. Even within a group of closely related species, such as gulls, the various species will often respond differently to various repellent techniques; and

d) to lessen habituation to repellent techniques:

1) use each technique sparingly and appropriately when the target wildlife is present;

2) use various repellent techniques in an integrated fashion; and

3) reinforce repellents with occasional lethal control (only when necessary depredation permits are in place) directed at abundant problem species.

8.1.4 Advances in electronics, remote sensing and computers have resulted in "intelligent'' systems that can automatically dispense repellents (for example, noisemakers, chemical sprays) when targeted wildlife enter selected areas. These devices are used to reduce habituation and increase the effectiveness of other repellent techniques. It should be remembered that automated repellents are not a substitute for trained people on the ground, who can respond appropriately to incursions by various wildlife species, and should be considered only when more traditional methods of control and dispersal have proved ineffective.

8.2 WILDLIFE PATROLS AND RUNWAY SWEEPS IN VEHICLES

Patrols of airside areas to disperse birds and other hazardous wildlife are a critical part of an integrated programme of wildlife hazard management on airports. Driving a vehicle toward the wildlife may be enough to cause the wildlife to disperse. This is especially true if the driver has been using repellent and removal techniques as outlined below. Regular and continuous patrols and sweeps help wildlife control personnel to learn the behaviour, daily movement patterns and habitat preferences of wildlife on the airport. This information helps identify hazardous wildlife attractants on the airport (for example, low areas that gather standing water after rains) and hence future problems. All wildlife carcasses found during runway sweeps should be collected, identified as to species and documented in a wildlife strike log of carcass remains.

8.3 CHEMICAL REPELLENTS

Chemical repellents for birds (these are not permitted by some States)

8.3.1 It is important to note that only chemical repellents registered and approved by the proper national, regional and local authorities should be used. It should be noted at the outset that there are no chemical “solutions” for airport wildlife hazards, and at best some applications may work on some species in some circumstances. Additional measures will always be necessary, and some chemical repellents may not be available or appropriate to local conditions. The following chemical repellents, listed by active ingredient, may be available for use on airports:

a) *Perches (polybutenes)*. Several commercial products are available in liquid or paste form. These sticky formulas make birds uncomfortable when they alight on them, encouraging the birds to look elsewhere to perch or roost. To be effective, all perching surfaces in a problem area should be treated, or the birds will move a short distance to an untreated surface. Under normal conditions, the effective life of these materials is six months to one year, but dusty environments can substantially lessen their life expectancy. Once the material loses effectiveness, it is necessary to remove it and apply a fresh coat. Applying the material over duct tape, rather than directly to the rafter surface upon which it will be used, will simplify clean-up.

b) *Turf feeding (anthraquinone, methyl anthranilate).* These two chemicals are commonly used as bird repellents for turf (grass):

1) *Anthraquinone* acts as a conditioned-aversion repellent with birds. Birds eating food treated with anthraquinone become slightly ill and develop a post-ingestion aversion to the treated food source. Birds can see ultraviolet (UV) light and this enables birds to detect anthraquinone visually using UV light. They become conditioned to avoid the treated food source. Because of its conditioned-aversion properties, anthraquinone should not be applied to the entire airfield. It should be applied only in areas where birds graze or in higher risk areas, such as runway approaches.

2) *Methyl anthranilate* is an artificial grape flavouring commonly used as a food additive, which is registered in some States as a feeding repellent for birds on turf. Birds have a taste aversion to methyl anthranilate, seemingly reacting to it in much the same way that mammals react to concentrated ammonia (smelling salts).

Both anthraquinone and methyl anthranilate are available in liquid formulations intended for foliar application. The effectiveness of these sprays in repelling grazing birds such as Canada geese varies, depending on growing conditions, rainfall, mowing and availability of alternate feeding areas. Repellency based on conditioned aversion is longer lasting than repellency based on taste.

c) *Water (methyl anthranilate).* Another formulation of methyl anthranilate may be applied to pools of standing water on airports and at other locations to repel birds from drinking and bathing. This application works well on temporary pools of standing water.

d) *General area (fogging with methyl anthranilate).* Methyl anthranilate is also available for use in fogging machines (thermal or mechanical) to disperse birds from hangars, lawns and other areas.

e) *Frightening agent (Avitrol [4-Aminopyridine]).* Avitrol is used to repel pigeons, house sparrows, blackbirds, grackles, cowbirds, starlings, crows and gulls from feeding, nesting, loafing and roosting sites. Birds eating Avitrol-treated bait react with distress symptoms and calls, behaviour that frightens away other birds in the flock. Although registered as a "frightening agent" Avitrol is toxic to the birds that eat treated bait. Avitrol-treated bait should be applied in small amounts with untreated bait so most birds in the flock do not eat the treated bait. The primary use of Avitrol at airports has been for pigeon control around buildings. The safe use of Avitrol requires:

1) knowledge of the bird's feeding patterns;

2) proper pre-baiting procedures to ensure bait acceptance and avoidance of non-target species; and

3) removal of dead birds after treatment.

