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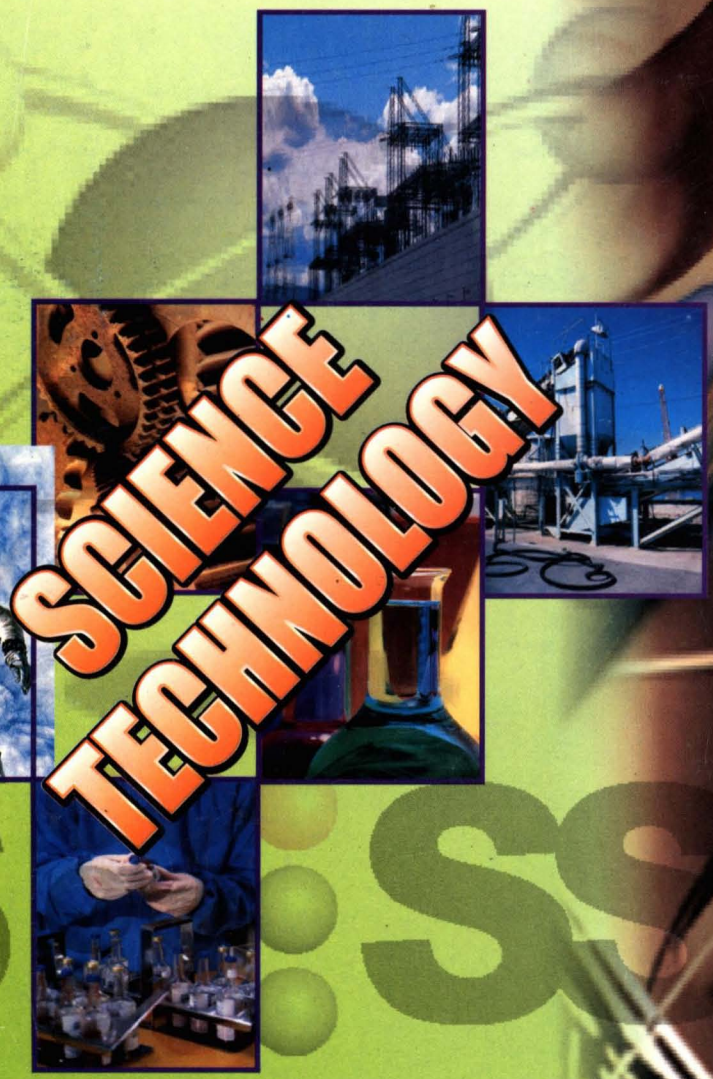

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The Occurrence of Bird-Strike on Aircraft: A Preliminary Study

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ABSTRACT

This paper is a preliminary report of an ongoing study and research of the occurrence of bird-strike on aircraft. According to statistics, almost 90% of the bird-strike happens during aircraft take-off. This could be very dangerous to the aircraft, and might lead to fatal accident if the strike really damages the critical parts of the aircraft. The study involves a survey on the trend of bird-strike near airports, and factors that excites the birds to flock at certain airports. Some common preventive measures to reduce the bird-strike occurrence will be discussed, and recent advances in technology that might further improve the prevention system will be proposed. As this is only a preliminary study, a detailed study in the future should also involve the ornithologists, for us to have better understanding about the bird habits and habitats.

Keywords: *Bird-strike, aircraft safety, preventive system, habitat and ecology*

Introduction

Birds are a serious hazard to aviation. A bird or a flock of birds that suddenly rises from a runway or the surrounding area may collide with incoming or departing aircraft and cause the aircraft to crash, possibly resulting in the loss of human life. Bird collision with aircraft is commonly known as 'Bird-Strike'. Damage caused to aircraft usually results from collision of one or more birds with the engines and/or fuselage (International Bird Strike Committee; Federal Aviation Administration Report on Wildlife Mitigation).

