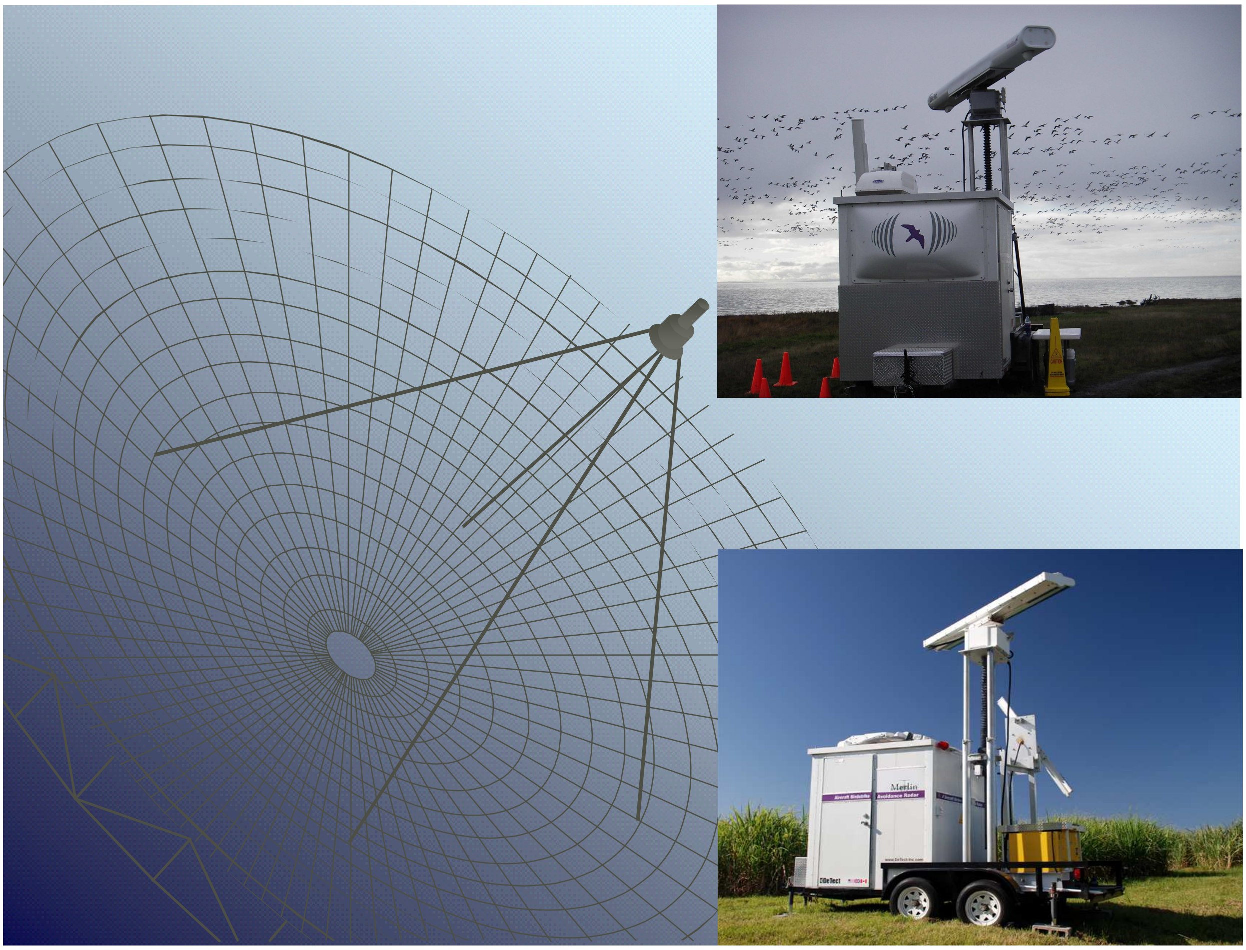
DRAFT SWALLOW MONITORING AND BIRD AIRCRAFT INTERACTION

April 2007



Albert Froneman
Airport Wildlife Hazard Management Project
Endangered Wildlife Trust
P Bag X11, Parkview, 2122
Tel: +27 (0)11 486 1102
Fax: +27 (0)86 671 0205
email: albertf@ewt.org.za

Jon Bortle and Ron Merritt
DeTect Inc.
3160 Airport Road,
Panama City,
Florida 32405 USA
email: jon.bortle@detect-inc.com
email: ron.merritt@detect-inc.com

Executive Summary

It is widely recognised that bird strikes pose a serious safety risk to the international aviation industry. It has therefore recently become a legislative requirement for airports to have a management plan in place to deal with bird hazards and minimising the occurrence of bird strike incidents.

Data from a specialised bird detection radar study and the bird surveys done at the proposed La Mercy airport site was used in conjunction with known bird strike statistics from ACSA airports and more specifically Durban International Airport to evaluate the potential bird strike risk. The Barn Swallow roost site to the south of the proposed La Mercy airport also deserved specific attention as it poses a potential aviation safety risk.

General bird strike risk:

Based on the species recorded at the proposed La Mercy airport site it is clear that a species profile comparable to that found currently at Durban International Airport occurs there and it can therefore be expected that a similar bird strike risk could exist. 10 potentially high risk species were identified and specific mitigation measures were recommended. The potential overall bird strike risk could however be mitigated by an integrated bird and wildlife management programme. Consideration must be given to bird hazard management implications throughout the design and construction phases of the airport. Bird hazard management should therefore be an integral part of the environmental management plan that will be developed following the EIA process. Given that the correct measures are implemented right from the beginning the proposed airport could have a significantly reduced bird strike risk compared to the current Durban International Airport.

Barn Swallow swarms – bird strike risk

Surveys conducted at the Mount Moreland reedbed to the south of the proposed La Mercy airport concluded that the Barn Swallow swarms gather above the reedbed in the late afternoon around dusk. The surveys including the bird detection radar aimed to determine the number of birds present at the site and most importantly from an aviation safety perspective the height at which the swarms fly above the reedbed – i.e. whether they pose a potential risk for approaching and or departing aircraft. Detailed radar data analysis indicated that there are times that the swallows do penetrate the approach path of aircraft. Such events occur most commonly during the early morning departures from the reedbed roost site. The early morning dispersals happen mostly before any scheduled aircraft arrivals or departures i.e. earlier than 06:00 in the morning – thus further limiting the potential risk. The late afternoon swarming behaviour took place mostly below the aircraft approach paths. The swallows did however on a few isolated occasions fly at higher altitudes but only under certain weather conditions and only a small proportion (less than 5%) of the birds flew at such high altitudes and these events lasted for a very short time (10 min). It was also found during radar demonstrations done at the current Durban International Airport that a swallow roost exists there in close proximity (<1000m) of the main runway – yet these birds have never posed a threat to aircraft operating there.