Chemical repellents for mammals

8.3.2 There are many taste and odour repellents marketed to repel deer, rabbits and other mammals from browsing on vegetation (Hygnstrom et al., 1994). These include odour repellents which are applied directly to the vegetation and general area (for example, predator urine). A recent study showed that predator urine had no influence on deer movements along established trails or at feeding sites. Some of these products might be suitable for short-term protection of valuable landscaping plants and fruit trees. However, they should not be used at airports to repel or discourage deer or other mammals because they are unlikely to have any influence on wildlife movements.

8.4 AUDIO REPELLENTS

Audio repellents for birds

8.4.1 The following are some examples of audio repellents that can be used on birds:

a) *Propane cannons.* Propane cannons (exploders) produce a shotgun-sounding blast. In general, birds quickly habituate to propane cannons that detonate at random or preset intervals throughout the day, and they can scare birds into flight paths creating extra hazard. Thus, to ensure they remain effective, cannons should be used only sparingly and when birds are in specific areas. Reinforcement by occasional shooting of a common bird species with a shotgun may improve the effectiveness of the cannons. Protected birds should be avoided unless the necessary depredation permits are in place. Some systems are designed so that cannons placed around an airport may be detonated remotely, on demand by radio signal, when birds are in the area.

b) *Distress-call and electronic noise-generating systems.* Recorded distress calls are available for birds commonly found on airports in many parts of the world, such as gulls, crows and starlings. Such calls,

broadcast from speakers mounted on a vehicle, will often initially draw the birds toward the sound source to investigate the threat. These birds should be dispersed using pyrotechnics or by shooting an occasional bird with a shotgun. Distress calls routinely broadcast from stationary speakers, with no associated reinforcement to provide added fear or stress, have little utility. Birds habituate rapidly to electronic sound generators that produce various synthetic sounds from stationary speakers.

c) *Shell crackers and other pyrotechnics.* There are various projectiles, fired from breech-loaded shotguns or from specialized launchers, that provide an auditory blast or scream as well as smoke and flashing lights to frighten birds. Some of the newer cartridges have ranges of up to 275 metres. Pyrotechnics, when used skilfully in combination with other harassment techniques and limited lethal reinforcement (shooting with a shotgun), are useful in driving birds off an airport. Pyrotechnic devices require that a person fire the projectile. This targeting of specific birds helps teach them to associate the pyrotechnic with a threat (person).

d) *Ultrasonic devices*. Ultrasonic (sound above the range detected by humans) devices are not proven to be an effective bird repellent. Bird species hazardous to aircraft are unable to hear ultrasonic frequencies, and therefore it is considered that these devices are largely ineffective as bird deterrents. Their use against mammals in airport environments is also largely unproven.

Audio repellents for mammals

8.4.2 Propane cannons are the most commonly used audio repellent for deer. However, deer rapidly habituate to propane cannons. Therefore, except for short-term emergencies (a few days), propane cannons should not be relied upon to repel deer and other mammals from runways. Other electronic noise-generating devices have also proven ineffective at repelling deer or other mammals for more than a few days. Pyrotechnics also provide only short-term repellency for mammals.