Occurrence of Bird-Strike

During the early days of aviation, when aircraft flew at slow speeds, birds had little difficulty in getting out of the way. Bird strikes were infrequent and damage was mainly confined to cracked windshields. The likelihood of the loss of aircraft and/or human lives was remote (International Bird Strike Committee: *op cite*; Royal Society for Protection Birds, UK); and Federal Aviation Administration Reports: *op cite*). With the development and introduction of jet aircraft, bird strikes have become a serious hazard and costly problem. Faster speeds mean birds have less time to react to approaching aircraft. The force generated by bird impact with a fast-moving aircraft is tremendous. Moreover, the newer turbine engines use light-weight, high speed mechanical parts which are vulnerable to bird strike damage (Anderson 1989; Lombardo 1990; Wild 1996; and Anderson 2003).

The bird strike problem has become more severe over time with crowded airspace, faster aircraft, and significant increases in hazardous bird populations. Globally, since 1990, there have been a minimum of 147 fatalities and over 120 aircraft lost due to bird strikes. It is virtually impossible to accurately calculate the costs of these incidents due to lack of mandatory reporting, differing reporting standards, indirect costs, and commercial interests but by any measure the costs are staggering (Aviation Civil Aircraft Accident Statistics; International Bird Strike Committee: op cite).

Rate of Bird Strikes and Its Cost

From year to year, the rate of bird strikes has significantly increased around the world. It causes substantial losses to the aviation industry in terms of damage and delays every year. While we may never know the total of bird strikes on civil and military aviation that occurred per year around the world, more importantly the potential for injury and loss of life is of greater concern. Furthermore, bird-aircraft strikes put the lives of aircraft crew members and their passengers at risk - over 400 people have been killed as a result of bird strikes over the past 20 years. The major cause for this problem increasing may due to the expanding of the aviation industries and more growing in flight rate in specific months (Aviation Civil Aircraft Accident Statistics : op cite).

For example, in the 14-year period (1990–2003), more than 50,000 bird strikes were reported to the United States Federal Aviation Administration (FAA). The number of strikes annually reported tripled from 1990 (1,739) to 2000 (5,979). For the recent years, FAA records an average of over 6,000 bird strikes per year to the civil aviation industry, including direct and associated costs at a minimum of $97.9 million per year. The estimates direct costs to the industry between $64 and $127 million US dollars annually from over 900 reported strikes per year and an estimated 30% unreported strikes (Federal Aviation Administration Report on Wildlife Mitigation : op cite; Canadian Civil Aviation Report in Wildlife Control).

The US Air Force (USAF) reporting rates are considered much higher than in the civilian sector due to mandatory reporting requirements. The USAF annually records approximately 4,000 bird strikes and direct costs of over $25 million. The USAF has recorded 22 lost aircraft and 33 fatalities since 1985. The steady increase in reports for 1990 to 2000 was the result of several factors: 1) an increased awareness of the wildlife strike issue, 2) an increase in aircraft operations, 3) an increase in populations of hazardous wildlife species, and 4) an increase in the number of strikes (Federal Aviation Administration Report on Wildlife Mitigation : op cite).

Meanwhile in Malaysia, for 1998 and 1999, there were 86 bird strikes reported by the Malaysian Airlines System. In 1998 alone, there were 30 bird strikes reported while in 1999 the incidents increased more than 50% to 56 bird strike reported. The increasing in reports on bird strike incidents may be caused by increases in numbers of flight and also lack of bird management system in airport (Malaysian Airlines System Bhd. 1998 and 1999 Incident Reports).

Nature of the Bird Strikes – A Preliminary Study

According to the data collected from the reports, most of the strikes recorded show that the incidents happened between 0700 hour and 2200 hour during the day, which was 71 % from total incident per day. The incidents were very high during that period of time because of the aircraft movements were the most frequent. The birds were also mostly active during that period of times to search for foods, water and even migrating. The record also revealed that other strikes occurred at night (23%) and at dusk (5%) and dawn (1%). Figure 1 summarizes the findings (Aviation Civil Aircraft Accident Statistics; International Bird Strike Committee; Federal Aviation Administrative Report on Wildlife Mitigation; Canadian Civil Aviation Report on Wildlife Control).