It can therefore be concluded that a co-existence model between the swallows and the proposed La Mercy airport is definitely possible. In light of available technology i.e. radar which can be incorporated into the operational plan of the airport aircraft can be warned and be in a position to take precautionary measures e.g. delay a departure or landing as is currently common practise for weather events during the few occasion when swallows could pose a risk.

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This chapter provides an overview of the bird species diversity and abundance at the proposed La Mercy Airport site in relation to the risk posed to the safe operation of aircraft. The bird surveys conducted since 2004 provide a comprehensive overview of bird species and abundance at the proposed La Mercy site. It is however important to note that the species diversity and abundance recorded at the site could change significantly over time as the airport and associated surrounding development alters the available habitat types. The way in which the habitat is changed as a result of the development both on and around the airport will have important implications regarding the bird species most likely to be found at the site. It is therefore important to ensure continuous involvement in the development process to ensure that little or no bird attractive areas are created at or in the vicinity of the airport!

In the case of the new proposed La Mercy airport, data exists of bird presence and abundance on the site as well as bird strike information collected at the nearby Durban International Airport. Given the bird presence and abundance at the new site and the bird strike history of Durban International airport the potential risk at La Mercy can be estimated, assessed and appropriate remedial measures proposed which could be highly effective if implemented as part of the design and construction of the airport.

1. Background

It is widely recognised that bird strikes pose a serious safety risk to the international aviation industry. It has therefore recently (ICAO, 2004) become a legislative requirement for airports to have a management plan in place to deal with bird hazards and minimising the occurrence of bird strike incidents.

The International Civil Aviation Organisation Annex 14 – Aerodromes: Volume 1 Aerodrome design and operations lists the following relevant standards for bird hazard reduction. Being standards it is required for ICAO member states to comply herewith.

9.4 Bird hazard reduction

9.4.1 The bird strike hazard on, or in the vicinity of, an aerodrome shall be assessed through:

a) the establishment of a national procedure for recording and reporting bird strikes to aircraft; and

b) the collection of information from aircraft operators, airport personnel, etc. on the presence of birds on or around the aerodrome constituting a potential hazard to aircraft operations.

Note.— See Annex 15, Chapter 8.

9.4.3 When a bird strike hazard is identified at an aerodrome, the appropriate authority shall take action to decrease the number of birds constituting a potential hazard to aircraft operations by adopting measures for discouraging their presence on, or in the vicinity of, an aerodrome.

> 9.4.4 The appropriate authority shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome unless an appropriate aeronautical study indicates that they are unlikely to create conditions conducive to a bird hazard problem.
>
> *Note.— Due consideration needs to be given to airport operators' concerns related to land developments close to the airport boundary that may attract birds/wildlife.*

It is estimated that birds cost the world-wide aviation industry more than US$ 1 billion per year (Short and Kelley, 1998; Allan, 2000). In addition, the risk of loss of human life (Burger, 1983; Leshem and Bahat, 1999) as a result of bird strikes makes an understanding of this conflict critical.

Most bird strike occurrences occur near to ground level during the critical take-off or landing phases of operation (Stables and New, 1968; Meyer and Boulter, 1973). Most bird strikes therefore occur within the airport perimeter or in its immediate surroundings.

Bird strikes with aircraft are also a concern in South Africa. The Airports Company South Africa Bird Strike Occurrence database indicates that since 1999 a total 1899 bird strikes have occurred at its ten airports. However only 7.5% of these occurrences led to damage to aircraft, one of which led to the aircraft being written off but fortunately no human lives were lost. Durban International Airport experienced a total of 555 bird strikes since 1999 (33% of the total incidents).

In order for airports to manage the ever present bird strike risk effectively, an ongoing risk assessment process need to be in place to identify the major hazards and establish the most cost effective means of reducing that risk on an ongoing basis (Allan, 2000).

2. Methodology

The bird surveys conducted since 2004 (Piper 2006) were used to determine the most abundant high risk bird strike species known to occur at the proposed La Mercy airport site.

When establishing an effective bird hazard management programme for a new airport it is important to know which bird species can and will occur at the proposed airport. There are three potential sources of bird species: the species currently found at site, the species that could be attracted to the new airport's airfield and its associated infrastructure and surrounding land use changes and those species which only over-fly the airport. Potential high risk bird strike species were classified according to these groups and potential mitigation measures discussed.

To asses the potential bird aircraft interaction at the proposed La Mercy airport the bird strike data for all ACSA airports were reviewed and more specifically those which occurred at Durban International to determine the species most commonly struck by aircraft. The species known to occur, or overfly the proposed la mercy airport were then rated in terms of their likely bird strike risk. The high risk species were discussed in more detail.

The Barn Swallow roost site to the south of the proposed La Mercy airport also deserved specific attention as it poses a potential aviation safety risk. Large numbers of Swallows are known roost at the site between November and April each summer. The birds gather in the late afternoon and form dense flocks that swarm about above the reeds before they drop down to roost in a dense reedbed. Flocks of swallows also again depart from the reedbed in the early morning. Regular swallow counts and height estimates were conducted at the site since the summer of 2004. To further understand the behaviour of the Barn Swallows at the Mt. Moreland roost area, a bird detection radar study was conducted. The Merlin bird detection radar was deployed by DeTect, Inc., of Panama City, Florida, USA, along with two radar ornithologists who have extensive experience in the use of radar systems for bird detection and aircraft bird strike issues. The Merlin radar used at the site is a dual radar system using a 10kw X-band vertically scanning radar for altitude sampling and a 30 kW S-band radar oriented for horizontal tracking of birds across the landscape. The radar began data collection on February 12, 2007. In the first phase of the study, the radar was placed at three different sites aimed at providing the best estimates of bird dynamics at the reed bed and associated with the proposed runway platform. Site one (12 -21 Feb) was located near the reed bed (29° 38' 29.06" S; 31° 05' 08.64" E), at approximately the same ground level as the reed bed. Site two (21 Feb – 6 Mar) was located on a hill side (29° 38' 11.21" S; 31° 05' 45.94" E) approximately 850 meters from the reedbed. Site three (7 – 14 Feb) was located at approximately the same level as the proposed runway (29° 37' 34.66" S; 31° 06' 21.77" E) 2600 meters away from the reedbed. See Figure 1 for radar locations. Each of the two radars collects data at a rate of approximately 20 revolutions per minute. During this phase, the radar made approximately 1.6 million observations of the airspace above the sites.