8.5 VISUAL REPELLENTS

Visual repellents for birds

8.5.1 The following are some examples of visual repellents that can be used on birds:

a) Most visual repellents are simply a variation on an ancient theme, the scarecrow. Visual repellents such as hawk effigies or silhouettes, eye-spot balloons, flags and Mylar reflecting tapes have shown only short-term effectiveness and are not suitable as long-term solutions to an airport's bird problems. Most short-term success achieved with these devices is likely attributable to "new object reaction" rather than to any frightening effect produced by them. In a test in the United States, a flag with a large eye-spot was exposed to pigeons in an abandoned building. As soon as the flag was put up, the pigeons left the building, giving the impression the eye-spot flag was repellent to the birds. However, within 24 hours the pigeons returned. From then on the pigeons behaved in a normal fashion and showed no interest in, or reaction to, the flag.

b) Taxidermy mounts of predators, designed to move in the wind, might be useful as part of an integrated programme to disperse certain bird species from airports. Such effigies should be used sparingly and moved often to reduce habituation. Permanently mounted effigies have little deterrent effect.

c) Displaying dead birds in a "death pose" has proven effective in repelling birds from local areas. Recent experiments and field demonstrations showed that a dead turkey vulture (freeze-dried taxidermy

mount with wings spread), hung by its feet in a vulture roosting or perching area, caused the vultures to abandon the site. Trials using dead gulls and ravens suspended from a pole have shown promising results in dispersing these species from feeding and resting sites. The dead bird should be hung in a "death pose" for maximum effect. Live birds ignore or are attracted to dead birds lying supine on the ground or in the roost. Needed permits should be obtained before using protected birds as dead-bird deterrents. Research is under way to determine if artificial dead-bird effigies can be developed that will be just as effective as the taxidermy mounts. However, in the United Kingdom the suspension of dead crows and rooks from poles to deter crop feeding has been shown to be effective only for a period of a few hours to a few days, after which birds will resume normal behaviour.

d) Hand-held laser projectors projecting a one-inch diameter red beam have been used successfully during trials in Europe to disperse birds such as Canada geese, double-crested cormorants and crows from night-time roosting areas in reservoirs and trees. Hand-held laser projectors are effective at long ranges (over 0.4 km) and have also shown some effectiveness in dispersing birds from hangars. Based on trials in France it was decided that automated, continuous-scanning, green-laser projectors could be used, without any safety problem, on civil and military airfields. However, the use of laser equipment is not universally accepted, and to some extent its effectiveness remains unproven. During trials, daylight conditions reduced or eliminated the effectiveness of lasers. The use of lasers in an airport environment requires caution. Annex 14, Volume I, Chapter 5, 5.3.1, recommends setting up a laser-beam free flight zone, a critical flight zone and a sensitive flight zone around aerodromes. Guidance on how to protect flight operations from the hazardous effects of laser emitters is contained in the *Manual on Laser Emitters and Flight Safety* (Doc 9815).

Visual repellents for mammals

8.5.2 Visual repellents such as flags and effigies have proven ineffective in repelling mammals. Red lasers (see above) were ineffective in dispersing deer.

8.6 THE USE OF TRAINED FALCONS AND DOGS TO REPEL BIRDS

8.6.1 Since the late 1940s trained falcons and other birds of prey have been used intermittently on various airports in Europe and North America to disperse birds. The advantage of falconry is that the birds on the airport are exposed to a natural predator of which they have an innate fear. The disadvantage is that a falconry programme is often expensive, needing many birds that must be kept and cared for by a crew of trained, motivated personnel. The effectiveness of falconry programmes in reducing bird strikes, in comparison with more conventional techniques, has been difficult to evaluate and, as important, wildlife management by these techniques requires a dedicated team of motivated, trained and competent personnel.

8.6.2 The following is considered to be a comprehensive summary of good operating practices for falconry use on airports:

a) properly trained birds of prey of the right species for the job, used regularly and persistently by skilled and conscientious personnel, are effective in clearing birds from airfields during daylight and good weather;

b) for good results, year-round, daily operations are usually needed;

c) several falcons are needed to have at least one bird always ready to fly;

d) a staff of at least two full-time, well-trained personnel are needed to capture, train, work and care for falcons. It should be noted that this practice may not be permitted in many parts of the world, where only captive-bred birds may be used, and indeed falconry is banned in some States; and

e) access to a full range of other techniques is also required.

8.6.3 The use of trained dogs, especially border collies, to chase geese and other birds from golf courses, airports and other sites is a recent development. The successful use of border collies to repel birds requires a high degree of dedication and commitment by the handlers. As with falcons, the advantage is exposure to a natural predator. The disadvantages are:

a) a trained person must always be in full control of the dog;

b) most dogs respond well only to a single handler;

c) the dog needs care and exercise every day; and

d) a dog will have little influence on birds that are flying over the airport.