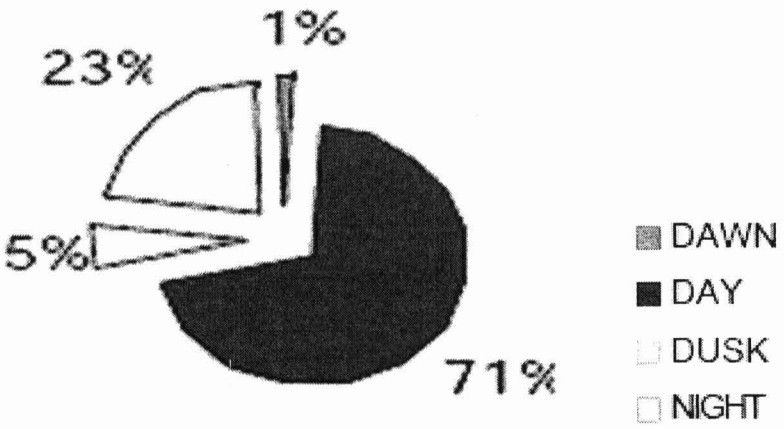


Fig. 1: Time of the Bird Strikes

According to the ICAO data for the period from 1997 to 1998, 54% of the strikes occurred below 100 feet, 12% between 101 and 200 feet, 10% between 201 and 500 feet; that is, 76% of the strikes occurred below 500 feet. The most recent study shows similar results (82.46%). For altitude above 501 ft to 1000 ft only 2% of the strikes occurred, from 1001 ft to 2500 records 10% of the strikes and over 2500 ft the remaining 12%. The study shows similar results (5.5% from 501-1000', 4.26% from 1001-2500' and 7.77% over 2500'). The result is shown in Figure 2 (Aviation Civil Aircraft Accident Statistics; International Bird Strike Committee; Federal Aviation Administrative Report on Wildlife Mitigation; Canadian Civil Aviation Report on Wildlife Control).

