สำนักงานการบินพลเรือนแห่งประเทศไทย
The Civil Aviation Authority of Thailand

Guidance Material on Wildlife Hazard Management at Aerodrome

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Approved By

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0. Introduction

0.1 Background

Wildlife strikes can cause serious damage to aircraft and the occasional loss of human life. Because most strikes occur on or within the aerodrome vicinity, aerodromes are the logical locations to place emphasis in addressing the problem. The following chapters and appendices, provide the information needed to develop, implement, and evaluate wildlife hazard management programmes to minimize the likelihood of wildlife strikes on aerodromes.

0.2 Purpose

The Guidance Material contains specifications that prescribe a Wildlife Hazard Management Programme (WHMP), that shall be provided at Public Aerodrome, also the roles and responsibilities of all the stakeholders involved in wildlife hazard control, and the modifications to be carried out at an aerodrome to remove the features which attract wildlife. It provides guidance on what is acceptable to CAAT to demonstrate compliance with Aerodrome Regulations.

0.3 Applicability

This Guidance Material applies to all persons or entities operating and/or maintaining aerodromes and/or heliports in Thailand, applicants applying for a Public Aerodrome Operating Certificate, or The holder of a Public Aerodrome Operating Certificate.

0.4 Effective Date

19-Apr-2021

0.5 Reference

0.5.1 Requirement of The Civil Aviation Authority of Thailand No. 14 on Aerodrome Standards B.E. 2562

0.5.2 Rule of The Civil Aviation Authority of Thailand on Standards for Public Aerodrome Manuals B.E. 2562

0.5.3 Rule of Department of Civil Aviation on Standards of Aerodrome Operating Procedures B.E. 2557

0.5.4 Notification of The Civil Aviation Authority of Thailand on Standards for Private Aerodrome Manuals B.E. 2561

0.5.5 Notification of Department of Civil Aviation on Competency in Private Aerodrome Managing and Evidences which show Competency in Private Aerodrome Managing B.E. 2557

1. Definitions and Acronyms

1.1 Definitions

Wildlife. Any animals that may pose hazards to aircraft when struck and includes all birds, bats and terrestrial animals as a practical definition. Birds or animals including native species **Wildlife hazard.** is the presence of wildlife (i.e. birds and other animals, both wild and domestic) that could result in damage to aircraft**.**

Wildlife hazard management programme. A method for aerodrome operators to adopt reasonable wildlife risk control measures, in order to prevent wildlife from colliding with aircraft.

Wildlife strike. This means a collision or near collision with, risk of collision, or evasive action taken by an aircraft to avoid wildlife/birds on a runway or on a helipad/helideck in use, including:

- Encounters with wildlife/birds on a runway in use or on any other movement area of the aerodrome.
- Instances where evasive action is taken by the flight crew that leads to a collision off the movement area of the aerodrome or to consequences other than a collision (e.g., gear collapsing)

Near-misses. The potential of a wildlife strike.

Wildlife-related incidents. Wildlife strike and Near-misses situation including the following events:

a) any reported collision between wildlife and an aircraft for which evidence in the form of a carcass, feathers, any other remains, or damage to the aircraft is found;
b) any reported collision between wildlife and an aircraft for which no physical evidence is found, but an indication of a collision exists (e.g., visual observation of the collision or acoustic perception of the impact);
c) any wildlife found dead on an aerodrome without any other obvious cause of death; and
d) incidents or observations where the presence of wildlife on or in the vicinity of the aerodrome could have an effect on a flight (e.g. missed approach, aborted take-off, etc.).

1.2 Acronyms

CAAT	The Civil Aviation Authority of Thailand
WCP	Wildlife Control Personnel
WHMP	Wildlife Hazard Management Programme

2. What is a Wildlife Hazard ?

The presence of wildlife (birds and other animals) on and within the aerodrome vicinity may pose a serious hazard to aircraft operational safety. Therefore, to reduce the risk to aviation safety, active assessments, reporting and management of wildlife are necessary.

The risk of a wildlife hazard depends on the size, behaviour and number of wildlife and their proximity to aircraft during different phases of flight. Wildlife hazards on the aerodrome or passing through critical airspace are likely to increase the probability of negative effects.

Wildlife risks fluctuate with the daily and seasonal cycles of wildlife activity. The species and number of wildlife at and around aerodromes may vary over the years due to land use and environmental changes (e.g. agricultural practices, urbanization, conservation and climate change). Aerodromes have site-specific characteristics regarding their habitat, climate and surroundings that should be reflected in their respective Wildlife Hazard Management Programmes (WHMP). Increased air traffic and the development of quieter aircraft engines may increase the likelihood of a wildlife strike. Wildlife hazard management methods and techniques should therefore be reviewed annually and updated regularly to ensure that effective control methods are implemented.

2.1 Fundamentals of Wildlife Hazard Management

2.1.1 The objective of wildlife hazard management at aerodromes is to reduce the risk of a wildlife strike by implementing appropriate mitigation measures.

2.1.2 To manage wildlife hazards, one must firstly assess the level of risk for each species present. Recording wildlife presence (at a species level) on, and in the vicinity of, the aerodrome, wildlife strikes and near misses is therefore necessary.

2.1.3 Wildlife-related incidents should be recorded and used for assessing and mitigating the risk of wildlife hazards

2.1.4 Measures to manage wildlife hazards at aerodromes may include, but are not limited to: manipulating habitats (see Chapter 4 Habitat Management), harassment and repellent techniques and removal of wildlife (see Chapter 5 Management of Hazardous Wildlife.) Emerging technology such as bird detection RADAR or remotely piloted aircraft systems (RPAS), may also enhance the detection, monitoring and control of hazardous wildlife

2.1.5 In addition to managing the land use on aerodrome property, off-site land use in its vicinity must also be assessed and mitigated, as it can affect wildlife presence or activity. Land use suggestions can be offered to owners around aerodrome property to aid in wildlife management (see Chapter 4, 4.4 Off-Aerodrome Management).

2.1.6 The strategy for assessing wildlife at aerodromes and the control measures for reducing wildlife risk should be outlined in the aerodrome's WHMP.

3. Wildlife Hazard Management Programme (WHMP)

3.1 Introduction

3.1.1 The chapter details provisions on the establishment of a wildlife hazard management programme (WHMP) at aerodromes and WHMP components, including: expelling and deterring wildlife, reporting and recording wildlife incidents, habitat and land use management, and personnel training

3.1.2 An aerodrome operator shall develop, implement and demonstrate an effective WHMP at the aerodrome, and this should be tailored to and commensurate the wildlife hazard risk assessment, according to the size and complexity of the aerodrome, and the number of aircraft movements and their type, taking into account the wildlife hazards identified and the risk assessment of those hazards.

3.1.3 A wildlife hazard management programme (WHMP) is a method for aerodrome operators to adopt reasonable wildlife risk control measures, address features that may attract wildlife, control the presence of wildlife on, and in the vicinity of, the aerodrome.

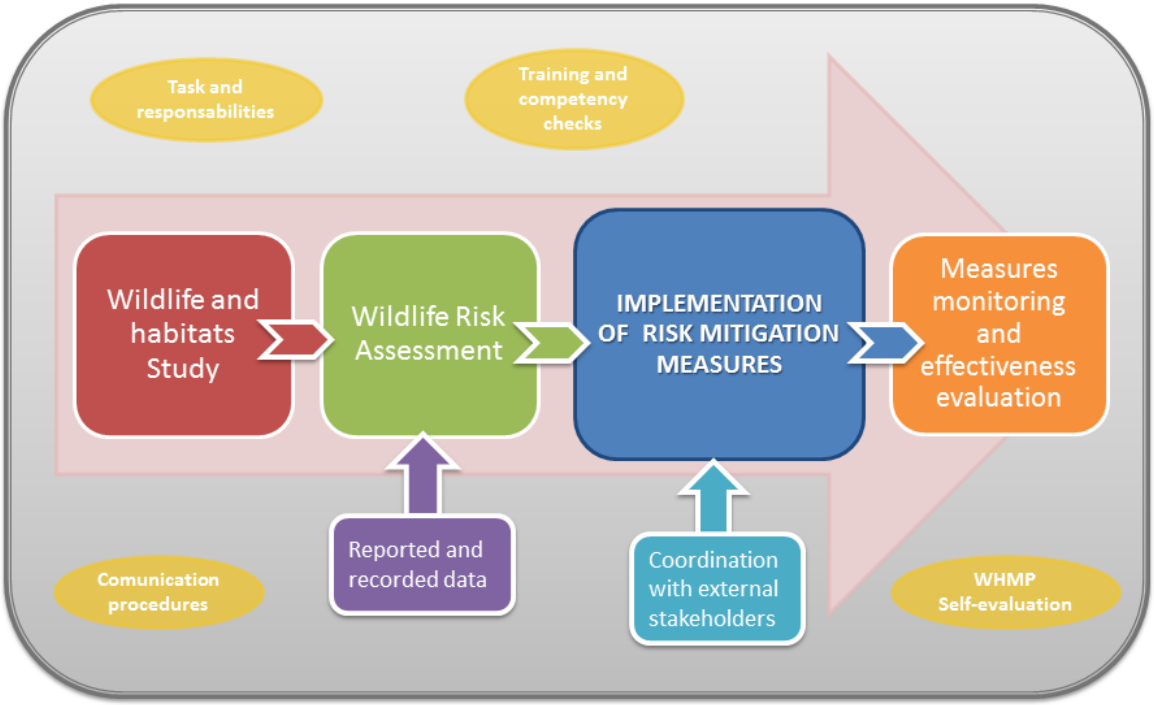

Figure 3-1 Wildlife hazard management programme process

3.1.4 An aerodrome should establish procedures for data collection, risk analysis and the implementation of wildlife control measures. Aerodrome personnel should be competently trained in wildlife hazard management with well-defined roles and responsibilities.

3.1.5 The WHMP should not only consider the establishment of internal actions specific to the aerodrome operator. For it to be effective, involving different stakeholders and external entities throughout its development will be needed, since they may be linked to the presence of wildlife, attracting habitats, land use, etc.

3.1.6 Wildlife hazards on, and in the vicinity of, the aerodrome are constantly changing due to modifications in land use, management policies, and environmental factors. In addition, wildlife can adapt or habituate to control strategies that were once effective, or they might develop new behavioural or feeding patterns on, or near, the aerodrome. These factors can affect the efficacy of the WHMP´s success.

3.1.7 The WHMP should be reviewed if changes to wildlife hazards are observed (e.g. planned land use changes, significant strike event, new wildlife species observed, operational changes, etc.) and at a minimum, this review should occur annually. The WHMP should be revised as necessary.

3.1.8 This management programme deals with the particulars of the procedures to deal with hazards to aircraft operations caused by the presence of wildlife on or near the aerodrome. It should also be designed to be incorporated as part of the aerodrome's overall Safety Management System (SMS).