8.7 RADIO-CONTROLLED MODEL AIRCRAFT TO REPEL BIRDS

8.7.1 Radio-controlled (RC) model aircraft, a relatively new technological innovation that provides both visual and auditory stimuli, have been used occasionally to harass birds on airports. If used precisely by competent and trained operators, limited trials have shown that RC aircraft can be used to herd birds away from airport runways, but their effectiveness remains largely unproven. Some RC aircraft, for example, have been designed to mimic the appearance of a falcon and to even fire pyrotechnics remotely.

8.7.2 Using RC aircraft in a busy airport environment requires highly trained operators and a thorough risk assessment, with written procedures, in coordination with other stakeholders such as ATC. Before using RC aircraft, it is important that operators ensure that the radio frequencies used are compatible with other radio uses in the airfield environment, particularly flight crew, airfield operations and air traffic control.

8.8 NON-LETHAL PROJECTILES TO REPEL BIRDS

Paint balls and rubber or plastic projectiles, fired from paint-ball guns and twelve-gauge shotguns respectively, have been used to reinforce other dispersal techniques. A high-quality paint-ball gun should be used to ensure accuracy and velocity. Paint-ball guns are typically fired at 6 to 30 metres from the target wildlife. There are several types of rubber or plastic projectiles (slugs, buckshot, pellets, beads) for use in a shotgun. The proper distance from the bird for firing varies by projectile and species of bird. Personnel should be trained in the safe use of firearms and the particular projectiles to be used. The objective is to shoot from a great enough distance for the projectile to cause temporary pain, but not injury, to the bird struck. However, the use and effectiveness of projectiles are largely unproven and would not be permitted by some States or airport operators due to health and safety regulations.

Chapter 9

BEST PRACTICES FOR BIRD/WILDLIFE MANAGEMENT PROGRAMMES ON AERODROMES

9.1 GENERAL

9.1.1 While there is considerable information available concerning the techniques that can be used to deter birds and other wildlife from aerodromes and thus control the wildlife strike risk, there is little guidance available on the effort that is necessary to achieve effective control. The effort required will vary with the particular airport concerned, the number of hazardous birds/wildlife in its immediate location and the attractiveness of the airport compared to the surrounding habitat. Despite this variability, experience has shown that for bird/wildlife control to be carried out to best effect a particular level of organization and investment is needed in equipment, training and resources.

9.1.2 The International Birdstrike Committee (IBSC) has produced recommended best practices for aerodrome bird control which, in the opinion of its members, are required to achieve fully effective bird control. A summary is reproduced below. Details can be found at www.int-birdstrike.org.

9.2 SUMMARY OF BEST PRACTICES FOR AERODROME BIRD CONTROL

Note.— These best practices should apply to any aerodrome carrying regularly scheduled commercial air traffic, irrespective of the movement frequency or type of aircraft involved. The following text is a direct facsimile of the IBSC paper; some text has been amended and endorsed by the 2011 review project team.

9.2.1 A named member of the senior management team at the airport should be responsible for the implementation of the bird/wildlife control programme, including both habitat management and active control.

9.2.2 An airport should undertake a review of the features on its property that attract hazardous birds. The precise nature of the resource that they are attracted to should be identified and a management plan developed to eliminate, reduce the quantity of, or to deny access to that resource, as far as is practicable. If necessary, support from a professional bird strike prevention specialist should be sought. Documentary evidence of this process, its implementation and outcomes should be kept.

9.2.3 A properly trained and equipped bird/wildlife controller should be present on the airfield sufficiently in advance of any aircraft movement to allow full inspection of vulnerable areas and dispersal of any hazardous wildlife to be achieved. If aircraft are landing or taking off at short intervals (e.g. every 5 minutes) there should be a continuous presence on the airfield throughout daylight hours. The bird controller should not be required to undertake any duties other than bird/wildlife control during this time.

9.2.4 Airport bird/wildlife controllers should make record entries ***at least*** every 30 minutes (if air traffic is sufficiently infrequent that bird patrols are more than 30 minutes apart, an entry should be made for each patrol carried out).

9.2.5 Bird/wildlife incidents should be defined in 3 categories:

a) *Confirmed strikes*: Any reported collision between a bird or other wildlife and an aircraft for which evidence in the form of a carcass, remains or damage to the aircraft is found.

b) *Unconfirmed strikes*:

1) Any reported collision between a bird or other wildlife and an aircraft for which no physical evidence is found.