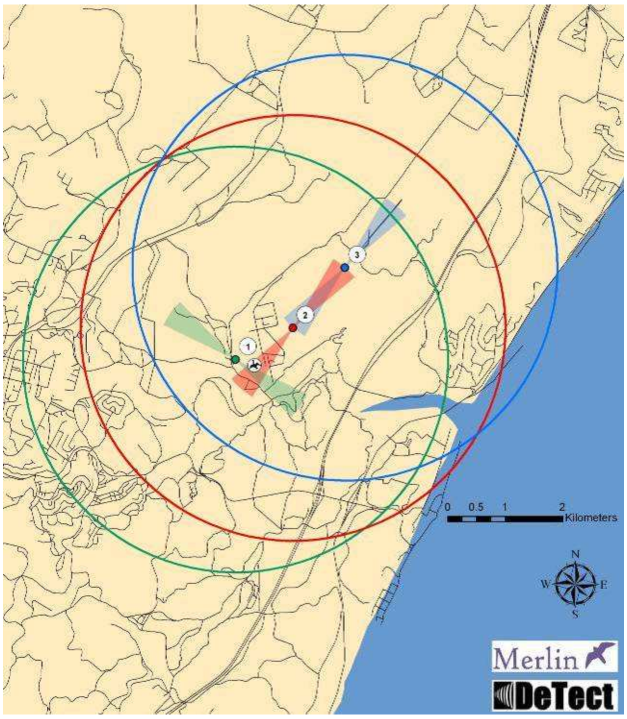


Figure 1: Site locations where radar data were captured from.

The abundance and occurrence of bird species currently found at La Mercy could change dramatically as the new airport is constructed and this change will be in response to the potential new habitats being created as a result of the construction. Naturally, one of the aims of a wise design will be to minimise the attractiveness of the final airport to birds, especially those bird species which are likely to pose a bird strike risk.

3. Findings & results

a) Bird strike data

The ACSA bird strike database contains data on all bird strike occurrences reported at ACSA airports since 1999. A bird strike is deemed to have occurred when:

- A pilot reports striking one or more birds.
- Aircraft maintenance personnel identify aircraft damage as having been caused by a bird strike.
- Personnel on the ground report seeing an aircraft strike one or more birds.
- Bird remains, whether in whole or in part, are found within 60 meters of an aircraft manoeuvring area, unless another reason for the birds' death is identified.

Table 1: Bird species involved in bird strike incidents between 1999 and 2006 at all ACSA airports and Durban International Airport. Species in bold have been recorded at La Mercy.

Species	Bird Strikes	
	All ACSA Airports	Durban International
Unknown	605	136
Swallow species	334	132
Lapwing species	308	16
Hadeda Ibis	133	23
Helmeted Guineafowl	80	-
Owl species	76	12
Birds of prey	74	47
Pigeons & Doves	74	2
Gull species	70	1
Thick-knees	33	2
Grassveld Pipit	32	20
Black-headed Heron	30	22
Northern Black Korhaan	23	-
Sacred Ibis	12	3
Orangethroated Longclaw	9	-
Spur-winged Goose	4	-
Egyptian Goose	2	1
Total:	**1899**	**417**

Table 1 lists the bird species reported as being involved in bird strike occurrences at all ACSA airports between 1999 and 2006 (O R Tambo International (Johannesburg), Cape Town International, Durban International, Port Elizabeth, East London, George, Bloemfontein, Kimberley, Upington and Pilanesberg). The large number of unknowns is as a result of incidents only reported by pilots who did not see the bird or could not identify it based on the speed at which the aircraft was travelling – no bird remains were collected from such incidents either.

The surveys conducted at the proposed La Mercy airport site indicates that 227 bird species were found to occur at the site (*See avifaunal specialist report*). 54 species (24%) were heavier than the 200g threshold which is regarded as having the potential to pose a danger to aircraft engines when ingested. Engines are however certified to withstand an ingestion of a 4 pound (1.8kg) bird and continue to provide enough thrust (Transport Canada, 2004). Of these heavier species 10 were identified as having a potential bird strike risk. Most of these species are currently also of concern at Durban International Airport where they are regarded as high risk bird strike species.

The surveys conducted since 2004 lists several species as overflying the site. Certain species might not use the actual site but could move over the area on a daily basis between roosting and/or feeding sites. It is therefore important to include such overflying species as they could potentially pose a bird strike threat if they continue to move regularly over the site. Based on the frequency of being observed over the site and the weight of the species potential bird strike risks were assigned (see Table 2).

The bird monitoring conducted since 2004 focussed only on the proposed La Mercy airport site. Monitoring did not extend far beyond the boundaries of the site apart from the Barn Swallow roost at the Mount Moreland reedbed, other bird concentrations / suitable habitat in the vicinity of the airport site were therefore not as thoroughly assessed. In the event of the proposed La Mercy airport development going ahead this shortcoming should be addressed as part of the environmental management plan. Based on the data collected regarding birds over flying the site there does however not seem to be a direct flyway of any particular species across the site. The bird detection radar study also indicated that there were no large concentrations of birds overflying the site during it's observation period apart from the Barn Swallows departing from and returning to their reedbed roost site.

Given that the habitat availability both on and around the proposed airport site could change quite significantly over time it is recommended that an area with a 10km radius around the airport be assessed on an ongoing basis during the construction phase and eventual operation of the airport for bird concentrations. Concentrations of species which could move onto the airfield should be noted and where necessary and applicable the local attractant be addressed or the bird hazard management programme at the airport should be altered to address such a potential influx.

The construction of the proposed airport and the associated surrounding developments will inevitably result in new habitats being created. Certain bird species which could potentially pose a risk to aircraft may in fact be attracted to the newly created habitats. The South Africa Bird Atlas Data (Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997) was used to predict which species could potentially move into the area given the known habitat changes that would occur. Every effort should however be made to not create habitats that would attract hazardous bird species to the area. Such species were included in the bird strike risk analyses for the proposed La Mercy airport (see table 2).

Table 2: Bird Species which should be considered as a potential bird strike risk at the proposed La Mercy airport.