3.1.9 A WHMP should include, as a minimum, but not limited to:

a) a description of the organization of the WHMP;
b) the roles and tasks of aerodrome personnel involved with the WHMP;
c) a description of the aerodrome operations;
d) procedures including means and aerodrome personnel for collecting, reporting and recording data on observed wildlife and wildlife strike events;
e) a wildlife safety risk assessment method and procedure (including annual reviews);
f) procedures, means and personnel for habitat and land management;
g) procedures, means and personnel for the expelling, deterring and removing of wildlife, including lethal means where appropriate;
h) procedures for coordinating with internal and external stakeholders;
i) procedures, means and provisions for the training of aerodrome personnel; and

j) procedures and performance indicators to monitor the mitigation measures applied and assess their effectiveness, as well as the effectiveness of the WHMP itself (in terms of increase or decrease on the wildlife strike risk level).

3.2 Roles and Tasks in The WHMP

3.2.1 The WHMP should detail the roles and tasks of all personnel who:

a) develop and implement the WHMP;

b) oversee the daily activities (detailed in the sections below);

c) record wildlife (presence and movements);

d) record and analyse the collected data (observations, wildlife strikes, etc.);

e) carry out periodic surveys, wildlife studies, by personnel with the knowledge and experience of studying wildlife, and safety risk assessments to develop and implement the WHMP;

f) manage the habitat to reduce the attractiveness of identified areas, if relevant;

g) expel, deter and remove hazardous wildlife;

h) report wildlife strikes to CAAT

i) coordinate with stakeholders and external entities;

j) evaluate and update the WHMP as needed; and

k) for any other reason, is involved in wildlife hazard management.

3.3 Collecting, Reporting and Recording Data on Wildlife Strikes and Observed Wildlife

3.3.1 General

A An effective WHMP depends on accurate and reliable data as possible. Reviewing and analysing wildlife strikes and wildlife observations will help identify hazards at the aerodrome and its vicinity and indicate the effectiveness of current wildlife strike prevention methods.

B The aerodrome operator shall establish or refer to the protocols or communication procedure in detection, recording, collecting and reporting of wildlife observations and strikes that have occurred at the aerodrome and its vicinity, in close cooperation with all relevant organizations operating at the aerodrome.

3.3.2 Recording Data

A The aerodrome operator should have policies and procedures in place on how to obtain data related to hazardous wildlife species and their use of the aerodrome and its vicinity, to further assess such related hazards to aviation. For best results, data collection should begin at the planning and design phase of an aerodrome and continue throughout its lifecycle.

B This data will mainly contain records of:

a) wildlife observed at the aerodrome and its vicinity;

b) wildlife control activities;

c) incidents with wildlife;

d) wildlife strikes and near-misses;

e) areas of high wildlife activity on the aerodrome and in its surroundings; and

f) wildlife observations or surveys from the aerodrome's vicinity taken periodically, at least seasonally and noting migratory activities.

3.3.3 Wildlife Observations and Control Activities Records

A A record of all observed wildlife activity on an aerodrome and in its vicinity should be maintained or to be recorded in a wildlife log. Aerodrome personnel involved in wildlife control should record these observations, important factors to record include:

a) date and time of the observation;

b) approximate numbers, species and location of the wildlife observations;

c) the type of wildlife activity and movements (for example: direction and altitude);

d) control actions taken to decrease the number of present wildlife and the results thereof; and

e) weather and lighting conditions.

f) the name of the person logging the data;

B The log should be completed by competent wildlife control personnel, at intervals commensurate with the number of aircraft movements and runways in use, and taking into account wildlife behaviour and other relevant local circumstances. Data should be analysed to identify which species represent a hazard at specific times of day and/or year, and during different types of meteorological conditions.

C Record this information on a standard form prepared by the aerodrome (see Table 3-1 Example of a daily log of wildlife control activities. for an example of a daily log form) that could be used by wildlife control personnel at the site where the activity takes place. The use of a standardized form or recording format, such as that presented in Table 3-1, is strongly recommended. The information recorded will be most useful if it is summarized into monthly and annual statistics. It is recommended that the records are accompanied by maps of the aerodrome, indicating the location of observations or control activities.

D Aerodrome operators should ensure that the identification of the species involved in any reported wildlife strikes is as accurate as possible, since these reports represent data that will help in the assessment of the level of safety risk that each species of wildlife presents to aircraft operations at the aerodrome. The compilation of precise wildlife observations and strike statistics should facilitate the analysis of data so as to improve wildlife hazard management.

E It should also be indicated what means and procedures the aerodrome operator uses to collect and identify species by feathers, animal remains, DNA analysis, etc.; as well as the personnel involved in the previous activities.

Aerodrome							Month	Year	
Date	Time	Weather and lighting conditions	Location (Grid)	Wildlife			Control method	Results/comments	Name (Initials)
				Species	Activity and movements	No.			

Table 3-1 Example of a daily log of wildlife control activities.

3.3.4 Periodic Wildlife Surveys

A Appropriate data on the presence and behaviour of wildlife on, and in the vicinity of, the aerodrome may also be obtained by means of periodic surveys. Wildlife surveys should cover the entire year to account for seasonal changes and should also consider different phases of the day. The survey should also consider aircraft movements, runways in use and wildlife behaviour. The greater the presence of hazardous wildlife, the greater the need to conduct surveys to gather information.

B The sampling method should be consistent, systematic and replicable, for the data to be comparable over time. This sampling method should also be aligned with the data collected in observation records.

C The possibility of using different data sources and methodologies to carry out the surveys will depend on the material and human resources of the aerodrome.

D The periodic surveys should be carried out by personnel with the knowledge and experience of studying wildlife.

E There are many methods to conduct wildlife surveys. For example, wildlife observation points can be used to record the species seen and their behaviour during a clearly defined period of time. There are also sampling methods using paths of a specific length in which the wildlife observed along a route is recorded (referred to as transects), carried out on foot or by vehicle.

3.3.5 Wildlife Incidents Records and Reporting

A All stakeholders must report wildlife-related incidents to the aerodrome operator.

B The aerodrome operator should have well-defined reporting procedures in place for wildlife-related incidents with different stakeholders and should ensure the appropriate and meaningful review of data, while considering all circumstances. All stakeholders should be made aware of the procedures described in the aerodrome manual or any associated aerodrome documentation.

C A wildlife incident reporting form should be included in the procedure and made available to all stakeholders. The forms used by the aerodrome operator or other stakeholders at the aerodrome, should contain at minimum the information in the CAAT Aviation Safety Report Bird/Wildlife. More detailed information results in a more accurate risk assessment of wildlife data.

D The aerodrome operator should report wildlife incidents to the CAAT in accordance with CAAT Requirement No.22/2562 on " Reporting of Civil Aviation Occurrences".

E The aerodrome operator's reporting system shall contain a requirement for all relevant third parties and all aerodrome personnel to report wildlife strikes, wildlife remains, including findings thereof during aerodrome inspections, and any other relevant identified hazards, to the aerodrome operator.

F The aerodrome operator should ensure that there is a process for rapid communication among those involved in wildlife control as well as with ATC and aircraft operators. This is necessary when a specific wildlife hazard is present to allow the issuance of appropriate warnings to aircraft operating on, and within the vicinity of, the aerodrome, by the air navigation services provider (ANSP).

G Wildlife species identification should be as accurate as possible. It is therefore essential for wildlife personnel to be adequately trained.

H The aerodrome operator should have a procedure in place for the collection, management, conservation and identification of animal remains to identify a species after a strike as well as any remaining organic material using DNA analysis.

3.4 Wildlife Safety Risk Assessment

3.4.1 General

A Aerodrome operators shall conduct a specific safety risk assessment of the wildlife situation and use the results to help target wildlife management measures and monitor their effectiveness. Safety risk assessments should be updated and repeated at regular intervals, commensurate with assessed risks.

B The data collected and recorded throughout the year should be used to carry out a wildlife risk assessment

C If the aerodrome operator has a safety management system, or a risk management plan, the assessment must be conducted in accordance with the system or the plan.

D The aerodrome operator's wildlife safety risk assessment should, as a minimum:

a) define the area for the safety risk assessment, which would, in most cases, be the entire aerodrome but may also include the vicinity of the aerodrome;

b) rate the strike probability using strike data from reports for each species, information on the presence of species, and the number of individuals and their biology, and update the data and probabilities regularly;

c) rate the severity of damage arising from those strikes for each species;

d) determine the risk for each species; and

e) identify the causes (attractants, migration routes) of each wildlife hazard.

E The results and conclusions of the wildlife risk assessment should be documented in the WHMP and provide information about the hazardous wildlife species and their presence. This will help identify which are the most sensitive areas of the aerodrome and its vicinity, since areas with high presence of wildlife may coincide with aircraft flight paths.

F The total number of wildlife strikes is not necessarily a comprehensive measure of safety risk, or indication of the performance of the wildlife control measures, at an aerodrome.

G The aerodrome operator should prioritize its wildlife management measures on those species with the highest frequency (probability) and which may create the greatest damage (severity). Mitigation measures should be applied to species with the highest risk.

3.4.2 Introduction to Safety Risk Management

A Safety risk assessments can take many forms including enabling the aerodrome operator to understand the very real risk of catastrophic outcomes from wildlife strikes. More frequently, however, such processes are used to allow potentially scarce wildlife control resources to be targeted at the most important areas.

B The first step in a safety risk assessment of wildlife hazards is to define the area that will be assessed. This should include the entire aerodrome and its vicinity, in particular aircraft approach and take-off.

C Knowledge of the wildlife living in the aerodrome and its vicinity, their movements and to which areas they are attracted, is essential. This can be achieved with an adequate wildlife monitoring programme and by keeping historical records.

D An important element of the safety risk assessment is understanding the definitions used for aerodrome wildlife management:

a) a hazard is a condition or object with the potential to cause or contribute to an aircraft incident or accident. In this context, a hazard is the presence of certain wildlife on or near an aerodrome; and

b) a safety risk is the predicted probability and severity of the consequences or outcomes of a hazard. In this context, safety risk is the probability of a wildlife strike by a particular species multiplied by the severity of damage to the aircraft that might reasonably occur.

safety risk = (probability of a strike) × (severity of damage caused)

E Any assessment of risk needs to estimate the probability that a strike will occur and the likely level of harm that may result. Estimation of harm is relatively straightforward because the analysis of various wildlife strike databases around the world show that there is a consistent relationship between wildlife mass and the percentage of damage to aircraft. Strikes involving flocks of a given species of bird are more likely to result in damage to the aircraft than strikes with single birds of the same species. The larger the bird and the greater its tendency to be struck in groups, the greater the risk.

F It is more difficult to estimate the likely strike frequency of a particular population of birds 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, skill level, experience and input data needed to apply them.

G The most common form of safety risk assessment involves the categorization of both strike probability and severity into a number of levels, usually very low, low, moderate, high and very high. These levels would apply in a double entry matrix in which wildlife species would be classified according to a determined level of risk.

H The results of a risk assessment matrix should be used to prioritize wildlife management techniques and methods. These actions should be documented in the WHMP.

I It is recommended that the risk assessment is conducted within a team environment involving all relevant stakeholders. The team should consist of personnel who are knowledgeable in:

a) the wildlife hazard;

b) any management/mitigation actions that are already in place; and

c) the risk assessment process itself.