2) Any bird/wildlife found dead on an airfield where there is no other obvious cause of death (e.g. struck by a car, flew into a window, etc.).

c) *Serious incidents:* Incidents where the presence of birds/wildlife on or around the airfield has any effect on a flight whether or not evidence of a strike can be found.

9.2.6 Airports should establish a mechanism to ensure that they are informed of all bird/wildlife strikes reported on or near their airport.

a) The total number of bird/wildlife strikes should never be used as a measure of risk or of the performance of the bird/wildlife control measures at an airport.

b) Airports should ensure that the identification of the species involved in bird/wildlife strikes is as complete as possible.

c) Airports should record all bird/wildlife strikes including as far as practicable the data required for the standard ICAO reporting form.

d) National regulators should collate bird strike data and submit them to ICAO annually.

e) Airports should conduct a formal risk assessment of their bird strike situation and use the results to help target their bird management measures and to monitor their effectiveness. Risk assessments should be updated at regular intervals, preferably annually.

f) Airports should conduct an inventory of bird/wildlife attracting sites within a 13 km circle centred on the ARP, paying particular attention to sites close to the airfield and the approach and departure corridors. A basic risk assessment should be carried out to determine if the movement patterns of birds/wildlife attracted to these sites mean that they cause, or may cause, a risk to air traffic. If this is the case, options for bird/wildlife management at the site(s) concerned should be developed and a more detailed risk assessment performed to determine if it is possible and/or cost-effective to implement management processes at the site(s) concerned. This process should be repeated annually to identify new sites or changes in the risk levels produced by existing sites.

g) Where national laws permit, airports, or airport authorities, should seek to have an input into planning decisions and land-use practices within a 13 km circle centred on the ARP for any development that may attract significant numbers of hazardous birds/wildlife. Such developments should be subjected to a similar risk assessment process as described above and changes sought, or the proposal opposed, if a significant increase in the bird/wildlife strike risk is likely to result.

Chapter 10

INCOMPATIBLE LAND USE AROUND AIRPORTS

10.1 ICAO's *Airport Planning Manual* (Doc 9184), Part 2 — *Land Use and Environmental Control* contains valuable guidance on land-use planning in the vicinity of aerodromes. Included in this guidance is a table in Appendix 2 providing land-use guidelines for the avoidance of bird hazards in the vicinity of aerodromes. Familiarity with the guidance in Doc 9184, Part 2, is highly recommended. It is recognized that some States have adopted strict legislation regarding land use around airports, where the legal system has allowed, and it should be accepted: that better legislation leads to better prevention.

10.2 It has long been recognized that land use around the airport can influence bird and other wildlife strikes to aircraft. Birds/wildlife can be attracted to areas near the airport and in turn go to the airport for food, water, resting or shelter. Some birds may also be struck outside airport property, over a land use that attracts them.

10.3 The concept of compatible land-use planning is an outgrowth of the focus of attention on the environmental relationship between airports and their community neighbours. This planning concept is relatively simple and the results can be impressive, but the implementation requires careful study and coordinated planning. Land use around airports can influence restrictions on aircraft flights as well as affect aircraft safety. To successfully deal with land-use issues, a comprehensive wildlife management plan including coordination among the aviation regulatory authority, airport operator, aircraft operators and the surrounding communities should be implemented.

10.4 Some communities and airports have reached the point where the effect of land-use planning guidelines may be minimal. However, there are still instances where their use will result in more compatible airport and community development. Implementation may take the form of aviation system plans, legislation for compatible land uses, easements or land zoning.

10.5 In applying the guidelines on incompatible land use, one must consider the location of the proposed land use in relation to the airport. The location of attractive land use beyond the recommended distance could still create flyways over the airport or through flight paths at the airport. In some cases more than one possible use of an area may have to be considered to ensure that bird hazards will not be increased at or near the airport.

10.6 Regulations should be placed on the use of land surrounding airports to reduce its attractiveness to birds. These regulations should be directed at all land uses mentioned in Appendix 2 of Doc 9184, Part 2. Prior planning is necessary to ensure that incompatible land use is not allowed to become established.

Chapter 11

EVALUATING THE WILDLIFE CONTROL PROGRAMME

11.1 Wildlife hazard prevention should be an integral part of the aerodrome safety management system.

11.2 The following questions are directed at airport management, specifically those responsible for the implementation and maintenance of the airport wildlife control programme. The questions are designed to assist in determining if there is an effective bird/wildlife control programme in place at an airport. If the answers to these questions are negative or unclear, a wildlife control programme should be established in order to improve aircraft safety.