Species	Weight (g)	Status / Frequency of recording	Bird Strike Risk significance	Flocking behaviour	Currently on site	Overflying	Transformed – operation airfield	Mitigation measures
White Pelican	12000	Rare	Low	Yes	No	Yes	No	Overflying only – Little or no active intervention possible to
Grey Heron	1750	Uncommon	Low	No	Yes	Yes	No	Remove all areas of standing water – easily scared away when present
Black-headed Heron	1750	Frequent visitor	High	No?	Yes	Yes	Yes	Minimise taller grass areas and disturbance events such as grass cutting. Easily scared away when present
Cattle Egret				Yes	Yes	No	Yes	Minimise disturbance events such as grass cutting which will attract these birds. Groups can be difficult to scare away.
Woolly-necked Stork	1750	Common	Medium – High	No?	Yes	Yes	Yes	Prevent areas of standing water with adjacent flooded short grass areas. Easily scared away.
Sacred Ibis	1700	Infrequent visitor	Medium	Yes	Yes	Yes	Yes	Prevent open temporary waste storage facilities and flooded areas. Flocks can be difficult to scare away.
Hadeda Ibis	1350	Common	High	Yes?	Yes	Yes	Yes	Eliminate moist short grass areas. Groups can be stubborn and difficult to scare away.
White-faced Duck	750	Rare	Low – medium	Yes	Yes	Yes	No	Eliminate areas of standing water
Egyptian Goose	2500	Frequent visitor	Medium – high	Yes	Yes	Yes	Yes	Eliminate standing water and associated short grass areas. Easily scared away.
Yellow-billed Duck	1100	Frequent visitor	Low – medium	No	Yes	Yes	No	Eliminate areas of standing water
Spur-wing Goose	5500	Common	High	Yes	Yes	Yes	Yes	Eliminate standing water and associated short grass areas. Easily scared away.
Yellow-billed Kite	875	Common migrant	High	No	Yes	Yes	Yes	Prevent open waste storage sites. Generalist feeder that often flies over airfields. Difficult to scare away.
Black-shouldered Kite	275	Frequent visitor	Low	No	Yes	Yes	Yes	Minimise suitable habitat for rodent prey in airfield grasslands. Place bird anti-perching spikes on potential perches. Easy to scare away.
Long-crested Eagle	1100	Common	Low – medium	No	Yes	Yes	Yes	Minimise suitable habitat for rodent prey in airfield grasslands. Place bird anti-perching spikes on potential perches. Easy to scare away.
Steppe Buzzard	875	Common migrant	Medium – High	No	Yes	Yes	Yes	Minimise suitable habitat for rodent prey in airfield grasslands. Place bird anti-perching

								spikes on potential perches. Easy to scare away.
Lanner Falcon	825	Infrequent visitor	Medium – High	No	Yes	Yes	Yes	Minimise suitable habitat for rodent prey in airfield grasslands. Place bird anti-perching spikes on potential perches. Easy to scare away.
Blacksmith Lapwing	165	Not recorded	Medium – High	No	No	No	Yes	Minimise moist short grass areas. Groups can be stubborn and difficult to scare away.
Spotted Thick-knee	500	Rare	Low – Medium		Yes	No	Yes	Minimise bare soil areas with spare grass cover. Relatively easy to scare away during day – but most active at night. Attracted to insects around lights.
Feral Pigeons	425	Rare	Medium	Yes	Yes	Yes	Yes	Prevent establishment of suitable roosting / perching space on buildings / hangers on and around airport.
Spotted Eagle Owl	750	Rare	Low	No	Yes	No	Yes	Minimise suitable habitat for rodent prey in airfield grasslands. Place bird anti-perching spikes on potential perches. Easy to scare away. Nocturnal.
Little Swift	27.5	Common	Low	Yes	Yes	Yes	Yes	Flocks could forage over airfield grasslands for insects. Difficult to scare away.
Barn Swallow	22.5	Common migrant	Medium	Yes	Yes	Yes	Yes	Flocks could forage over airfield grasslands for insects. Minimise insects in airfield vegetation as much as possible. Potential threat is flocks of swallows perch on the runway surface.
Pied Crow	575	Common	Medium / Low	No	Yes	Yes	Yes	Prevent open waste storage sites. Generalist feeder that often flies over airfields. Could be difficult to scare away. Very agile seldom involved in bird strikes.
White-necked Raven	850	Common	Medium / Low	No	Yes	Yes	Yes	Prevent open waste storage sites. Generalist feeder that often flies over airfields. Could be difficult to scare away. Very agile seldom involved in bird strikes.

b) Description of high risk species and proposed mitigation measures

It is estimated that the following subset of species will pose the most significant bird strike threat at the proposed La Mercy airport.

Black-headed Heron — Red data book status: n/a

During the bird surveys done at the La Mercy site Black-headed Herons were not regularly reported. Given that the construction of the airport could create suitable habitat for these birds it is envisaged that these birds could, as is the case at the current Durban International Airport, become a bird strike risk. Black-headed Herons prey on large insects, small reptiles and rodents in grasslands. Care should therefore be taken to minimise the potential food sources of these birds in the vegetation planted on the airfield. Although they are usually seen on their own they have been known to occur in small groups at Durban International Airport especially during grass cutting activities when food is more readily available. Their slow flight pattern increases the risk of being struck by an aircraft.

Woolly-necked Stork — Red data book status: Near threatened

Woolly-necked storks were recorded fairly regularly at the La mercy site. Although being generalist feeders they prefer to forage in close proximity to water, or moist grasslands and then rest in open short grass areas. Care should be taken to avoid suitable habitat for these birds both on and in areas nearby the airport. The slow flight behaviour of storks further increases their risk of being struck by an aircraft.

Hadeda Ibis — Red data book status: n/a

Hadeda Ibises are attracted to moist short grass habitats where they forage by probing with their long beaks in the soft soil surface for invertebrates. Local influxes of these species occurred at the end of winter early summer when feeding conditions became more favourable in selected areas on the site but more so in the surrounding lands. Given that these birds were regularly reported as overflying at the site it is envisaged that they could become a significant bird strike threat if suitable moist short grass habitat is going to be created. Care should therefore be taken to limit or prevent the establishment of any suitable habitat for these birds.

Egyptian Goose — Red data book status: n/a

The Egyptian Goose is a large heavy bird that favours open short grass areas to forage on. Largish flocks can gather at favoured sites. These birds, although not as common as the larger Spurwinged Goose were recorded in the area. No areas of open water should be allowed. Care should also be taken to not create suitable areas for these geese in close proximity to the airport. Given their close association with human habitation is can potentially be expected that their numbers will increase when more and more development takes place at and around the airport.

Spur-winged Goose — Red data book status: n/a

These large heavy geese were reported fairly regularly as overflying during the bird surveys at the site. Given their large size and heavy mass they can be considered as a significant bird strike risk. Similar to the Egyptian geese they prefer grasslands, usually with water nearby. Potential suitable habitat for these birds must be eliminated both at the airport and in surrounding areas.

Black / Yellow-billed Kite Red data book status: n/a

Kites are opportunistic birds of prey that pose a significant bird strike threat at several African airports. Locally they are summer visitors, present for eight months of the year. They tend to fly slowly over any habitat in search of food, either actively hunting for prey or scavenging. Once they start realising that the airport is a potential source of food, be it for example insects, other invertebrates, bird strike remains or amphibians that crawl onto the runway surface they will regularly visit the site to quarter over the fields and or runways and taxiways in search of food. They are extremely difficult to scare away.

Steppe Buzzard Red data book status: n/a

A Palaearctic migrant that is present for 4 – 5 months of the year. Being a sit and wait predator they are less of a threat than the Yellow-billed Kites that fly around constantly but they are still sometimes a nuisance when they soar over approach or departure paths.