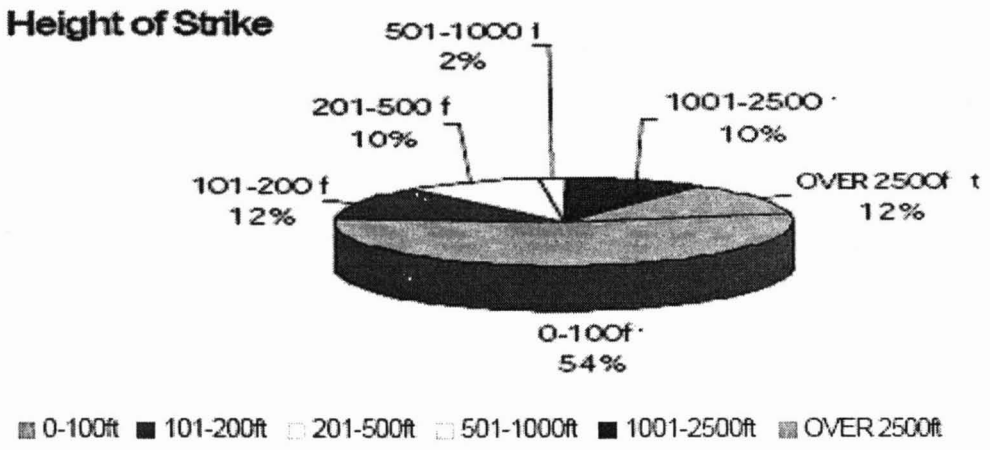


Fig. 2: Height of Bird Strikes Occurrence

Strikes were registered at almost all phases: take-off run (19%), climb (15%), approach (35%) and landing (30%). Only a very low rate of strikes occurred en-route (1%).The most recent study shows take-off run (27.32%), climb (20.24%), approach (32.44%) and landing run (18.78%), en-route (0.24%). The higher rate of strikes happened during aircraft at its lower altitude such as during take-off and approach. This situation is due to the fact that birds fly below 200 feet at the airport area to find the foods, prey and even rest. Another cause for the strike occurrence is, during take-off or approach, aircraft fly at high speed and the birds are easily sucked up into the engine. Figure 3 below sums up the condition (Aviation Civil Aircraft Accident Statistics; International Bird Strike Committee; Federal Aviation Administrative Report on Wildlife Mitigation; Canadian Civil Aviation Report on Wildlife Control).

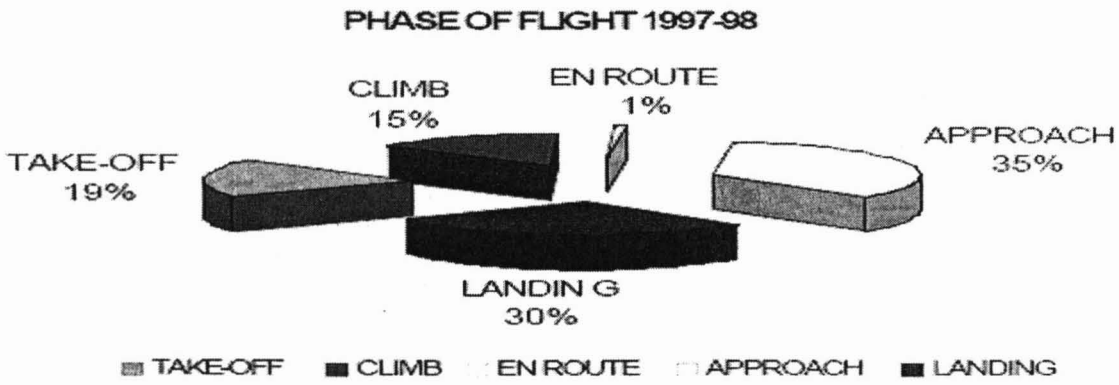
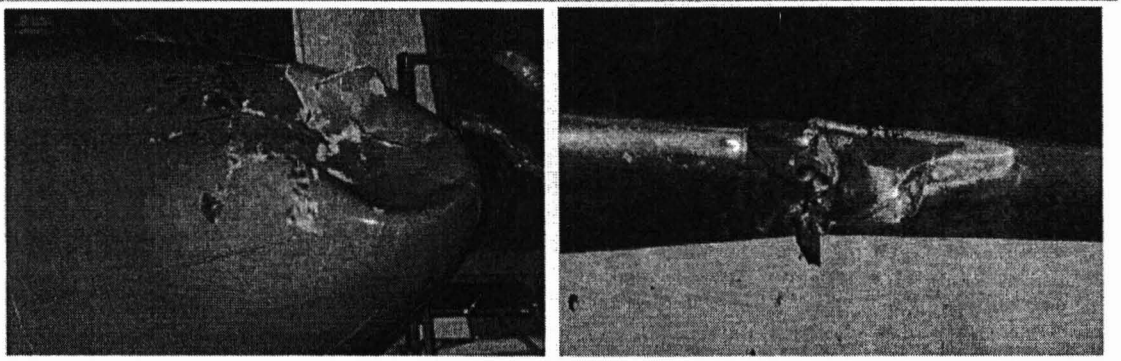


Fig. 3: Phase of Flight with Bird Strikes

Common Damage Caused to the Aircraft

The most common aircraft components reported struck by birds are nose / radome, windshield, engine, wing/rotor, and fuselage.