3.4.3 Estimating The Probability of A Strike

A The probability of a wildlife strike should be calculated using wildlife incident data and current data on the presence, location and behaviour of wildlife in the aerodrome and its vicinity. Strike records also allow the determination of daily and seasonal trends to determine the likelihood of future strike events.

B To identify the risk(s), the likelihood of the hazard event should be considered based on the best and most complete data available. This assessment should consider, but not be limited to, the following sources of information:

a) Previous strike events;

b) Previous strike events resulting in damage to an aircraft;

c) Previous wildlife incidents or near misses;

d) Results from wildlife monitoring activities, population studies, observations, etc;

e) The proximity of known wildlife activity to aircraft manoeuvring areas and flight paths;

f) Wildlife migratory information;

g) Wildlife behavioural characteristics (hunting and feeding practices, roosting and nesting, reproduction, socialisation etc.);

h) Wildlife agility, speed, manoeuvrability and their ability to avoid aircraft;

i) Wildlife grouping or flocking tendencies

j) Wildlife response to management actions;

k) Aircraft type, schedules, operating times and flight paths.

C Using wildlife strikes to calculate probability depends on the number of strikes and the reporting culture. Aerodromes with fewer operations may generate fewer collisions; therefore, the limited data may not allow accurate or useful predictability on strike probability.

D Where good quality strike data is not available, it is important to consider the potential risk of collision determined by the existence of wildlife and their movements on and in the vicinity of the aerodrome.

E Based on the above, the probability of a wildlife strike is defined for diverse variables which are not exclusive. The more knowledge about the presence and behaviour of wildlife on, and in the vicinity of, the aerodrome, the stronger the estimation of wildlife strike probability and the final safety risk assessment for each relevant species.

F The aerodrome should have records of wildlife incidents, as well as information about observed wildlife, its habits, preferred areas, etc. This information can provide an input for wildlife probability calculation.

G Due to the differences in resources available depending on the aerodrome, the data to be used in the safety risk assessment can be quantitative and qualitative. Best practice is to use quantitative data.

H Both quantitative and qualitative measurements of abundances of wildlife and number of strikes are used to rank probabilities of a species being involved in a strike at a particular aerodrome since aerodromes differ in the quality and quantity of information that they hold. This is useful to take into account different levels of knowledge and available statistics for different aerodromes.

I An example is shown in Table 3-2 Example of impact probability categorization regarding the values of some descriptive variables of a specific species, in order to be categorized (quantitatively and qualitatively) for probability of impact:

	Probability category				
	Very High	High	Moderate	Low	Very Low
QUANTITATIVE APPROACH Presence of wildlife (number of days per year a species is observed on the aerodrome and its surroundings)	> 200	100-200	50-100	50	10
QUALITATIVE APPROACH Presence of wildlife (subjective evaluation)	Permanent	Most	Some	Few	Occasional
QUANTITATIVE APPROACH Average number of strikes per year (5 years)	>10	3-10	1-2.9	0.3-0.9	0-0.2
QUALITATIVE APPROACH Strikes per year (subjective evaluation)	Very often	Often	Some	Occasional	Rare/None

Table 3-2 Example of impact probability categorization

J Different biological and behavioral characteristics of wildlife species can help classify them in specific risk levels. For instance:

a) species that shy away from aircraft noise or that learn to avoid aircraft could be rated as low probability;

b) birds that flock in large numbers to certain habitats in the flight path could be rated a high or very high probability;

c) solitary animals might be rated as moderate probability;

d) species with low or erratic flights could be rated as high or very high probability; and

e) species with nocturnal activity on aerodromes with nocturnal flights should have a higher probability of impact.

K Other behavioral factors should also be considered. The probability might also vary with the season, age or gender of the creatures, or other conditions such as grass length or rain and other weather conditions.

L Other variables to assess the risk more accurately include: flight activity on the aerodrome (the higher

M number of air operations, the higher the probability of wildlife strike), the type of aircraft using the aerodrome (larger, faster aircraft are likely to increase the risk of wildlife strike). Relating the number of impacts with the number of flight operations may help better understand if an increasing frequency of impacts can be related to a greater number of operations, to a greater wildlife presence, or both.

3.4.4 Estimating The Severity of a Strike

A The next step is to rank the expected severity of the impact or damage resulting from a strike event. A scale similar to the strike probability scale can be used.

B When assessing the possible consequence of a wildlife strike event or incident, consideration should be given to, but not be limited to, the following:

a) Aircraft type;
b) Previous strikes causing adverse effects (damage or delay);
c) The mass of the wildlife species (both observed and previously struck);
d) that the strike or incident will involve multiple animals;
e) The velocity of the aircraft involved, the resultant impact force(s) and the damage that could result; and
f) If adequate control of the aircraft can be maintained following a strike event or wildlife incident.

C Wildlife strikes have a directly associated severity, defined by the damage that the animal has caused to the aircraft after the impact. For observed wildlife, the severity scale will depend essentially on the size of the animal and its tendency to flock or congregate. Generally, heavier wildlife and greater flock size increases the probability of damaging an aircraft and impacting its flight performance. Flocking behavior could include multiple impacts or increase the probability of a strike.

D Severity can be rated, among other approaches, in terms of aircraft damage and human casualty, wildlife strikes with a consequence of damage to the aircraft, and number of events with an adverse effect on flights (for example missed approach or aborted take-off).

E Table 3-3 describes how to categorize, in two different approaches, the severity related to a determined species according to the damage this species has

caused in the strikes recorded by an Aerodrome. In this example, the severity of the common kestrel to aviation in a theoretical aerodrome is analysed:

	Probability category				
	Very High	High	Moderate	Low	Very Low
Percentage of strikes with common kestrel causing damage (compared with the total amount of wildlife strikes at the Aerodrome)	>20%	10-20%	6-10%	2-6%	0-2%
Type of aircraft damage and/or human casualty (in strikes with common kestrel)	Catastrophic	Hazardous	Major	Minor	Negligible

Table 3-3 Example of severity categorization (common kestrel)

Note. — Descriptions of damage category terms used above are shown below in Table 3-3.

Catastrophic	— Equipment destroyed; and — multiple deaths.
Hazardous	— A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely; — serious injury; and — major equipment damage.
Major	— A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency; — serious incident; and — injury to persons.
Minor	— Nuisance; — operating limitations; — use of emergency procedures; and — minor incident.
Negligible	— No safety consequences; — no aircraft damage; and — near miss.

Table 3-4 Example of safety risk severity

F In case of species for which no data about the severity of the damage they can cause is available, the severity could be calculated by the mass multiplied by the type of flock (see H, flock size).

G To perform this calculation, previous categories of weights or sizes of wildlife, and flock sizes should be established by the aerodrome operator to fit each species within a category.

H Table 3-5 is an example of how to establish these categories:

Body Mass	Examples	Body Mass Value
< 50 g	Asian Barbets	2
< 50 g	Cisticolas and allies	2
< 50 g	Ioras	2
< 50 g	Old world sparrows	2
< 50 g	Shrikes	2
< 50 g	Sunbirds	2
< 50 g	Swallows,Martins	2
< 50 g	Swifts	2
< 50 g	Wagtalls,Pipit	2
< 50 g	Sparrows	2
51-200 g	Kingfishers	4
51-200 g	Bulbuls	4
51-200 g	Bee-eaters	4
51-200 g	Vangas and allies	4
51-200 g	Fantalls	4
51-200 g	Coursers,pratincoles	4
51-200 g	Starlings	4
201-1 000 g	Pigeons	8
201-1 000 g	Nightjars	8
201-1 000 g	Rollers	8
201-1 000 g	Chats,old world flycatchers	8
201-1 000 g	Drongos	8
201-1 000 g	Sandpiper,Snipes	8
1-5 kg	Cormorants,shags	16
1-5 kg	Ducks,geese & swans	16
1-5 kg	Jacanas	16
1-5 kg	Large gulls	16
1-5 kg	Plovers	16
1-5 kg	Ralls,crakes & coots	16
1-5 kg	Stilts,avocets	16
> 5 kg	Anhingas,Darters	32
> 5 kg	Barn Owls	32
> 5 kg	Big birds of prey	32
> 5 kg	Crows,Jays	32
> 5 kg	Cuckoos	32
> 5 kg	Herons,Bitterns	32
> 5 kg	Kites,Hawks & eagles	32
> 5 kg	Ospreys	32
> 5 kg	pelicans	32
> 5 kg	Pheasants	32
> 5 kg	Storks	32

Table 3-5 Example of wildlife categorization based on body mass

Note.— Generic and birds found in Thailand data.

Flock size	Examples	Flock value
Usually solitary or widely spaced	Big birds of prey, Sparrows	1
Often in loose flocks	Pigeons, Large gulls	2
Often in tight flocks	Starlings	4

Table 3-6 Example of wildlife categorization based on flock size

I Flock size may depend on specific aerodrome location and species involved.

J With the example values given in H, it is possible to locate the analysed species in one of the severity ranges that could cause a collision with an aircraft.

	Severity category				
	Very high	high	Moderate	Low	Very low
Severity value (mass category value x flock category value)	32-128	16	8	4	2

Table 3-7 Example of severity categorization based on severity value

K Regarding the severity categories to be established, each aerodrome should determine its own scale. Since the severity of collision also depends on the type of aircraft, the range of aircraft sizes or types of aircrafts operating at an aerodrome would also need to be taken into consideration; clearly the views of the aircraft operators should be considered.

3.4.5 Estimating The Safety Risk of Wildlife Species

A A safety risk assessment matrix is completed by combining the probability and severity of each species to determine whether further action is required. A safety risk assessment should be reviewed at least annually or following a significant wildlife strike event and existing wildlife control measures adjusted to see if further action is required.

B An example of a risk assessment matrix is shown in Table 3-8:

		Probability				
		Very High	High	Moderate	Low	Very Low
Severity	Very High					
	High					
	Moderate					
	Low					
	Very Low					

Table 3-8 Example of risk assessment matrix

C The three risk levels are defined as follows and should be the main focus when interpreting the risk matrix:

Level 1 (Green) — *Acceptable*. The risk is acceptable as it is. No further action is required.

Level 2 (Yellow) — *Tolerable.* The risk can be tolerated based on the safety risk mitigation. Review current action undertaken, identify possible further action.

Level 3 (Red) — Intolerable. Take immediate action. Further action is required to reduce the risk.

D Example of a case study.

In an aerodrome, the following data of three wildlife species were collected throughout the year:

— A common resident species at the aerodrome, the common kestrel, produced nine impacts, causing minor damage to aircraft in two of them.

— The migratory barn swallow produced many impacts in spring and summer, although it was not possible to calculate the exact number of impacts. Due to the bird's size, it has never caused any damage.

— This year, griffon vultures appeared for the first time in the area for several days throughout the year. There are no historical records about the presence of vultures in the aerodrome, but due to the bird's size and possible formation of flocks, their possible hazard for operations must be taken into account.