Lanner Falcon Red data book status: Near threatened

Lanner falcons have become a significant bird strike risk at the nearby Durban International Airport. Several resident pairs in the area breed annually and their youngsters and other suspected nomadic juveniles are often seen on the airfield. They favour the open grasslands where they hunt small birds. Often they will perch on the runway surface or nearby airfield infrastructure. Care should be taken to not attract pigeons to the surrounding light industrial areas which will attract adult lanner to the area, where after they might become resident. The airfield itself should also not provide a prey base for either adults or juvenile Lanner Falcons.

Lapwings

During the bird surveys conducted at the proposed La Mercy site no Lapwings were recorded. The South Africa Bird Atlas data for the area indicates a 60% reporting rate for Blacksmith lapwings (Harrison, Allan, Underhill, Herremans, Tree, Parker & Brown, 1997). Although other Lapwing species, Crowned and Blackwinged have also been reported they are far less abundant – therefore not posing a threat. The situation should however be monitored continuously to detect any potential influx as a result of changes in available habitat should the proposed airport be constructed.

Blacksmith Lapwings favour short grass areas preferably in close proximity to water. Care should be taken to minimise short grass areas in association with wetlands on or around the airfield. Once established in an area lapwings can become very territorial and as a result difficult to scare away.

Barn Swallows Red data book status: n/a

The pattern of occurrence at La Mercy of Barn Swallows is extremely interesting because the population shows a massive peak in November, at about 8500 individuals counted over the grasslands of La Mercy in 2004 and about 5200 in November of 2005.

Further observations conducted during 2006 indicated that large numbers of swallows move over the grasslands at the proposed La Mercy site en-route to the reedbeds during cloudy conditions when a south-easterly wind blows.

The number of Barn Swallows drops away during the summer but then builds up again as autumn approaches. The numbers peaked during April 2005 at nearly 6000 just before the Barn Swallows departed on their northerly migration.

Careful consideration therefore needs to be given regarding the vegetation used on the airfield. It is imperative that the vegetated areas harbour as little as possible insect food sources for birds. This will limit the attractiveness of the site for many species but most importantly the flocks of swallows.

Another important consideration it the fact that the swallows, if they are to feed over the airfield, could end up perching on the warm runway surface in the late afternoon or during adverse weather conditions. Such a carpet effect of perched birds on the runway could pose a significant bird hazard. When the swallows start perching in large numbers on the runway it is extremely difficult if not impossible to scare them away.

c) Bat hazards:

Radar observations as well as visual observations confirm a moderate level of bat activity in the vicinity of the Mt. Moreland reedbed and the proposed runway platform. Bat activity usually increases during sunset hours and continues to early morning hours with peak activity usually between 22:00 and 24:00 hours. Bat activity ranges in altitude from near ground level to over 1,300 meters above ground level. This distribution will put bats in potential conflict with aircraft operations for brief periods of time. However, the low density of the bat distribution as well as the low mass of the animals results in bats presenting a very low aviation safety risk. There are fewer than five bat strikes reported at airports in South Africa, none of which have reported any damage.

d) Overall bird strike risk evaluation at the airport:

Durban International Airport has always been known to have a high bird strike risk profile. Based on the species recorded at La Mercy during the detailed surveys it is clear that a comparable species profile occurs there and it can therefore be expected that a similar bird strike risk could exist. Such a risk could however be mitigated by an integrated bird and wildlife management programme. Consideration should be given to bird hazard management implications throughout the design and construction phases of the airport. Bird hazard management should therefore be an integral part of the environmental management plan that will be developed following this EIA process. Given that the correct measures are implemented right from the beginning the proposed airport could have a significantly reduced bird strike risk compared to the current Durban International Airport.

Given the above scenario regarding bird strike risk an integrated bird hazard management program with dedicated staff is recommended for the La Mercy airport. Such a program should be tailor made for the airport as part of the environmental management plan for the airport construction and ultimate operation.

Vegetation management plan

The vegetation establishment and ultimate vegetation management plan at the proposed La Mercy airport will be key to addressing the bird strike risk. The current patches of grassland vegetation on the runway platform are of a very low diversity and carry a very low biomass. Ideally such vegetation structure must be encouraged in areas adjacent to the proposed airport runway as the bird surveys have indicated that it supports very few bird species.

Fulltime bird hazard control unit in operation at the airport

In a similar fashion to the unit in operation at the current Durban International Airport a fulltime bird hazard control unit with sufficient staff to cover all daylight hours seven days a week will be required.

Specific mitigation measures in relation to the swallow roost are discussed in greater detail below, the management of the swallow roost should however also form part of the integrated management plan.

4. Potential impact of the Barn Swallow roost at Mount Moreland on the safe operation of aircraft into the proposed La Mercy Airport

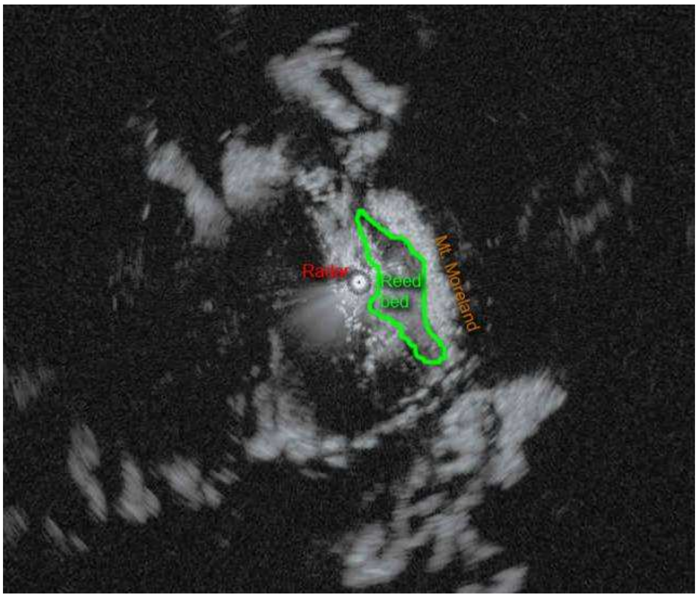
Detailed observations have been done at the Mount Moreland swallow roost since the 2004 summer season. These weekly observations (during the summer months when the swallows were present at the site) were done to determine when the swallows arrive and depart, to estimate the number of swallows using the roost site and to estimate the height at which they swarm before dropping down to roost in the reedbed. During the early part (Feb – April) of 2007 a bird detection radar system was deployed at the site to conduct a more detailed assessment of the swallows (See Figure 2 and 3 for radar imagery).

Given that the Mount Moreland swallow roost lies directly underneath the approach / departure path of the proposed La Mercy airport's runway it is imperative that a thorough understanding exists regarding the foraging, dispersal and roosting behaviour of the swallows as this could potentially effect the safe operation of aircraft. Concerns exist especially regarding aircraft approaching the runway from a southerly direction when the aircraft would be at it's lowest over the reedbed.