Local risk assessment

1. Has a bird/wildlife strike reporting procedure been implemented at the airport?
2. What is the bird/wildlife strike rate at the airport over the last five years (with or without damage to the aircraft)?
3. Is there a procedure to collect regularly information about birds/wildlife, both dead (carcasses) and living?
4. Has a means for positively identifying carcass remains been established?
5. How many reports from pilots are related to intrusions of wildlife, other than birds, over the last five years?
6. Has a list of bird/wildlife attractants at and surrounding the airport been completed?

Wildlife control programme

1. Is there a wildlife control officer responsible for the management of wildlife on the airport?
2. Has a land-use plan been established with regard to effective land use on and off the airport as it pertains to the wildlife control programme?
3. What ecological measures are implemented to reduce wildlife attractiveness at the airport and in the vicinity?
4. Is there a habitat management programme on the airport?
5. Are garbage dumps forbidden around the airport? If yes, within what distance are they forbidden?
6. Is the airport fence suitable to prevent hazardous animal incursions?
7. Which scaring methods are implemented at the airport?
8. Have staff been employed and trained specifically to scare off birds/wildlife at the airport?

Chapter 12

EMERGING TECHNOLOGY AND COMMUNICATIONS PROCEDURES

12.1 GENERAL

12.1.1 There is a variety of existing and new technologies available, such as Avian Radar, to predict and detect birds potentially hazardous to aircraft operations and provide information to reduce the risk of these hazards. Such technologies and procedures are particularly important in dealing with the significant hazards posed by birds beyond the boundaries of airports.

12.1.2 All States and airports should use proven available technologies and explore new technologies to advance predictive and real-time detection, avoidance and dispersal of hazardous birds/wildlife on and around airports. All States are encouraged to share technologies, new developments or open markets for systems to ensure compatibility of systems and procedures between stakeholders.

12.2 PREDICTIVE AND REAL-TIME BIRD AVOIDANCE SYSTEMS

12.2.1 A number of States have developed predictive and real-time bird avoidance systems for use by civil and military aircraft. Examples include the European BIRDTAM system, Bird Avoidance Models (BAM) used by several States, and Avian Hazard Advisory Systems (AHAS) developed for the United States military. Use of historical ornithological data and near-real-time data from weather and/or national defence radars form the basis of these systems. Data from numerous sources and new applications of existing technological systems are underutilized in most States and can be further developed for reduction of bird strike hazards. All States should explore and develop the use of these systems where possible for flight scheduling, planning, and operational procedures to reduce risks of bird strikes for off-airport and surrounding areas.

12.2.2 Dedicated remote-sensing systems, primarily using bird detection radars, are in use and under development at a number of civil and military airports in several States. These systems provide real-time detection capability and can provide three-dimensional information on birds on and surrounding airports. Other systems, such as infrared and satellite imagery, can potentially provide similar detection capabilities.

12.3 COMMUNICATIONS PROCEDURES

12.3.1 Data from predictive models and remote-sensing systems should be shared with all entities responsible for reducing bird/wildlife strike hazards, including airport operations staff, air traffic control, airlines, pilots and regulators. Communications procedures and regulatory oversight are necessary to ensure timely information exchange and proper responses to hazard advisories. Data from models and remote-sensing systems can be supplied at varying levels of detail to different agencies. For example, airport operations/wildlife control staff will need detailed and specific information on the level of hazard and the specific time and location of the detected or predicted hazard to appropriately

respond with control or dispersal equipment. Air traffic control staff will need to be advised only when threshold levels are exceeded. Pilots will be provided information to allow alteration of operations or flight paths or to increase situational awareness of potential hazards.

12.3.2 Data links are available through wireless computer systems or even cellphone technology to alert individuals and agencies that can respond to hazard advisories. Links to airport operations, including their vehicles, are currently available in numerous States and airports. Links to ATC should be established with appropriate audio or visual triggers when threshold levels are met. Uplinks to aircraft are possible with existing communications networks, in either voice or digital formats, should action from pilots be necessary.

12.3.3 Airport operations/wildlife control efforts will be enhanced and timeliness improved with additional resources dedicated to detecting and directing efforts to areas of concentrated hazards.