According to the tables previously shown as examples of ways to categorize the probability and severity of impacts:

— For the common kestrel, its impact probability is HIGH. Its severity, taking into account the percentage of impacts that have caused damage, is VERY HIGH. However, knowing that the common kestrel is typically solitary, and weighs less than 300 g, its severity could be reduced to some degree, to MODERATE. This reduction would also depend on the type of damage or caused effect on flight, the type of aircraft affected, etc. As it is known from aerodrome records that the aircraft damage has always been minor, the reduction to the degree of severity is confirmed.

— For the barn swallow, which has produced several impacts, the probability is HIGH. However, it should be taken into account that its occurrence is seasonal, which concentrates its probability of impact to a few months per year. This could allow for reduction to some degree of the probability of impact. Its severity, according to the absence of damage, and with its small size (20 g), is VERY LOW.

— For griffon vultures, although there have been no impacts yet, their new and persistent presence at the aerodrome should be taken into account. Its probability would be HIGH. Its severity, considering its size (more than 7 kg) and flight form, would be VERY HIGH.

Therefore, the final risk assessment matrix in this example, after categorizing the analysed species, would be the following:

		Probability				
		Very High	High	Moderate	Low	Very Low
Severity	Very High		Griffon vulture			
	High					
	Moderate		Common kestrel			
	Low					
	Very Low		Barn swallow			

Table 3-9 Example of risk assessment matrix categorizing analysed species

Note. — Generic data.

This could be interpreted as:

— It is necessary to apply more mitigation measures, or improve existing ones, to control the presence of the common kestrel at the aerodrome, thus decreasing the probability of impact.

— The presence of barn swallows is acceptable, although mitigation measures that are already being applied should continue to be applied in order to minimize their presence at the aerodrome as much as possible.

— Mitigation measures must be applied on the griffon vulture to minimize or eliminate its presence at the aerodrome, before impacts occur.

3.5 Wildlife Hazard Management Measures

3.5.1 General

A The aerodrome operator should apply measures for habitat and land use management, to prevent the entry of wildlife at the aerodrome and to expel or eliminate the wildlife currently present within the aerodrome.

B The WHMP should include the resources used to perform wildlife management tasks (e.g. vehicles, pyrotechnics, traps, etc.). Personnel in charge of habitat and wildlife management, and personnel responsible for carrying out the preventive and corrective measures should be indicated. Further information about these measures can be found in chapter 4 Habitat Management and chapter 5 Management of Hazardous Wildlife. All different mitigation measures should be included in the WHMP, enabling appropriate assessments throughout the year.

C It is advisable that each measure in the WHMP include the following information, at a minimum:

a) species and risk activity targeted;
b) type and description of mitigation;
c) technical details;
d) implementation period and time frame;
e) personnel responsible for its application; and
f) results and effectiveness.

3.5.2 Habitat and Land Use Management

A Habitat and land use management, including preventive and proactive actions, is intended to reduce the presence of wildlife on the aerodrome by taking appropriate actions.

B Aerodrome operators should conduct an inventory of sites that attract wildlife within a defined radius around the aerodrome, paying particular attention to sites close to the airside and the approach and departure corridors. The appropriate radius (i.e. aerodrome vicinity) in this context should be 13 km around the aerodrome reference point. However, the radius may be extended or reduced, based on a wildlife evaluation of the aerodrome vicinity.

C The 13-km circle was based on a statistic that 95% of bird strikes occur below 2 000 ft, and that an aircraft on a normal approach would descend into this zone at approximately 13 km from the runway. An assumption was made that birds would remain overhead the attraction (at up to 2 000 ft) and that overflying aircraft would be at risk.

D Aerodrome operators should regularly review features on, and within the vicinity of, the aerodrome that attract wildlife. A management plan should be developed to reduce the attractiveness of these features and to decrease the number of hazardous wildlife present or to deny them physical access to these areas.

E Aerodrome development should be designed such that it will not be attractive to hazardous wildlife and no attraction will be created during construction. This may include denying resting, roosting and feeding opportunities for hazardous wildlife. In some cases, specific wildlife hazard control may need to be employed during the construction and reinstatement phases, and wildlife hazard management controls implemented as part of any approval process.

F A complete perimeter fence of adequate height, strength and structure, is the prime method of preventing hazardous wildlife, other than birds, from gaining access to the aerodrome areas. Fences and gates should remain closed and be regularly inspected. Fencing should also be trenched in order to preclude burrowing animals from gaining access to the aerodrome.

Figure 3-2 Fencing should also be trenched

G No food sources should be available to hazardous wildlife on the aerodrome. The aim should be to prevent food sources from being available through management of the aerodrome environment.

H Where applicable, vegetation should be kept at a height that is considered unattractive to hazardous wildlife. Where applicable, the vegetation composition on the aerodrome should not encourage wildlife.

I Agricultural crops should be discouraged from the aerodrome environment since agricultural crops and related activities (ploughing, seeding) may provide food for hazardous wildlife.

J Water bodies such as depressions, open drainage ditches, ponds and lakes may be a particular hazard as they may attract hazardous wildlife. These hazards should be made less attractive by mitigation measures such as drainage, replacement by buried drain pipes, netting and fencing to deny access to wildlife that walk in or by steepening the sides.

Note. — A list of types of land use that should be prevented, eliminated or mitigated in and around aerodromes is shown in *K Land use on and around aerodromes*

K The following is a non-exhaustive list of types of land uses which have proven to attract hazardous wildlife and which should, in particular, be prevented, eliminated or mitigated on and in the vicinity of aerodromes:

a) fish processing;
b) agriculture;
c) cattle feed lots;
d) garbage dumps and landfill sites;
e) factory roofs and parking lots, or other infrastructure;
f) theatres and food outlets;
g) wildlife refuges;
h) artificial and natural lakes;
i) golf or polo courses, etc.;
j) animal farms; and
k) slaughterhouses.

3.5.3 Expelling and Deterring Wildlife

A The following is a non-exhaustive list of types of land uses which have proven to attract hazardous wildlife and which should, in particular, be prevented, eliminated or mitigated on and in the vicinity of aerodromes:

a) wildlife patrols;
b) acoustics, such as distress and alarm call simulators, specific signals, natural and synthetic cries;

c) pyrotechnics, such as medium- and long-range cartridges and shell crackers;

d) optical and visual deterrents, such as laser devices, flags and streamers, lights, predator models, gull models, hawk kites, balloons; and

e) other techniques such as firearms, chemical repellents, lethal chemicals, trained predators (dogs and falcons), gas cannons, traps and relocation methods.

Note. — The effectiveness of the techniques and measures listed above may vary based on the species, location and their application.

B Wildlife control personnel should be equipped with devices for deterring, dispersing or removing wildlife appropriate to the species encountered, the numbers of wildlife present, and to the area that they need to control, or obtain the means of calling on expert support at short notice.

C In case hazardous wildlife are still attracted to the aerodrome after proactive measures have been implemented, it may be necessary to remove them by trapping or using lethal methods.

D The challenge for wildlife hazard management is that some wildlife may become accustomed to certain dispersal techniques. Therefore, best results may be obtained if aerodrome operators routinely adjust and vary the control and dispersal measures being used. An aerodrome operator should proactively seek different or new effective ways to reduce the wildlife hazard, where or if existing methods prove ineffective.

E Actions to manage wildlife should be prioritized on the movement area with particular attention given to the runways and approach/departure routes within the aerodrome vicinity.

F All devices and methods should be used in compliance with national regulations or practices (e.g. in compliance with regulations on the use of firearms, environment, and animal protection).

3.5.4 Measures Performance Indicator

A Each measure should have an appropriate performance indicator, i.e. a specific measurable characteristic that can assess its effectiveness.

B Some examples of performance indicators are provided below:

Example 1

Issue: The buzzard population at Aerodrome X increased despite habitat management, resulting in an increased risk. The main food source for the buzzards was identified as small rodents. Rodenticide was introduced on the aerodrome to reduce the number of rodents as food source for buzzards.

Indicators: the number of buzzards on the aerodrome; the number of rodents on the aerodrome; the mass of rodenticide used; the number of buzzard strikes.

Example 2

Issue: Cracks and cavities are found in the terminal building. Increased number of swifts and pigeons are nesting and sheltering. The aerodrome operator introduces netting in these cavities to prevent access.

Indicators: number of cracks or cavities detected; number of cracks or cavities covered; number of nests in the cavities; number of birds in the cavities; amount of faeces found in the cavities.

3.6 Coordination with Stakeholders

3.6.1 General

A Effective wildlife hazard management requires communication, cooperation, and coordination with all relevant stakeholders. Aerodrome operators should identify which stakeholders on and off the aerodrome should be involved and consulted. Such stakeholders may include transportation officials (including government), aerodrome staff, the ATS unit, aircraft operator representatives (including pilots), nature conservation organizations (government and non-government), local municipalities/cities, and organizations responsible for land management and local planning and development approvals in the vicinity of the aerodrome.

B The WHMP should include a process to hold regular meetings with the stakeholders present at the aerodrome (including aircraft operators, ATS, ground handlers, as appropriate). The aerodrome operator should encourage stakeholders to share data that was collected, reported and recorded on wildlife observations and strikes, in order to improve the WHMP.

C The aerodrome operator should ensure that there is a process for rapid communication among those involved in wildlife control as well as with ATS. This is necessary when a specific wildlife hazard is present to allow the issuance of appropriate warnings to aircraft operating on, and within the vicinity, of the aerodrome, by the air navigation services provider (ANSP).

D The aerodrome's WHMP should include a process for liaising with non-aerodrome agencies, local landowners and other relevant stakeholders, to ensure that the aerodrome operator is aware of developments that may contribute to creating additional wildlife hazards in the infrastructure, vegetation, land use and activities within the aerodrome's vicinity (e.g. crop harvesting, seed planting, ploughing, establishment of land or water features, hunting). The aerodrome operators should consider options to influence the land-use within the vicinity of the aerodrome, in order to reduce the hazard from wildlife.

E Wildlife hazard management mitigation measures undertaken by external stakeholders in the vicinity of the aerodrome should be recorded, monitored and evaluated in the aerodrome WHMP.

F The aerodrome operator should participate in wildlife related meetings (e.g. National committee or forum) with other aerodromes to share experience and discuss common problems.

3.7 Personnel Training

3.7.1 General

A Some of the personnel involved in wildlife control activities, hereafter referred to as wildlife control personnel (WCP), might not have formal education in wildlife biology. All WCP must have sufficient training to be knowledgeable in the basic principles of wildlife management and in the identification, behaviour, general life history, and legal status of the hazardous species in the area. WCP also must be trained in the proper implementation or deployment of various control strategies and techniques outlined in the Wildlife Hazard Management Programme. The minimum initial and recurrent training requirements for wildlife control personnel, and a typical training syllabus, are included below.

B The WHMP should include training information for:

a) wildlife control personnel; and

b) those responsible for WHMP development and implementation.

C The WHMP should include procedures for the initial and recurrent training of personnel involved in wildlife control and in wildlife hazard management.

3.7.2 Training Requirements

A An aerodrome operator should adequately train their wildlife hazard control personnel and managers in wildlife hazard management. This training should be conducted by competent wildlife hazard control personnel or specialists with proven experience in this field in accordance with recognized competency-based training principles.