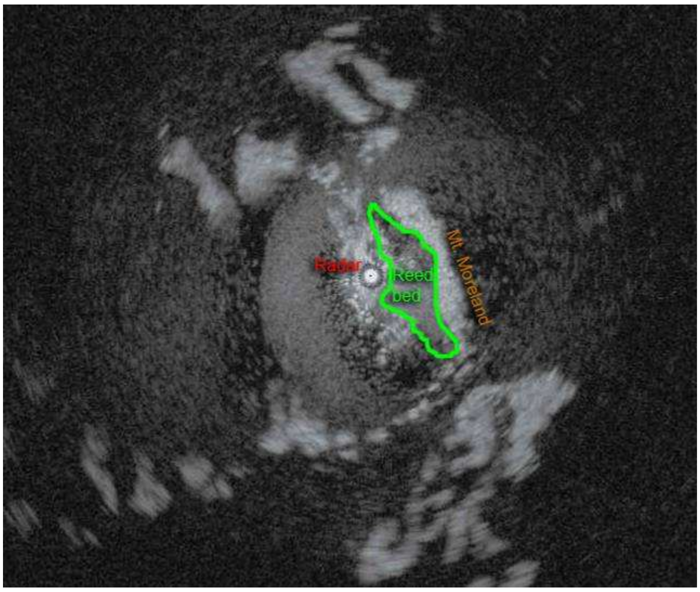
In order to assess the potential interaction between the Barn Swallows and aircraft the following factors were considered:

- The foraging behaviour of the swallows
- Estimated number of swallows in the flocks ~ Density Estimates
- Swarming behaviour of the Barn Swallows
  - Arrival of the swallows at the roost site - evening swarming
  - Dispersal of the swallows from the roost site - morning
- Barn Swallows at the current Durban International Airport – a comparative assessment

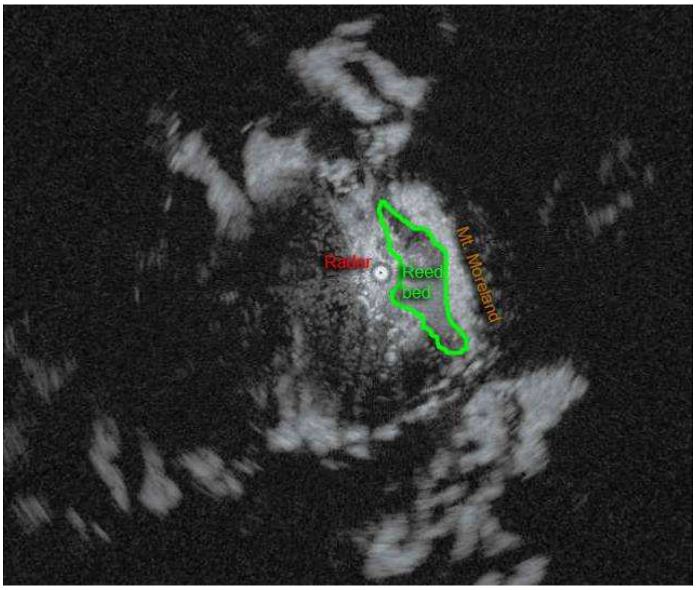
Given the above factors and information the potential impact of the swallows were outlined in terms of a thorough risk assessment and subsequent risk mitigation measures are proposed.



A base map depicting the horizontal radar beam image. For ease of reference the position of the radar in relation to the reedbed and Mt. Moreland has been drawn in.

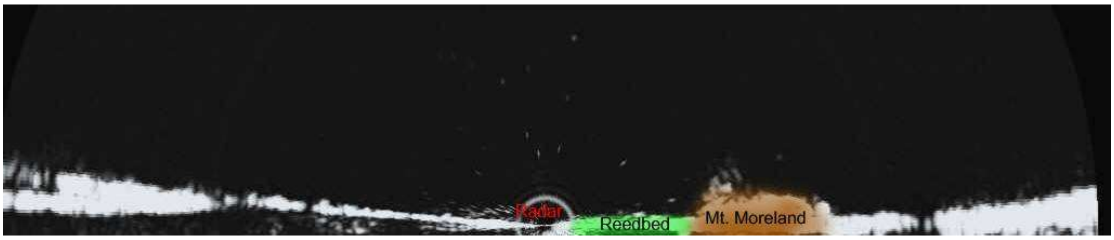


Morning dispersal of the swallows from the reedbed – two distinct waves of birds are visible in the radar image.

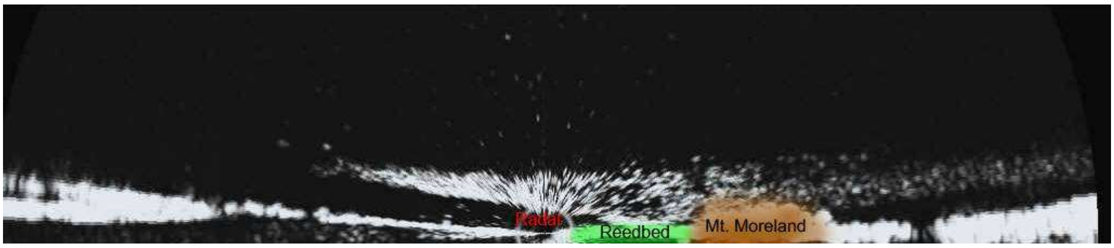


Afternoon arrival of the swallows at the reedbed – lines and concentrations of birds are evident to the left (west) of the reedbed and radar.

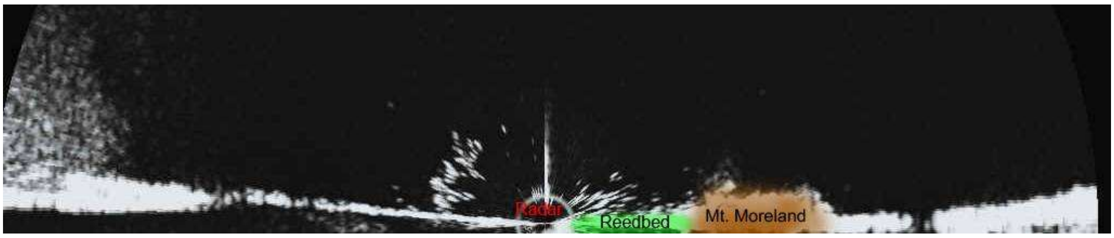
<u>Figure 2:</u> Horizontal radar images



A base map depicting the vertical radar beam image. For ease of reference the position of the radar in relation to the reedbed and Mt. Moreland has been drawn in.



Morning dispersal of the swallows from the reedbed.