Aircraft engines are the most frequently damaged by bird strikes (33 percent from all damaged components). From the 7,511 aircraft engines reported as being struck by birds, 34 percent (2,591) were damaged while in the other cases, the engines is still in working condition after going through a costly repairing processes. An example of real case photo of bird-strike impact on aircraft is shown in the pictures below (Lombardo 1999; Anderson 1989; Anderson 2003; Aviation Civil Aircraft Accident Statistics).



A B-737-300 departing a Midwestern USA airport on 26 December 2003 hit a flock of snow geese while climbing through 2,900 feet above ground level (AGL) at 240 knots. The birds damaged the radome, nose, wing, tail, and lights; and part of one bird was ingested into an engine. The aircraft returned to the airport where passengers were rerouted to other flights. The aircraft was out of service for 11 days, and repair costs exceeded $500,000. The snow goose population in North America increased at a mean annual rate of 3.5%, 1980–2002 (Dolbeer and Eschenfelder 2003).

Picture 1: An impact of bird-strike on a B737-300

Factors Attracting Flock of Birds in Airport Vicinity

Airports provide a wide variety of natural and human-made habitats that offer food, water, and cover for the birds. Many airports are located along migratory routes used by birds. One of the first steps in reducing bird hazards is to recognize these attractants. Usually, several attractants acting in combination are responsible for the presence of birds and their behaviours at an airport (International Bird Strike Committee; Royal Society for Protection Birds, UK 1998; Federal Aviation Administration Report on Wildlife Mitigation; Canadian Civil Aviation Report in Wildlife Control).

Food

Birds require relatively large amounts of food. Most airports support an abundance and variety of foods such as seeds, berries, grass, insects, grubs, earthworms, small birds, and small mammals. Seeds and berries are sought by several migratory and resident birds such as sparrows, finches, starlings, blackbirds, mourning doves, common pigeons, and waterfowl.

Geese are attracted to open expanses of grasses. Gulls, starlings, robins, and crows often feed on earthworms on the surface of the ground following a rain. Gulls are opportunistic feeders and frequently feed on grasshoppers and ground nesting birds. Raptors are attracted to airports because of rodents, birds, and other small animals that harboured by tall, poorly maintained grass stands and borders.

Occasionally, food becomes available through careless waste disposal practices by restaurants and airline flight kitchens. Airport personnel have been known to feed birds during their lunch breaks. Many airports have inadequate garbage disposal systems that permit access to various food items. These are a favourite of several species of birds, especially gulls. Nearby landfills or sewage outlets may also provide food for birds and other wildlife.

Landfills are often located on or near airports because both are often built on publicly owned lands. Under these circumstances, landfills contribute to bird strike hazards by providing food sources and loafing areas that attract and support thousands of gulls, starlings, pigeons, and other species. Generally, landfills are a major attraction for gulls, the most common bird involved in bird strikes.

Waste paper, paper bags, and other litter blowing across the ground attract gulls, presumably because litter is mistaken for other gulls or for food. A gull that is attracted to litter decoys other gulls and encourages flocking.

Water

Birds of all types are drawn to open water for drinking, bathing, feeding, loafing, roosting, and protection. Rainy periods provide temporary water pools at many airports. Many airports have permanent bodies of water near or between runways for landscaping, flood control, or wastewater purposes. These permanent sources of water provide a

variety of bird foods, including small fish, tadpoles, frogs, insect larvae, other invertebrates, and edible aquatic plants. Temporary and permanent waters, including ponds, borrow pits, sumps, swamps, and lakes, attract gulls, waterfowl, shorebirds, and marsh birds. Fresh water is especially attractive in coastal areas.