B An aerodrome operator should ensure that wildlife management personnel are competent. Competency is the combination of skills, knowledge and attitude required to perform a task to the prescribed standard. Potential wildlife management personnel should complete a training programme and be tested, and the results recorded and kept on file. This record-keeping period should be kept long enough to provide proof of competency.

C Recurrent training should be carried out to ensure that personnel are kept up-to-date with any changes in wildlife hazard management at the aerodrome. Recurrent training is recommended to be completed at least every two years

3.7.3 Content of A Training Plan

3.7.3.1 Initial Training

A The initial training for Wildlife Control Personnel, Aerodrome Wildlife Control Personnel or Wildlife Control Operator who performs the front line role should, as a minimum, address the following areas:

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

b) an understanding of national and local regulations, standards, and guidance material related to the aerodrome wildlife hazards management programme (use of best-practices models);

c) a broad appreciation of local wildlife ecology and biology;

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

e) local and national laws and regulations relating to protected species, and species of special concern, and the aerodrome operators' policies relating to them;

f) high-risk species identified in the wildlife risk assessment;

g) wildlife strike remains collection procedures, identification and reporting;

h) active/tactical measures, using well-established effective wildlife removal, dispersal, detection and control techniques;

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

j) firearms, drones and any other equipment and their use on the aerodrome, including the use of personal protective equipment.

B When training Personnel For Wildlife Hazard Management, Aerodrome Wildlife Coordinator or Manager who is responsible and accountable for wildlife hazard management and personnel engaged in wildlife hazard control, the topics mentioned in 3.7.3.1 A, should be covered and may also include, but are not limited to:

a) nature and extent of the wildlife management problem;

b) management of hazardous wildlife and their habitat;

c) national and local regulations, standards and guidance material related to aerodrome wildlife hazard

d) overview of aerodrome WHMP;

e) wildlife ecology and biology;

f) wildlife identification and observation, including the use of field guides and wildlife survey methods;

g) protected species, including related regulations and policies;

h) documentation, identification, and reporting measures of wildlife strikes;

i) off-aerodrome land use issues;

j) wildlife removal techniques;

k) safe use of firearms, hazardous materials;

l) stakeholder involvement;

m) importance of awareness and outreach programmes; and

n) basic principles of the safety management system (SMS) and how they apply to aerodrome wildlife hazard management

3.7.3.2 Recurrent Training

A In order to maintain the competence of wildlife management personnel, recurrent training should be carried out, including a selection of general topics covered in the wildlife control initial training. This should include:

a) changes in legislation or regulation

b) changes in local environment

c) recent wildlife events at the aerodrome

d) changes in active and passive measures

e) any other matter the that the aerodrome operator deems appropriate.

3.7.3.3 Additional Trainings Requirement

A Wildlife control personnel should be fully aware of the details pertaining to aerodrome operations, the aerodrome environment and should have received appropriate training, including:

a) airside driver training, aerodrome familiarization, air traffic control communications (radiotelephony (RTF)), signs and markings, navigational aids, aerodrome operations and safety, and other matters that the aerodrome operator deems appropriate; and

b) aircraft familiarization, including aircraft identification and effect of wildlife strikes on aircraft systems.

3.7.3.4 Wildlife Control Training Syllabus

Aerodromes with well managed and researched programmes that are delivered by fully qualified and trained staff are better prepared and positioned to deal with wildlife threats at aerodromes. The following is a guide to help plan training content:

Overview Theoretical Training	Familiarization Practical Training	Specification Specific Wildlife Training
• Aerodrome overview • Aerodrome certification • Aerodrome procedures • International regulations • National regulations • Environmental regulations • Aerodrome safety management system • Promulgation of information • Health and safety overview • Accident and incident reporting/investigation	• All aerodrome operational procedures and standards • Landside overview • Airside safety • Airside security • Apron driving • Radiotelephony • Runway incursion training • Protection of NAVAIDs • Low/reduced visibility programme • On-the-job training • Recurrent refresher training • Familiarization programme	• Detailed theoretical aspects of wildlife programmes • Integrated approach to all elements of habitat/wildlife programmes • All practical elements required to support programmes • Familiarization programme • Equipment training and procedural use of all equipment • Defined on-the-job training • Recurrent refresher training • Administration programme in respect of specific record-keeping • On/off field programme

Table 3-10 Wildlife control training syllabus

3.7.4 Selection and Appointment of Training Providers/Personnel

A Wildlife hazard management training should be conducted by qualified persons or specialists with proven and relevant experience.

B Personnel appointed to provide training in wildlife hazard management should hold:

a) qualifications in wildlife control (or possess relevant experience)
b) qualifications in aerodrome operations (or possess relevant experience)
c) qualifications in education or training and assessment.

3.7.5 Assessment of Competency

A The successful completion of the training program should be demonstrated by passing a theoretical and practical competency assessment.

B Following the completion of training and the attainment of competency, written confirmation or certification should be provided to the trainee.

C If a published training procedure is not provided or cannot be readily referenced, the assessor should attest in writing the fields, skills or units of competency that the trainee has successfully completed.

3.8 Wildlife Hazard Management Programme Evaluation

3.8.1 General

A The aerodrome operator should evaluate the effectiveness of the WHMP annually, at minimum. Changing conditions on the aerodrome, both operational and ecological, personnel performance and outdated procedures may be identified during this evaluation, prompting a review of the WHMP.

B WHMP evaluation may have several levels of complexity and detail, and may consist of simple responses to basic checklists, or establishing a quantifiable measurement system, which includes leading and lagging indicators and qualifications, from which it will be considered if the WHMP is working well or if it needs to be improved, or evaluation plan report to be forwarded to the aerodrome wildlife committee and the senior management responsible for the delivery of the plans.

3.8.2 Basic Self-Evaluation

A The most basic level of WHMP evaluation should be to respond affirmatively or negatively to questions contained therein. If the answers to those questions are negative or unclear, measures should be established to address shortcomings. Basic questions may include:

Wildlife hazard management programme evaluation questions	S	U	Remark
Are wildlife management roles, tasks and responsibilities adequately established at the aerodrome?			
Is the “wildlife manager or coordinator” considered in the WHMP?			
Is there a proper communication procedure between the different stakeholders to alert about the presence of strikes with wildlife?			
Are the wildlife management personnel aware of the species that pose a risk to air traffic and about attractive areas for wildlife at the Aerodrome and its vicinity?			
Are wildlife observations and strikes recorded and reported properly?			
What is the average of identification of species on wildlife strikes?			%
Does the WHMP include an appropriate wildlife risk assessment conducted by competent personnel?			
Are habitat management measures and measures of dispersion and extraction of wildlife taken at the aerodrome?			
Is the effectiveness of these measures measured?			
Is there coordination with external stakeholders?			
Are regular meetings held with them?			
Is the local wildlife committee effective?			
Is training on wildlife management given to personnel involved in wildlife management (at all different levels)?			
Is the self-evaluation of the WHMP being performed?			

S – Satisfactory U - Unsatisfactory

Table 3-11 Wildlife hazard management programme evaluation basic checklist

B The foundation for these evaluations is the maintenance of consistent records of wildlife presence, wildlife control activities and wildlife incidents. Using a standardized format for all record keeping allows for an easy compilation of events and activities into monthly and annual statistical and narrative summaries. Once these summaries are available, objective examinations and comparisons of trends in strikes, wildlife activities, control methods deployed, and other factors can be made. Examples of systematic documentation procedures include: daily logs of wildlife activities, surveys, patrols, wildlife strikes with aircraft and wildlife control activities.

3.8.3 Performance Measurement Mechanism

A The most rigorous and systematic method to know how well wildlife is being managed at the aerodrome would be to use a performance measurement mechanism. Performance indicators (parameters used for monitoring and assessing performance) are select metrics that are most closely aligned with the ultimate goal of reducing wildlife risks and will help to assess if the wildlife hazard is adequately managed by the aerodrome operator.

B Performance indicators should be metrics obtained and measured in a simple way, and which are clear about what they measure. They can be primary (lagging) or secondary (leading) indicators.

C Primary (lagging) indicators measure events that have already occurred. They are also referred to as outcome-based indicators and normally represent, but not always, the negative outcomes the organization is aiming to avoid. Secondary (leading) indicators measure processes and inputs being implemented to improve or maintain performance. These are also known as activity or process indicators as they monitor and measure conditions that have the potential to lead to or contribute to a specific outcome.

D Lagging indicators are typically output oriented, easy to measure but hard to improve or influence (e.g. Number of wildlife strikes), while leading indicators are typically input oriented, hard to measure and easy to influence (e.g. number of repellent activities).

E Although there has generally been a tendency to use lagging indicators (number of wildlife strikes related to aircraft movements, percentage of strikes resulting in damage or effect on flight, etc.) as measures of the effectiveness of a WHMP, leading indicators are good indicators as well. They show how personnel are performing their tasks and how the system is prepared to prevent the worst events (incidents and accidents) from happening, through good safety practices, correct use of procedures, etc.

F Some leading indicators for evaluating a WHMP would be:

a) presence of wildlife at the aerodrome;
b) completeness of wildlife strike reports;
c) completeness of wildlife management logs;
d) percentage of wildlife species identification in strike events;
e) percentage of personnel receiving wildlife management training;
f) percentage of wildlife management actions completed; and
g) frequency of meetings of wildlife committees.

G An ideal performance measurement will take into account both primary and secondary indicators. In order to use these metrics, it is essential to have an accurate historical record of all activities and events that belong to wildlife hazard management.

4. Habitat Management

4.1 General

4.1.1 Wildlife is attracted to habitat because of their specific requirements for food, water, breeding activities shelter and safety. That habitat increases the likelihood of their presence and the risk of a strike. Modifying the on-site habitat and environment can limit the attractiveness of an aerodrome to wildlife. Additionally, habitat management of attractive sites on, or in the vicinity of, the aerodrome is the foundation for an aerodrome's WHMP because it addresses the root cause of wildlife hazards.

4.1.2 Land use practices that attract hazardous wildlife populations on, or in the vicinity of, the aerodrome can significantly increase the potential for wildlife strikes.

4.1.3 Before undertaking activities to manage habitats, a safety risk assessment that identifies the hazardous wildlife and the root cause of their association with specific habitats must first be carried out. Further information can be found in Chapter 3, 3.4 Wildlife Safety Risk Assessment

4.1.4 Following a safety risk assessment, any habitat used by hazardous wildlife should be identified and a habitat management strategy should be developed. This strategy should prepare for the impacts of habitat management activities on the hazardous wildlife species at the aerodrome. In some cases, management activities that decrease the risk of strikes with some species may increase the risk of strikes with others. In these cases, the risk assessment should be used to determine which species present the greatest risk and are therefore the target of habitat management efforts.

4.1.5 When considering proposed land uses, aerodrome operators, local planners and developers must consider whether the proposed land uses, including new development projects, will increase wildlife hazards.