Afternoon arrival of the swallows at the reedbed – flocks of birds are visible above the reedbed as well as to the left (west) of the radar.

Figure 3: Vertical radar images

- ***Foraging behaviour of the swallows:***

Barn Swallows are insectivorous and are known to feed especially over grasslands. Given the extensive sugarcane fields in the immediate vicinity of Mount Moreland and La Mercy it is suspected that most of the swallows that come to roost in the Mount Moreland reedbeds forage over these sugarcane fields.

- Radar observations indicate that swallows leaving the roost depart in all directions and do not select the airport as a preferred area. (see figure 13). On one occasion, bird dispersal was observed at a lower altitude. Birds moved low from the roost rather than the more typical swarm and rise behaviour usually observed. This resulted in many swallows passing over the proposed runway platform as low as 15m above ground level. This observation was made from radar site 3, which was located very near to the proposed runway threshold.

- Radar did indicate that periodically birds congregate in the vicinity of the airport grounds during afternoon returns to the roost. Swallows were observed foraging over the vegetation on the proposed runway platform and staging on power lines and trees. However, these behaviours were also observed throughout the areas surrounding the reed bed, and the habitat at the proposed airfield did not appear to have any increased attraction compared to other areas.

- Foraging behaviours periodically resulted in leading line activity with birds following distinct corridors or lines during returns towards the roost.

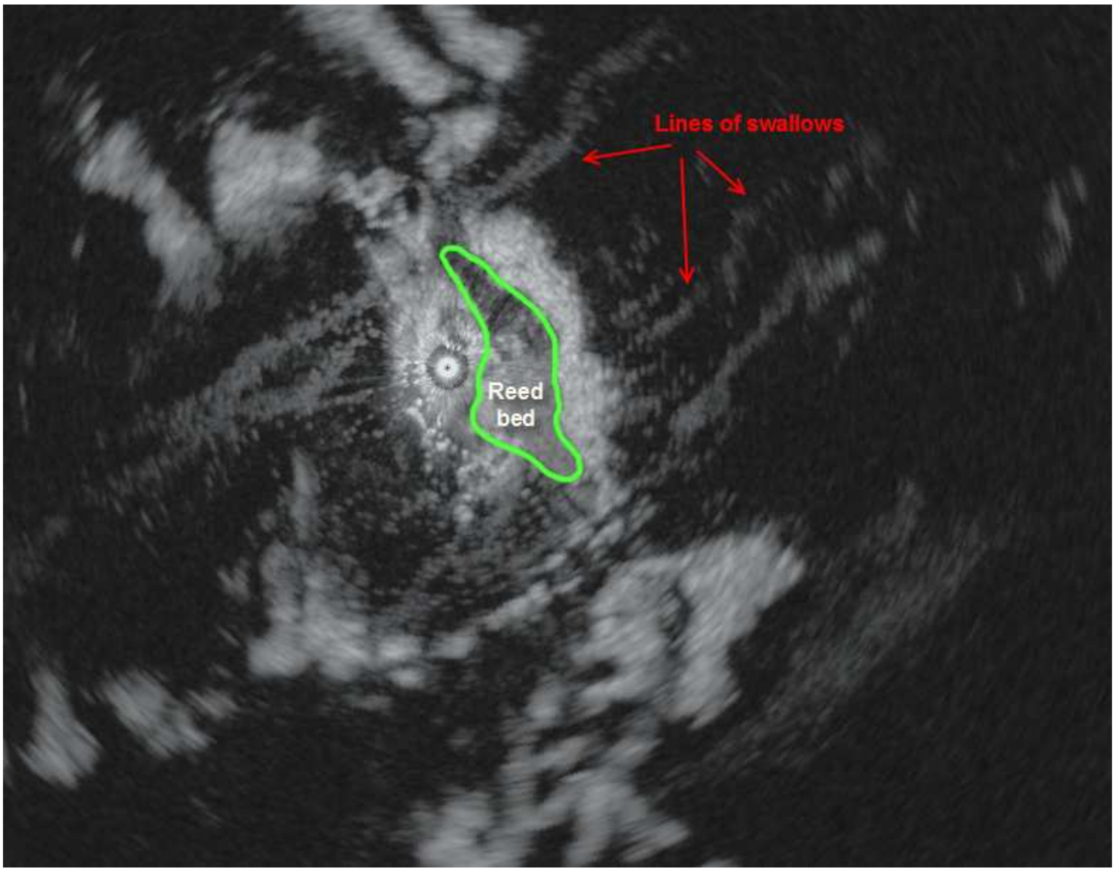


Figure 4: Radar images depicting leading line activity observed in swallows.

- Optimum foraging strategy is not well understood. Recommend additional studies on food preferences and associated vegetation as part of airport management program. Further, foraging habitat in immediate vicinity of airport will change dramatically in coming years with associated development.

- ***Estimated number of swallows in the flocks ~ Density Estimates:***

Estimating the density of birds at the Mt. Moreland reedbed is a challenging task using any available technology. The evening swarming activity, while of greatest concern to aviation risk assessment, presents the worst case scenario for estimating the numbers of birds. During this evening swarming, birds arrive into the area, drop to the reedbed, then rise again, leave the immediate area and then return after a brief period of time. Additionally, as the birds swirl around, they are very likely to be counted several times over any sample period. To estimate the density of the roost, we used the vertical scanning X-band radar to count birds as they passed over radar site 3. By this time the birds had distributed in space to a degree that they could be tracked and counted by the radar. The subsequent density estimate was made by counting all bird tracks over the radar site (known area of sampling) through the entire morning dispersal. By determining the equivalent departure areas around the reedbed, the population of the reedbed can be estimated. This methodology assumes that birds evenly distribute from the reedbed around all points of the compass. Departure data, taken from site 1, however, show a slight tendency for birds to distribute to the north, northeast, placing the site 3 sample station in a worse case scenario (over-estimating) position. This method also compresses all bird tracks detected at the various altitude bands in the vertical beam into one plane.

Further, this estimate converts all target sizes observed into small bird equivalents, that is, it assumes that all targets crossing through the beam are swallows, and not larger birds. This may further over-estimate the number of birds flying overhead as a single large bird would be counted as several small birds.

Table 3: Site 3 - Morning dispersal counts

Date	Small Bird Equivalents
3/7/07	19712
3/9/07	11360
3/10/07	24251
3/11/07	5985
3/12/07	15922
3/13/07	9651
3/14/07	26844

The maximum number of bird tracks recorded from Site 3 during departure was on 14 March. The next step was to determine what percentage of the area the radar was covering during that departure period. Using a GIS analysis, it was determined that the radar was covering approximately 1.7 % of the reedbed departure corridors. Using this as a correction factor, the population of barn swallows at the Mount Moreland reedbed was estimated at 1,340,000 birds.