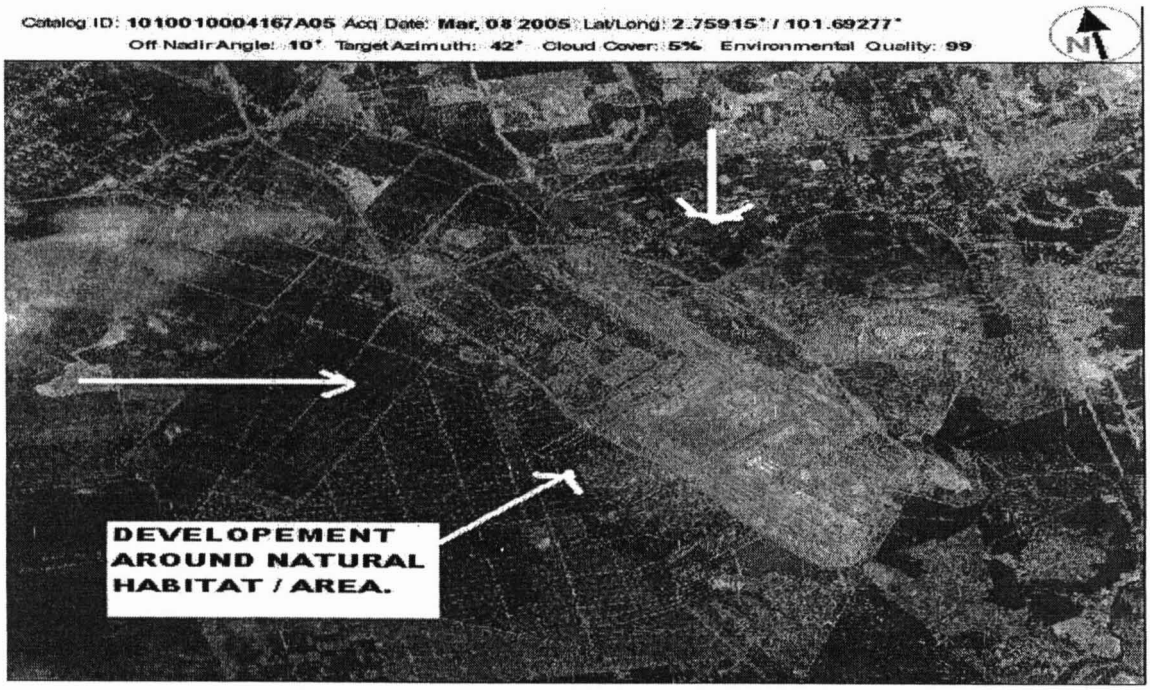
Cover

Birds need cover for resting, loafing, roosting, and nesting. Trees, brushy areas, weed patches, shrubs, and airport structures often provide suitable habitat to meet these requirements. Almost any area that is free from human disturbance may provide a suitable roosting site for one or more species of birds. Starlings, pigeons, house sparrows, and swallows often roost or nest in large numbers in airport buildings or nearby trees, shrubs, or hedges. Large concentrations of blackbirds and starlings are attracted to woody thickets for winter roosting cover. Gulls often find safety on or near runways of coastal airports when storms prevent their roosting at sea, on islands, or on coastal bays.

Migration

Many airports are located along traditional annual bird migration routes. Birds may suddenly appear in large flocks on or over an airport on their annual migration, even when the airport itself offers no particular attraction. Dates of migration vary by species and area. Flock size of a given species may vary widely from year to year depending on time of year, weather conditions, and many other factors.

Local Movements



Shorebirds, waterfowl, gulls, and other birds often make daily flights across airports from their feeding, roosting, nesting, and loafing areas. Airports near cities may experience early morning and late afternoon roosting or feeding flights of thousands of starlings.Picture 2 below shows the case of KLIA, which is built on the habitat that is attractive to birds (Malaysian Airlines System Bhd 1998 & 1999 Incident Reports).

Picture 2: Example of habitat fragmentation, where the development of Kuala Lumpur International Airport (KLIA) was built around the oil plantation farm that attracts birds

Common Preventive Measures

This section will brief on the common measures taken to prevent bird-strikes (Federal Aviation Administration Report on Wildlife Mitigation; Canadian Civil Aviation Report on Wildlife Control).