4.2 Attractants

4.2.1 Food

A Vegetation

a) Vegetation is frequently the dominant land cover at many aerodromes and can consist of open grassland, shrubs and trees. Certain vegetation may produce seeds, berries and attract invertebrates or other animals that are a food source for various hazardous wildlife. Managing an aerodrome's vegetation to minimize its attractiveness to wildlife is a critical activity

b) Management actions targeted at vegetation can increase the risk of exposing prey items in the short-term. For example, mowing grass too short may expose invertebrates or other small animals, making them available to predatory birds. On the other hand, when the vegetation becomes too tall, it could fall down, providing shelter and a fertile layer for mice or other wildlife.

c) When planning any habitat modification, one must consider how the change may increase the availability of prey

d) Bare soil gives weed a chance to grow and may expose food such as seeds or invertebrates.

e) Soil cultivation can also expose these food sources and may even bring buried prey items closer to the surface to attract hazardous wildlife.

f) The timing and frequency of management actions on an aerodrome should be oriented to minimize hazardous wildlife.

B Agriculture

a) Agricultural systems can increase the presence of wildlife on and around aerodrome lands depending on the cropping system. Agricultural systems that produce highly nutritious foods that can be exploited by wildlife (for example cereal grain) can increase the risk of strikes, as will those that involve frequent field tillage or mowing that exposes seeds, invertebrates or small animals.

b) Certain cropping systems may benefit the aerodrome by removing vegetation that would otherwise provide habitat for prey species (e.g., hay operations that remove cut grass that would otherwise provide refuge for invertebrates or small mammals).

c) Agricultural systems far from the aerodrome may aid in decreasing strike risks by luring hazardous wildlife away from the area of flight operations.

C Waste Management

a) Food and garbage waste bins, slaughterhouses and open-air markets may be highly attractive to scavenging wildlife.

b) Landfills and garbage dumps are a significant source of food for wildlife. Certain species will travel several tens of kilometres to reach a dump and may cross over an aerodrome or aircraft flight paths. The greater presence of birds may give rise to problems for approaching aircraft.

4.2.2 Water

A Water bodies

a) Water is a primary requirement for wildlife: it offers them drinking water; a resting site; an escape from predators and a feeding site. Eliminating water habitats or excluding wildlife from using these habitats will decrease the number of wildlife using an aerodrome.

b) Ponded water that forms in depressions can be an attractive habitat for a variety of wildlife, particularly water birds, and should be removed.

c) Emergent vegetation in drainage ditches may decrease the drainage capability and provide refuge and food sources for wildlife. Alternatively, emergent vegetation may exclude hazardous wildlife from using them. Steep banks may limit access to some types of wildlife, whereas others will not be affected.

d) Wetlands are often used by significant numbers of water wildlife, which tend to be a higher hazard species due to their size and flocking behaviour. If possible, any change to these water bodies should reduce their attractiveness to wildlife if the wildlife is known to present a flight safety risk.

e) Water bodies can be made inaccessible in a variety of ways: for example, covering them with wires or netting to inhibit birds from landing. Water bodies that cannot be eliminated or covered should be designed to discourage their use by wildlife as much as possible and have a perimeter road so that wildlife-control personnel can quickly access all parts of the water body to disperse birds.

B Wastewater management

Wastewater management facilities and their settling ponds often attract large numbers of wildlife. The closer the building is to the aerodrome, the greater the potential risk. The aerodrome operator should develop an agreement with those responsible for the wastewater management facility to ensure that wildlife hazards resulting from sewage ponds are suitably managed. New facilities should not be constructed near an aerodrome or where wildlife movements to and from the ponds may affect aircraft movements.

C Quarries

Areas from which raw materials and stone are extracted are often filled with water. It is common for these areas to be left without being restored, thereby attracting birds. With any new excavation, the site should be restored to a state

that suits flight safety. The enhancement of old extraction pits should be discouraged, as this can increase the risk of wildlife hazards.

4.2.3 Shelter (resting, security and nesting)

A Open areas

a) Grasses can shelter prey that are fed upon directly by hazardous wildlife. Managing the species of grass on the aerodrome, as well as the height and density of grasses, may reduce the attractiveness of the habitat.

b) Soil will influence the vegetation that grows on a site and will also act as habitat for soil-dwelling organisms, some of which may be prey for hazardous wildlife. Some hazardous wildlife may use burrows or tunnels in the soil as a place to shelter from the environment, escape predators, or breed.

c) Other offsite land uses, such as parks, golf courses, and other amenity grasslands may attract hazardous wildlife. Managing these sites requires the dedicated engagement of stakeholders outside the aerodrome in order to influence land use changes that can reduce the attraction to hazardous wildlife.

d) Aerodrome pavement may provide a resting and loafing site for wildlife that are attempting to stay warm. For example, after heavy rainfall, pavement areas may become more attractive to gulls, increasing their presence at the aerodrome.

B Forest

Trees and shrubs provide nesting or roosting opportunities for wildlife. Depending on the wildlife safety risk assessment, these may have to be eliminated on aerodrome property. The aerodrome operator should be aware of such areas in the vicinity of the aerodrome and the potential transiting routes for wildlife.

C Nature reserves

The establishment of nature reserves in the vicinity of aerodromes can provide a strong attractant to hazardous wildlife. In general, nature reserves are formed where unique, diverse or remnant habitats exist and they may host hazardous species. The aerodrome operator should develop a solid relationship with reserve management, so that if habitat enhancement is conducted on the reserves, wildlife hazards to aircraft are considered.

D Buildings

a) Wildlife often seek shelter and breeding sites on aerodrome property in the structural beams of hangars and bridges, in the nooks of jet ways and other structures. Aerodromes should adopt a zero tolerance for hazardous wildlife using any Aerodrome structure.

b) The attraction of hazardous wildlife should be considered in the design phase of buildings, hangars, bridges and other structures at aerodromes to minimize exposed areas that birds can use for perching and nesting.

4.3 On-Aerodrome Management

4.3.1 General

The key to effective habitat modification is to remove existing attractions without introducing new enticements that may appeal to other species. Every species on the aerodrome represents a direct or indirect hazard; however, aerodromes should consult their risk assessment matrix (see Chapter 3, 3.4 Wildlife Safety Risk Assessment) to identify the species with the greatest risk.

The aerodrome operator should be aware of not only managing habitat attractants on airside locations, but also ensure that habitat attractants are identified and managed landside.

4.3.2 Design (Aerodrome buildings and structures)

A Screening holes and openings of hangars can prevent access to these buildings. In the case of hangars, where doors may be left open for an extensive period of time, netting can be installed across the base of the rafters to exclude birds from nesting in the rafter system. Adding a slope greater than 45 degrees to edges of buildings can also deter birds from nesting on these sites.

B Where perching sites are present on existing structures, their access can often be eliminated with the installation of netting. Anti-perching devices, such as spikes, can be installed on ledges, roof peaks, rafters, signs, posts and other roosting and perching areas. If wildlife is already present on existing structures, the aerodrome operator should refer to Chapter 5 Management of Hazardous Wildlife. for more management techniques.

C Unused structures such as sheds, abandoned buildings and structures, old windbreaks and rotten fence posts should be removed from Aerodrome lands to prevent nesting and roosting.

D Where birds have already nested in buildings, nest removal may be possible, but should be done in consultation with local and national environmental

requirements. The trapping, removal or relocation of young birds may be conducted if nest removal is not completed outside the breeding season.

E Perches are places from which birds sing, call and display. They also act as observation points, hunting lookouts and as places to rest, digest, preen, roost and gather socially. As potential perches for birds, lone trees, hedgerows, fences, gates, posts, shrubs, stumps, junk, weed patches and boulders should be removed from Aerodrome lands. If this is not possible, spoked wires can be attached to perching sites to discourage their use. Power lines are popular perches and should be relocated underground. Certain specific wire can also be fitted to runway, approach, taxiway and apron lights to discourage their use as perches.

F Aircraft parked on aprons or fields are also popular nesting locations. Birds usually enter aircraft through small access holes just large enough to accommodate them. Parked aircraft should be regularly checked for nesting birds, and if they are expected to be parked long-term, the aerodrome operator should consider installing netting to prevent such access.

4.3.3 Fencing

A A complete perimeter fence is the prime method of preventing hazardous wildlife, other than birds, from gaining access to the aerodrome. There is a variety of fencing available, including electric fences. The most suitable fence for an Aerodrome depends on many factors, including the observed wildlife hazards, the potential impacts of certain types of fencing, seasonality of hazards, costs (both for construction and maintenance) and adjacent habitat types. Adding the use of cattle gates at entry and exit points for vehicle access points within a perimeter fence can prevent many hoofed mammals from crossing into aerodrome property.

B Fencing should be buried below the ground when possible to discourage animals from digging under the fence to gain access to aerodrome property.

C Fences and gates should remain closed and be regularly inspected.

4.3.4 Grass

A Grass height should be decided based on the target high risk species. Grass height may be limited next to the manoeuvring area, but grass may be kept at a taller height depending on the management of local high risk species.

B There is no single recommended grass height that is effective at all aerodromes. It is recommended that aerodromes conduct a site-specific study to find an

optimal grass height. The decision to maintain short or tall grass depends on which species pose the highest hazard at the specific aerodrome.

C Vehicle access to grass areas should be restricted to minimize damage and alteration to grass heights. Damaged grass areas might lead to standing water and the emergence of weeds attractive to hazardous wildlife.

D Vegetation that is undesirable or mildly toxic to wildlife may deter wildlife feeding. For example, there are varieties of tall fescue and perennial ryegrass that contain fungal endophytes that may be unattractive to some birds, mammals and insects. The aerodrome operator should be aware of Thailand regulations concerning these varieties.

E There are alternatives to grass covering bare soil around an aerodrome. An example of this is the application of a wood mulch added to water, seed, fertilizer and soil amendments which can provide coverage to areas that may be more attractive to.

F hazardous species and help aid in the growth of new grass. The use of artificial turf may reduce food, shelter and burrowing attractants for hazardous wildlife.

4.3.5 Forest, Vegetation and Agriculture

A Large areas of brush, shrubs or forests, natural or decorative, can provide habitat with safe areas where wildlife loaf, perch, roost and nest. These areas are commonly found on undeveloped Aerodrome grounds and can attract birds and other wildlife.

B Brush and bushy vegetation should be eliminated from Aerodromes when possible and at the very least be eliminated from the proximity of manoeuvring areas.

C Trees should be located as far as possible from runways. Tree species that produce soft fruits, berries, or high numbers of seeds are especially attractive to wildlife and should be removed. Trees also provide cover for medium-sized and large mammals. Large trees located at the edges of open areas provide excellent vantage points from which raptors can survey for food. In addition, trees can create an edge effect, which is an intermediate area often rich in bird life because it borders two different habitats such as grassland and wooded areas.

D Where tree removal is not possible, undergrowth should be removed. Trees can also be thinned at their tops to make them less attractive as roosting sites. Trees should be frequently inspected for colonies of nesting or roosting birds.

E Aerodrome lands not be used for agriculture. Agricultural activities at aerodromes may attract hazardous wildlife. If Aerodromes have on-site

agricultural practices should ensure that crop selection is done in line with their wildlife hazard management programme. Modified ploughing and harvesting practices may also be necessary to decrease the risks to aviation.