12.3.4 Clear and precise procedures should be developed for air traffic control, and controllers should be trained such that they are able to give specific and timely information to pilots and wildlife control crews to avoid identified hazards. Operational standards for procedures and training protocols should be uniformly developed and implemented among States. It is important that ATC be involved in local discussions and invited to comment and review wildlife hazard management plans and participate in local bird strike committees.

12.3.5 Pilots have the authority to alter flight operations when hazard advisories are issued by ATC or other agencies based on observed, remotely-sensed or other data. Training in procedures for such altered flight operations based on these data should be provided by airlines and developed and monitored by State regulatory agencies.

Appendix

REFERENCES

PUBLICATIONS

Airports Council International (ACI), *Aerodrome Bird Hazard Prevention and Wildlife Management Handbook,* ACI World Operational Safety Subcommittee in collaboration with Bureau de travaux et d'etudes en environnement, 2005.

Borstel, K. and S. Haemker, "A Long-Term Study on the Correlation Between the Population of Small Mammals and the Number of Predatory Birds at Bremen Airport, Taking into Account the Changes in Grassland Management," *Bird and Aviation*, Vol. 23, Issue No. 1, 2003, <http://davvl.de/Voluenglisch/2003/Borstel%20&%20Haemker.pdf>.

Briot, J.L., A. Eudot, and M. Laty, *Les oiseaux des aerodromes français: prevention du peril aviaire*. Direction générale de l'aviation civile, Paris, France.

Brockmann, J. and B. Rohloff, "Zusammenhaenge zwischen der Gruenlandbewirtschaftung, der Bestandsentwicklung von Feldmaeusen (Microtus arvalis) und dem Auftreten von Greifvoegeln auf dem Flughafen Hannover-Langenhagen" ["Relation between Grassland Cultivation, Development of Vole Population (*Microtus arvalis*) and the Occurrence of Birds of Prey at the Hannover-Langenhagen International Airport"], *Bird and Aviation*, Vol. 19, Issue No. 1, 1999, pp. 53–61.

Brough, T. and C.J. Bridgman, "An Evaluation of Long Grass as a Bird Deterrent on British Airfields," *Journal of Applied Ecology*, Volume 17, No. 2, 1980, pp. 243–253.

Cleary, E.C., R.A. Dolbeer, and S.E. Wright, *Wildlife strikes to civil aircraft in the United States, 1990–2004*, U.S. Department of Transportation, Federal Aviation Administration, Serial Report No. 11, DOT/FAA/AS/00-6 (AAS-310), Washington, D.C., USA, 2005.

Cleary, E.C. and R.A. Dolbeer, *Wildlife Hazard Management at Airports: A Manual for Airport Operators,* Second Edition, Federal Aviation Administration, Office of Airport Safety and Standards, Washington, D.C., 2005, <http://wildlife-mitigation.tc.faa.gov/wildlife/>.

De Hoon, A., "Crowed Airspace," *ISAF Mirror*, Issue 47, 2008, pp. 12, <http://www.nato.int/isaf/docu/mirror/2008/mirror_47_200801.pdf>.

De Hoon, A. et al., *Cyprus' Flamingoes Commuting Across the Runway: Adapting the Aircraft's or Birds' Flight Schedule?* IBSC 27/WP V-3, Athens, 2005, <http://www.int-birdstrike.org/referenceInformation.cfm?ref=Athens>.

Dekker, A. and F.F. van der Zee, "Birds and Grassland on Airports," International Bird Strike Committee, Proceedings and Papers, London, May 1996, pp. 291-305.

Dolbeer, R.A., S.E. Wright, and E.C. Cleary, "Ranking the hazard level of wildlife species to aviation," *Wildlife Society Bulletin,* Volume 28, Issue 2, 2000, pp. 372–378, <http://www.mendeley.com/research/ranking-the-hazard-level-of-wildlife-species-to-aviation-1/>.

European Union, EASA Skybrary, Operators Checklist for Bird Strike Hazard Management, <http://www.skybrary.aero/index.php/Operators_Checklist_for_Bird_Strike_Hazard_Management>.

Hahn, E., "Zur Oekologie von Flughaefen — Angewandte Oekologie als Grundlage der Vogelschlagverhuetung auf Flughaefen" ["Airport Ecology — Applied Ecology as a Basis for Bird Strike Prevention on Airports"], *Bird and Aviation,* Volume 15, Issue 1, 1995.

Hygnstrom, S.E, R.M. Timm, and G.E. Larson (eds.), *Prevention and Control of Wildlife Damage,* University of Nebraska Cooperative Extension Division, Lincoln, Nebraska, United States, 1994.