Habitat Modification and Control Methods

Several habitat management practices can make an airport less attractive to birds. These include eliminating standing water, removing or thinning trees, removing brush and managing grass height. Buildings can be modified to reduce or eliminate roosting or nesting sites. This method should involve the ecology experts, bird specialist, environmentalist and town planner in proposal for any new airports. The main strategies to be taken are 1) grass and vegetation management, 2) drainage, 3) airside building and structure, 4) active control, 5) amenity planting, 6) building design, and 7) control of water.

In opening new airport, safeguarding of future developments will be critical, to ensure that the bird hazard is not worsened around the airport. In addition to the easily recognized attractions, such as landfills, scrutiny should be given to applications which are likely to increase the number of trees and bushes in the vicinity of the airport, as well as any areas of open water. It will also be necessary to scrutinize changes to the nature reserves and designated areas around the airport which require planning permission to implement, should habitat improvement be proposed for these areas.

Detection Method

This method is to install detection and early warning system or mechanism in the airport. Signal or information from the system should be made available to all aircraft in the airport vicinity. One of the methods is the installation of aircraft bird strike avoidance radar. This method is proven effective, but incurred high investment cost.

Frightening Methods

Frightening is a reliable and expeditious means of repelling birds. Frightening programmes, however, provide only temporary relief and require constant monitoring. An early priority in reducing bird hazards is to establish a bird dispersal patrol team to harass and scare birds and provide immediate protection for aircraft within the airport perimeter. Frightening methods inclusive of distress calls and alarm calls to scare birds away.

Pyrotechnic Methods

Pyrotechnics are highly recommended for bird dispersal at airports. This technique can be extremely effective when used as part of a well-balanced and dynamic wildlife-management plan. Pyrotechnics include various ammunitions that are fired from shotguns, starter and flare pistols, and purpose-built pyrotechnic launchers. They include shell crackers, flares, firecrackers, rockets, and mortars. The loud and abrupt noise emitted by some pyrotechnics is similar to that of shotguns, making them particularly effective against game birds that are familiar with the effects of weapons.

Some pyrotechnics also involve flashes of light, providing a visual as well as an auditory deterrent. Some devices travel 25 to 300 metres before exploding in a flash of bright light. Others travel as far as 100 metres while emitting a continuous screaming or whistling noise. This method is preferred by most naturalist or wild-life protectionists. One of the effective methods is the sonic bird-chaser that mimics the sound of owl or hawk to deter small birds away from the airport.

Shooting

Shooting birds with shotguns or rifles can be a highly selective and useful form of hazard control under certain conditions. Federal, state, and possibly municipal permits are required. Shooting has been used to reduce hazards caused by birds that habitually fly over airport runways. For example, at the Tawau airport, shooting is the best method to reduce bird strike. Caution must be used so that shooting does not disturb non target species. Shooting is not practical or desirable as a method for reducing large numbers of birds. The use of shooting to reinforce frightening techniques can be effective and should occur simultaneously with the scare devices often enough to maintain fear in the birds. In most cases, an integrated approach that incorporates several frightening devices will produce the best results. As expected, this method invites constant protest from the environmentalist and bird conservationists.

Discussion

From this preliminary study and report, we can understand the importance of airport design and management in term of natural habitats of birds. Bad or insensitive design or management of airport can invites massive bird strikes that could lead to disaster. The best preventive methods should be a holistic approach, and the team should include the ornithologists, ecologist, environmentalist, town planner, engineers and scientist. The team should propose from the initial stage of airport development, from locating suitable area (to avoid natural bird paths or habitats), to the building design, landscaping, airport systems and deterring methods. This area itself can be a good research area for all the said experts. Therefore, further collaborative research involving multi-discipline experts should be encouraged.

Conclusion

Bird-strike on aircraft is a real and serious matter, and further studies in this area are critical. Future research should be a multi-disciplinary study involving various experts as mention earlier. Inclusion of this topic in teaching of engineering, ecology, environmental, town planning and zoology subjects should be one of the options.

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