4.3.6 Waste Management

A Aerodromes should require a wildlife-proof storage of food waste, prohibit wildlife feeding and promote good sanitation and litter control programmes. In many instances, simply closing the lid of waste bins can limit the access to these food resources by hazardous wildlife.

B Waste disposal sites on aerodrome property should be removed to an off aerodrome location, outside of the 13-km circle. If this is impossible, organic waste should not be accessible to hazardous wildlife (e.g. buried or incinerated). Where waste management must occur on aerodrome property, disposal activities should also be conducted at night to attract fewer birds. Additional mitigation could also include fencing, netting or overhead wires to prevent access.

C Aerodrome should ensure that waste management procedures include closing the lids of garbage bins and that waste is disposed of into bins and not littered on the property. Improperly disposed refuse can attract wildlife. Signage to discourage the feeding of wildlife should also be erected in public areas.

4.3.7 Water

A The best method to reduce the attractiveness of water bodies on aerodrome property is to remove them: for example, by draining or filling. Where aerodromes have drainage ditches, these can be replaced with buried culverts. Where drainage ditches remain, aerodromes may have to clear these ditches of emergent vegetation. Areas where temporary water pools form after rain or spring melts should be filled or fitted with improved drainage systems.

B 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.

C Where water bodies cannot be removed, Water bodies should be cleared of emergent and submerged aquatic vegetation and the banks should be cleared of vegetation and brush. This can be done by cutting, dredging, or herbicide use.

D The slopes of water bodies should be graded to a steep slope, which will discourage burrowing mammals, bird species and offer a clearly defined edge which can be easily mowed.

E Physical barriers should be erected to prevent wildlife access to water bodies. Methods include fencing around the perimeter, exclusion wiring and netting across all the surfaces or riprap installed on water embankments. Visual enhancements can be attached to the wires and netting to prevent birds from flying into the barriers. In certain instances, barriers such as large black balls that float on water bodies have been used successfully to prevent access to water bodies.

F If water bodies cannot be covered or drained, dredging will increase the water depth and, as a result, decrease the surface area.

G Where storm water management ponds are present on aerodrome property, the aerodrome should ensure a maximum retention period for the storm water to reduce attractiveness (e.g. in North America, this time period has been identified as 48 hours).

4.4 Off-Aerodrome Management

4.4.1 The concept of compatible land use planning is the environmental relationship between Aerodromes and their community neighbours. Its implementation requires careful study and coordinated planning. Land use around Aerodromes can influence restrictions on aircraft flights and affect aircraft safety.

4.4.2 A 13-km circle centred on the aerodrome reference point is recognised where land use should be assessed with regard to wildlife hazard management. However, the circle may be extended or reduced based on a wildlife evaluation of the aerodrome vicinity. Aerodrome operators are encouraged to communicate their safety concerns with the local authority in order to raise awareness (see Chapter 6, 6.3 The Communication, Cooperation and Coordination). Prior planning is necessary to ensure that incompatible land use is not allowed to become established. Such developments should be subjected to a risk assessment process as described in Chapter 3, 3.4 Wildlife Safety Risk Assessment and changes sought, or the proposal opposed, if a significant increase in the wildlife strike risk is likely to result.

4.4.3 A monitoring process of sites where hazardous wildlife is to be found should be instigated, at least seasonally. The survey of the land use around aerodromes should be reviewed at a period determined by the safety risk assessment. In general, it is desirable to carry out a new comprehensive land use survey assessment every five years.

4.4.4 The aerodrome operator should engage with local farmers in the vicinity of the aerodrome to encourage them to choose agriculture practices that are the least attractive to hazardous species. These practices may include types of crop, livestock and grain and feed storage

4.4.5 The appropriate authority should encourage prohibiting or restricting the establishment of new or existing organic waste sites near aerodromes. If a waste management site in the vicinity of an aerodrome cannot be closed, it may be necessary to provide control measures at the site to reduce its attractiveness to hazardous wildlife.

5. Management of Hazardous Wildlife.

5.1 The Importance of Understanding Animal Behaviour

5.1.1 Wildlife can react in different ways to different methods of dispersal, and protect themselves from predators by hiding or fleeing. The role of the wildlife control personnel on duty at an aerodrome is to understand the ways in which hazardous wildlife species are likely to react vis-à-vis the different methods of dispersal in order to reduce their presence on or around an aerodrome most effectively and reduce their risk to aircraft.

5.1.2 Hazardous species may respond differently to expelling and deterring techniques. Some species fly away from the stimulus while other species crouch down and hide or even approach the stimulus. Knowing these responses will enable the controller to select the correct method to reduce the immediate risk.

5.1.3 When confronted with deterring or expelling techniques, all wildlife will initially become ‘alert’ to a potential threat before they exhibit their ‘response’. A wildlife control vehicle or person will result in wildlife becoming ‘alert’ but not necessarily responding until the control method becomes clear. If wildlife remains undetected on the aerodrome, it will learn that such a response and will therefore be able to continue with its activities unhindered. The reaction of species can therefore be controlled by moving past the wildlife, stopping and waiting or instigating an action. It is important to understand these responses on a site-by-site basis because of reaction of wildlife in different ways at different aerodromes. Control can be achieved by understanding whether the ‘response’ of wildlife will be to ignore, hide or flee.

5.1.4 At aerodromes where active wildlife control measures are routinely implemented, behaviours may differ from aerodromes where infrequent actions are undertaken. The most likely response will again differ in relation to the amount of time target species have been subjected to deterring or expelling techniques at any given aerodrome.

5.1.5 Wildlife controllers must therefore be able to identify the species present at their aerodrome and understand their behaviour. The aerodrome should provide a wildlife guidebook to officers to assist them in detecting species. A dynamic risk assessment based on the likely reaction of the species present, the location of aircraft movements at the time and the control methods available will then enable the most appropriate cause of action. Chasing hazardous wildlife with simple methods such as loud noises and manual techniques (arm waving, clapping, etc.) may be all that is required to disperse them directly away from the wildlife control personnel. More sophisticated methods may include using a distress call system to draw a flock of gulls away from a runway, or using pyrotechnics to deter a group of circling raptors.

5.1.6 Wildlife control personnel should be equipped with a range of appropriate systems for deterring, dispersing or removing species they are likely to encounter and the ability to deploy such systems wherever necessary on the aerodrome. The objective of deterring or expelling is to control movements and disperse them away from high risk areas and the ultimate objective is to render the aerodrome a hostile location and 'educate' hazardous species that the risk of remaining within the aerodrome environment outweighs the beneficial environment.

5.1.7 All active control systems should only be deployed when required, in order to reduce habituation. Overuse of individual methods results in habituation and the subsequent failure of those methods. Human operated (active) control will always, therefore, be more effective than automated (static) scaring systems. Similarly, the use of lethal threat will remain an important tool to reinforce the effect of non-lethal expelling and deterring techniques.

5.1.8 Once the responses of different wildlife species at an aerodrome are understood, they can be associated with control actions to reduce their risk. When recording such actions, the patrols and observations explained in 5.2 Patrols and Observations should be considered.

5.2 Patrols and Observations

5.2.1 Patrols of airside areas to check for birds and other hazardous wildlife are a direct requirement for wildlife hazard management of aerodromes. Critical risks result from wildlife being present on or crossing runways and approach or departure paths, therefore patrols should aim to prevent their presence in these areas. These patrols should facilitate either immediate dispersal from those locations or preventative dispersals from areas likely to result in such movements. Additionally, ATC and other personnel should inform wildlife controllers when they observe wildlife; the wildlife controller can then determine the level of hazard

5.2.2 Patrols should target the locations of hazardous wildlife activity, especially near runways and approach or departure paths. Local knowledge, data assessments and visual observations can provide vital information on where recent hazardous wildlife has been congregating or dispersed from.

5.2.3 During patrols, the recording of hazardous wildlife will enable the aerodrome operator to identify existing and future problem areas. Such areas should be logged to take proactive habitat management action.

5.2.4 Wildlife controllers should ensure that wildlife does not habituate to routine pathways or timings. Randomization of routes and wildlife controller behaviour is beneficial. Constantly varied patrols will also help wildlife controllers to learn the behaviour in different seasons, times of the day, weather conditions and habitat preferences of wildlife at an aerodrome. For example, some aerodromes conduct wildlife management patrols at least 15 minutes prior to any movement. When possible, wildlife management personnel should position themselves at the most critical areas.

5.2.5 During patrols, any wildlife remains found should be collected, identified to the species level and documented in a wildlife log. Even if remains are not evidenced as being recorded in a collision with an aircraft, its presence on the aerodrome may assist with identifying risks with that species that could prevent future strikes.

5.2.6 When a control action is undertaken, the wildlife management personnel should ensure they record the following information;

a) name of the personnel on duty
b) shift start and finish time
c) time for each activity or record
d) weather and lighting conditions

e) location of activities
f) details of the wildlife observed and/or dispersed
g) numbers of each species seen, including zero sightings
h) type of dispersal action taken
i) reaction of wildlife to dispersal
j) direction of dispersal

5.3 Repellents

5.3.1 Overview

A The following provides an outline of possible options for controlling wildlife on aerodromes to reduce strike risks This list is not exhaustive but covers a group of the main techniques used around the world for active wildlife control on aerodromes. There are many more systems available than it is possible to cover here. There is no single solution or set of procedures that is best for all situations. Aerodrome operators should carry out a thorough review of any equipment before purchase to ensure that it is fit for purpose. Each wildlife species is unique and will often respond differently to various repellent techniques. To lessen habituation: use each technique sparingly and appropriately when target wildlife is present; use various repellent techniques in an integrated fashion; and if necessary, reinforce repellents with occasional lethal action directed at problem species.

B Equipment used by wildlife management personnel on the aerodrome to control hazardous wildlife should be appropriate to the aerodrome environment and species encountered.

C Advances in electronics, remote sensing and computers have resulted in systems that can automatically dispense repellents (for example, noisemakers, chemical sprays) when targeted wildlife enter selected areas. 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.

5.3.2 Audio Repellents

A Pyrotechnics

Figure 5-1 The use of pyrotechnics

a) Use of pyrotechnic wildlife scaring techniques, either from a cartridge fired from a shotgun, a specialized pistol or from a stationary cannon, is a common means of dispersing wildlife at aerodromes Wildlife will usually move away from the detonation so it is possible to control their direction to some degree: detonations behind wildlife can hasten their departure, and to either side can keep them on track and to hold a flock together.

b) There are various projectiles, fired from breech-loaded shotguns or from specialized launchers, which provide an auditory blast or scream as well as smoke and flashing lights to frighten birds. 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 aerodrome. Using pyrotechnics distributed by wildlife management personnel and targeting a specific species, helps teach wildlife to associate the pyrotechnic with a threat (person).

c) The effect of a cartridge can be improved by using a trace, especially when trying to control direction. The trace should be visible in sunlight throughout its flight.