International Civil Aviation Organization, *Airport Planning Manual* (Doc 9184), Part 2 — *Land Use and Environmental Control,* ICAO, Montréal, Quebec, Canada, Third Edition, 2002.

International Civil Aviation Organization, Annex 14 — *Aerodromes*, Volume I — *Aerodrome Design and Operations,* ICAO, Montréal, Quebec, Canada, Fifth Edition, 2009.

International Civil Aviation Organization, Annex 16 — *Environmental Protection*, Volume I — *Aircraft Noise,* ICAO, Montréal, Quebec, Canada, Fifth Edition, 2008.

International Civil Aviation Organization, *Manual on the ICAO Bird Strike Information System (IBIS)* (Doc 9332), ICAO, Montréal, Quebec, Canada, Third Edition, 1989.

International Civil Aviation Organization, *Safety Management Manual (SMM)* (Doc 9859), ICAO, Montréal, Quebec, Canada, Second Edition, 2009.

MacKinnon, B., R. Sowden, and S. Dudley (eds.), *Sharing the Skies: An Aviation Guide to the Management of Wildlife Hazards* (TP 13549), Chapter 10, Transport Canada, Aviation Publishing Division, Tower C, 330 Sparks Street, Ottawa, Ontario, Canada, 2001.

Morgenroth, C., "Bird Deterrence at Airports by Means of Long Grass Management — A Strategic Mistake?" *Bird and Aviation*, Vol. 2, 2004, <http://davvl.de/Voluenglisch/2004/04-2%20Morgenroth,%20Sum..htm>.

Thorpe, J., "Fatalities and Destroyed Aircraft Due to Bird Strikes, 1912–2002," *in Proceedings of the 26th International Bird Strike Committee meeting,* Warsaw, Poland, 2003.

Transport Canada, *Wildlife Control Procedures Manual* (TP 11500), Ottawa, Canada, 2001.

United Kingdom Civil Aviation Authority, Aeronautical Information Circular, AIC 28/2004, "Operational Considerations in the Event of Multiple Bird Strikes to Multi-Engine Aeroplanes," <www.ais.org.uk>.

WILDLIFE/BIRD STRIKE WEBSITES

International Bird Strike Committee (INBSC)
www.int-birdstrike.org

INBSC Best Practice Guides
http://www.int-birdstrike.org/Best_Practice.htm

IBSC Risk Assessment Methodology and Technique
http://www.int-birdstrike.org/Amsterdam_Papers/IBSC25%20WPOS3.pdf

Canada

Bird Strike Association of Canada
http://www.birdstrikecanada.com/

Transport Canada Airport Bird Hazard Risk-Assessment Process
http://www.tc.gc.ca/eng/civilaviation/publications/tp8240-awmb38-appendix-b-5033.htm

Embry-Riddle Aeronautical University

Center for Wildlife and Aviation
http://worldwide.erau.edu/professional/seminars-workshops/wildlife-hazard-management/external-link-airport-wildlife-biologists.html

Germany

German Bird Strike Committee (GBSC)
http://www.gbsc.de

Online scientific journal, *Bird and Aviation*, Editor: German Birdstrike Committee
http://www.davvl.de/en/scientific-journal/complete-index

Italy

Bird Strike Consulting and Training
www.birdstrike.it

United Kingdom

UK Birdstrike Committee (UKBSC)
http://www.caa.co.uk/UKBSC

UK birdstrike information
http://www.caa.co.uk/Birdstrikes

UK Civil Aviation Authority — Birdstrike Risk Management for Aerodromes
http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=2726

UK Food and Environment Research Agency (FERA) — Bird Management Unit
http://fera.defra.gov.uk/wildlife/birdManagement/

United States

Bird Strike Committee USA
http://birdstrike.org

Federal Aviation Administration, Advisory Circular, *Qualifications for Wildlife Biologist Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards on Airports*
http://www.faa.gov/documentLibrary/media/Advisory_Circular/draft_150_5200_36a.pdf

Federal Aviation Administration Wildlife Strike Database
http://wildlife-mitigation.tc.faa.gov/

U.S. Air Force Safety Center — Bird/Wildlife Aircraft Strike Hazard (BASH)
http://www.afsc.af.mil/organizations/bash/index.asp

— END —

ISBN 978-92-9231-929-8