Figure 5-2 cartridge

d) Several types of pistols are used at aerodromes. The pistol should be fit for purpose and be pressure-tested for the type of cartridge used. Using pyrotechnics may present a FOD hazard to aircraft which should be managed accordingly.

e) In many circumstances, wildlife management personnel may not be allowed to fire a cartridge beyond the aerodrome perimeter, but by firing at a greater angle its effect can be extended outwards over a considerable distance, including locations with the approach path. A large flock of birds, rather than several smaller ones, is more likely to leave the aerodrome using this method. However, firing directly into a flock will probably fragment the cartridge and the wildlife may not regroup. Care is needed to control and not scare birds away. A detonation in close proximity to a flock may be useful to disperse wildlife that regroups quickly, such as flocks of starlings.

f) Each aerodrome should coordinate with ATC concerning the use of pyrotechnics.

g) In very dry conditions, proactive fire prevention is needed after a shot is taken. In these conditions, any trace should be followed until it has landed to check it has not ignited the vegetation.

h) Propane cannons (exploders) produce a shotgun sound blast. In general, birds quickly habituate to propane cannons that detonate at random or pre-set intervals throughout the day and they can scare birds into flight paths, creating extra hazard. To ensure they remain effective, cannons should be used only sparingly and only 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. Some systems are designed so that cannons

placed around an aerodrome may be detonated remotely, on demand by radio signal. Such systems are preferable to those on random timers.

Figure 5-3 Propane cannons

i) Propane cannons are the most commonly used audio repellent for deer. However, deer, like most wildlife, will rapidly habituate to their use. Such systems are therefore best implemented infrequently for short-term emergencies (a few days) and should not be relied upon to repel wildlife effectively. Propane cannons are likely to be more useful as a secondary tool provided they are manually operated via remote control. Automated cannons should not be used as this may result in scaring wildlife into a higher risk location as opposed to controlling their departure.

B Distress calls

a) Distress calls are a unique call only given by certain bird species when they have been caught by a predator. Distress calls should not be confused with other calls such as alarm calls and contact calls. Flocking species such as gulls, corvids, lapwings and starlings are the species that tend to have, and therefore respond most positively to, distress calls. Distress call equipment should always be manually operated as static automatic units increase the risk of habituation and have the potential to scare birds into the critical airspace rather than control their movements. The most effective units are vehicle mounted, administered through roof-mounted, forward facing speakers. Hand-held units can also be used. Distress call equipment should always be used from a stationary position, although starlings may be herded using a slowly moving vehicle.

b) With the distress call equipment, the controller is attempting to recreate a scenario where a bird has been caught by a predator. Other members of the species will then investigate the threat as a group and fly to the origin of the call, circling above and trying to ascertain where the potential danger is coming from. Throwing a lure up which resembles a struggling victim, can stimulate a

flock to lift if necessary. Aerodrome operators should be aware that predatory mammals may approach the sound of a distress call as they investigate a possible food opportunity. Volume settings should be natural so they will not attract birds onto the aerodrome from a distance. It is good practice to start the broadcast at a low volume and increase it until the target birds start to respond.

c) When the call is stopped, the remaining birds' instincts are to move away from the danger as a group. They will fly further away from the source of the perceived threat in the direction from which they arrived. Birds will become habituated to distress calls relatively quickly hence they should be used sparingly within a suite of techniques underpinned with lethal control. At the time a distress call is being broadcast, other forms of dispersal should not be implemented as this may confuse the behavioural reaction of the birds in question

C Electronic noise-generating systems

a) Modern technology allows for the use of systems that can emit targeted sounds over very long distances. These long range acoustic devices (LRAD) offer the opportunity to target any sound type at wildlife some distance away. As the use of distress calls is primarily to draw birds towards the sound source their use at significant distances may not be appropriate for an aerodrome. Similarly, the use of 'noise' may startle wildlife but if it is unable to determine where the noise is coming from it may be difficult to control their reaction. Caution is required with the use of long range projection devices to ensure they do not draw birds in from a wider environment.

5.3.3 Visual Repellents

A Presence of humans and vehicles

While there are many visual stimuli that can be used to control wildlife, the most effective tool that elicits a response from hazardous wildlife is often the simple sight of a vehicle or person who implements wildlife hazard management. Wildlife that is consistently harassed within the aerodrome environment will quickly become aware of the approach of a controller and may react if the vehicle stops or a person alights from the vehicle before any control method is implemented. This demonstrates a learned behaviour in that wildlife is aware that control is forthcoming and it will leave before any further threat occurs.

B Visual objects

Most visual repellents are a variation of the scarecrow. Visual repellents such as hawk effigies, silhouettes on kites, eye-spot balloons, flags, reflective tape and lures have short-term effectiveness that are not suitable as long-term solutions to an aerodrome's bird problems. If a system can educate hazardous species that control personnel is on-site, it may have some value as an indicator but it does not generally work as a long-term control method. Displaying dead birds in a "death pose" can scare other birds from entering a specific area by presenting what is interpreted by the birds as a deadly threat. However, species of scavenging wildlife are attracted to dead birds lying on the ground so their use on aerodromes should be carefully considered prior to any deployment.

C Lasers

Certain species of birds perceive the approaching laser beam as a threat, causing the birds to fly away. Lasers are best used at night or at dawn and dusk. Since lasers may present a secondary hazard to pilots or drivers of other vehicles, caution should be exercised. Operator shall follow as specified in Announcement of the Civil Aviation Authority of Thailand on the implementation of activities within the air navigation safety zone B.E. 2563. 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)

D Trained predators

Trained dogs and falcons introduce a predator presence, resulting in a flee response of hazardous wildlife. Proper training for animals and instruction for their handlers will ensure that the animals do not become a strike risk.

E Non-lethal projectiles

Any projectiles can be shot or catapulted toward the targeted species to elicit a flee response. Aerodromes should be aware of any restrictions for using these devices and wildlife personnel should be properly trained to ensure their safe handling.

5.3.4 Trap and Relocate

Hazardous wildlife can be caught and released away from the aerodrome. The aerodrome operator should be aware of local laws and regulations when trapping and releasing hazardous wildlife. If live bait is used, it should be monitored and fed regularly (daily at a minimum). When bait or decoys are used, measures should be taken to prevent additional wildlife from being attracted to the aerodrome.

5.3.5 Chemical Repellents

Figure 5-4 chemical repellents

Non-lethal chemical repellents work by affecting the animal's senses through smell or taste aversion. These repellents may be sprayed on roosting sites, food sources or other gathering areas where hazardous wildlife is present. Certain chemical repellents (e.g. predator urine) may actually attract other hazardous wildlife, and aerodromes should be aware of the impacts of using these repellents. It is important to note that only chemical repellents registered and approved by the proper national, regional and local authorities should be used.

5.3.6 Lethal Control

A All lethal control should be undertaken humanely and safely by management and according to local laws as specified in Wild Animal Reservation and Protection Act, at all times. It is often a national law to ensure that lethal action is only implemented after non-lethal methods have shown to be unsuccessful. Aerodrome personnel should maintain a record of the managed species and those removed through lethal control each year. If injurious and lethal substances or any other techniques are used, they will need to be utilized within national regulations.

B The implementation of lethal action to reduce or eliminate the presence of hazardous wildlife on or around an aerodrome requires understanding the behaviour of the species being targeted. Action to influence and educate wildlife may be needed in full view of all targeted species in order for them to associate lethal action with the presence of a wildlife controller. When habitat management and wildlife repellents fail to reduce risk, the implementation of lethal methods can therefore reinforce the effect of non-lethal techniques. It can also be used to reduce the numbers of hazardous individual animals, remove sick or injured wildlife, or to deal with an immediate risk. In certain circumstances lethal measures

can be used to eradicate an airside population of a species that cannot be educated by non-lethal methods.

C Adults and juveniles can be euthanized using humane methods such as firearms or carbon dioxide gas. Bird eggs may be oiled or addled to prevent hatching or nests can be removed after eggs are laid.

6. The Local Aerodrome Wildlife Committee (Aerodrome Wildlife Hazard Management Committee)

6.1 General

6.1.1 The establishment of an Aerodrome Wildlife Committee is required to facilitate the communication, cooperation and coordination of hazardous wildlife management at and around the aerodrome. This committee might be included within the safety management committee. In place of a dedicated local wildlife committee, the topic may be discussed in an airside or runway safety committee.

6.2 Members of The Committee

6.2.1 Include a representative from each of the key groups and agencies that have a significant involvement or interest in wildlife issues on the aerodrome. aerodrome committee might include representatives from security, maintenance, operations, and air traffic control. From government, representatives from the state wildlife agency, Department of National Park, Wildlife and Plant Conservation might be appropriate. In case of joint-use facility with military aviation, representatives from the military should be included in the committee.

6.2.2 In addition to regular members, invite representatives from any facility near the Aerodrome that significantly attracts wildlife (such as a landfill or wildlife refuge), people with specialized knowledge, interest, or concerns to the meetings as appropriate.

6.2.3 Members of the committee may include, but are not limited to:

a) accountable or senior manager;
b) senior safety or compliance manager;
c) wildlife coordinator or manager;
d) wildlife controller representative;
e) aircraft operator representative;
f) Aerodrome planning manager;
g) aerodrome maintenance and operation manager;
h) ATC representative;
i) active aircrew representative familiar with the aerodrome;
j) local runway safety team representative; and
k) local authorities.

6.2.4 Depending on the organizational structure of the Aerodrome, other representatives can also be included, such as the rescue and firefighting department or the airside operations.

6.3 The Communication, Cooperation and Coordination

6.3.1 The success in the communication and coordination from a local perspective (on and in the vicinity of the aerodrome), is reliant to a large extent on the effective communication of the wildlife threat and recognized control measures adopted and agreed to by the local aerodrome wildlife committee.

6.3.2 Communication between internal stakeholders and users of the aerodrome should go both ways, i.e. the users should have a forum for expressing concerns, raising issues or submitting proposals. This forum may also increase the awareness of stakeholders in reporting wildlife-related incidents and convey the need to include wildlife hazard management in their SMS.

6.3.3 For external stakeholders, the local aerodrome wildlife committee will be mostly advisory, with the opportunity to share input, feedback, and, in some cases, take action aimed to reduce the presence of wildlife in the surroundings of the aerodrome.

6.4 Meetings

6.4.1 At least annually hold a meeting of the committee to conduct a general review of the overall wildlife hazard management program for the aerodrome and to discuss special issues or problems as needed. Include the following in the general discussion:

a) Strike trends and significant strike events
b) Source of wildlife causing strike problems.
c) Wildlife control activities
d) Wildlife Hazard Management Plan evaluation

6.4.2 Special issues to be discussed might include projected impacts of land-use changes on or near the aerodrome, trends in populations or behavior of various species of wildlife, wildlife removal permits, evaluation of new wildlife control technologies, and clarification of roles and responsibilities. A good way to end the meeting might be with a field demonstration of a wildlife management activity on the Aerodrome or a site visit to a nearby wildlife attractant (e.g., sewage treatment facility) that might need addressing.

6.4.3 Special meetings of the entire committee or a working group might be needed after significant strike events or other developments affecting wildlife hazards if a regular meeting is not scheduled for the near future.

6.5 Meeting Reports

6.5.1 Make arrangements to have minutes taken and a summary report written for each meeting. Include in the report a list of attendees, decisions made by the group, deadlines and responsible parties for task assignments, and a list of critical issues that were not resolved.