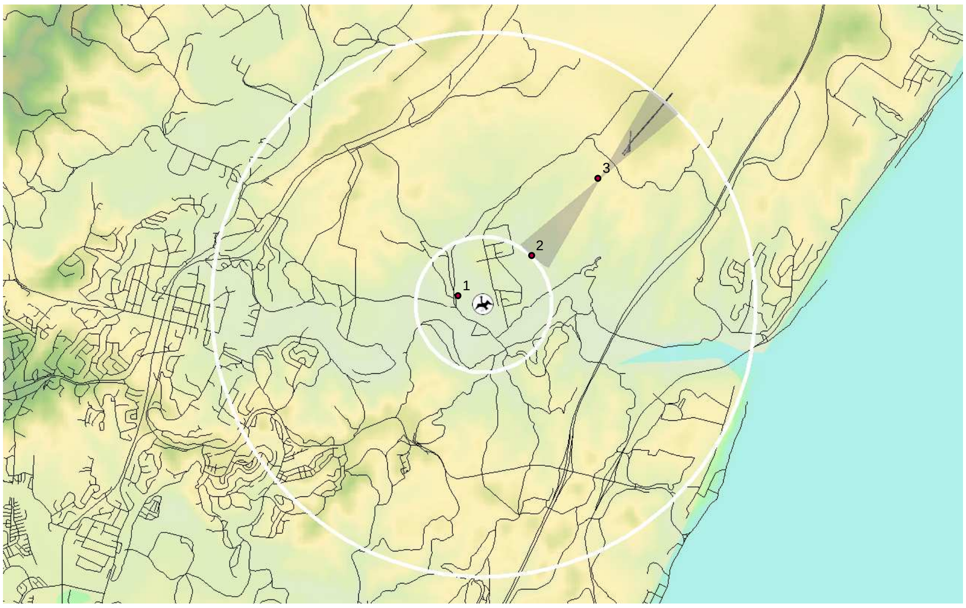


Figure 5: Area of beam coverage from the Radar site 3.

Evening swarming activity has a density component (number of birds in the area), a vertical distribution component (how many birds are at each altitude level), and a time component (how long the birds remain at that altitude). Using vertical distribution calculations from site 1 where the radar had the best view of the swarm (from ground level up), the average distribution of birds in 15 meter intervals was calculated by taking the average vertical distribution patterns over a 7 day period. Table 4 below provides the vertical distribution of the estimated 1.3 million birds.

Table 4: Vertical distribution of the number of birds.

AGL (m)	Percent of Total	Cum Percent	Number of birds
15	0.00	0.3	4027
30	0.05	5.6	71135
45	0.13	18.9	178517
60	0.15	33.7	199050
75	0.11	44.7	147032
90	0.08	53.1	112381
105	0.06	59.3	83818
120	0.07	66.3	94043
135	0.07	72.8	87657
150	0.04	77.2	57906
165	0.05	82.2	67985
180	0.04	86.1	52497
195	0.02	88.6	33533
210	0.02	90.8	29073
225	0.02	93.1	30922
240	0.03	95.9	37133
255	0.02	98.1	29582
270	0.02	100.0	26527

The areas of table 4 above highlighted in yellow indicate percentages and numbers that would be distributed at altitudes from 225 to 270 meters above the reedbed. Over 90% of the swarm activity would be located below the glide slope of aircraft approaching runway 06. Using a lateral distribution of a 0.5 km diameter circle (196,350 meters^2) and the estimated 124,164 birds in altitude intervals at 225 meters and above, the horizontal density would be approximately 0.6 birds per meter^2. Further distributing these birds vertically over the 45 meter vertical airspace (from 225 to 270 meters) the volumetric density would be approximately 0.014 birds per meter^3 or 1 swallow for every 70 cubic meters of airspace. This assumes, however that the birds are evenly dispersed across the volume of airspace, when in fact, the birds tend to form tighter flocks and move through the airspace in a more random fashion. This would dramatically increase the risk at one instant, while dramatically decreasing the risk at the next.

Finally the time component of the evening swarm contributes to the risk estimation. During the day with the highest observed swarming behaviour, birds were only observed at the highest altitude intervals for a period of 10 minutes, or roughly ¼ of the evening swarm activity. However, visual observations of bird swarms above the reedbed in Phase II of the radar study suggest that higher swarming activity may occur over longer periods of time during a few weeks in late March or early April.

- ***Swarming behaviour of the Barn Swallows***

Observations on the height of the swallow swarms were done on a weekly basis in the late afternoon during the 2004/5 and 2005/6 seasons. The Merlin bird detection radar was used on a daily basis during the early part of 2007 to more accurately measurements of the height at which the swallow flocks swarm both when they arrive in the afternoon and when they depart in the early morning.

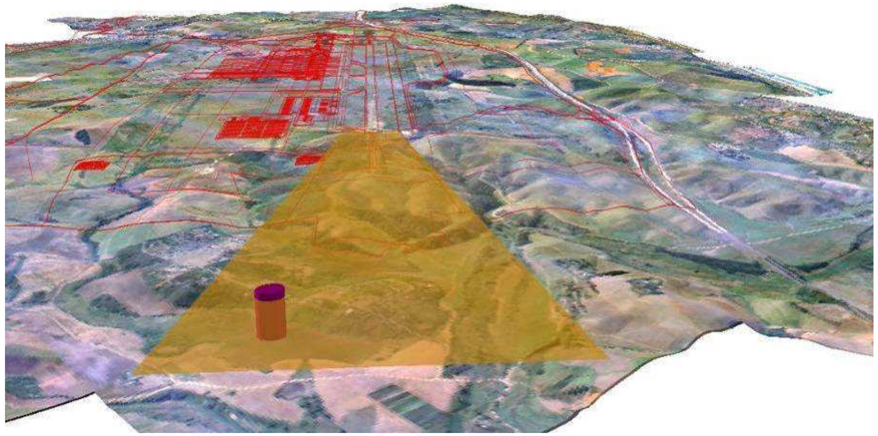
Observations indicated that the flock forms on average at a height of about 100m above the reedbeds towards the beginning of the season and then gradually declines to about 50m by mid summer after which it increased again but also became more variable.

The below diagram (Figure 6) depict the height of the expected approach angles of aircraft in relation to the swallow flocks above the reedbed. A 3-dimensional Geographic Information System analysis yielded similar results in terms of approach angle heights above the reedbed. A standard 3 degree instrument landing system approach to a runway would place an aircraft at approximately 230m above the reedbed when on approach to the La Mercy airport from the South runway 06 in use. It is, however, also worth noting that in some instances e.g. Cape Town International Airport the approach to runway 19 is at 3.2 degrees as a result of the nearby Tygerberg hills being an elevated obstacle directly on the approach to the runway.

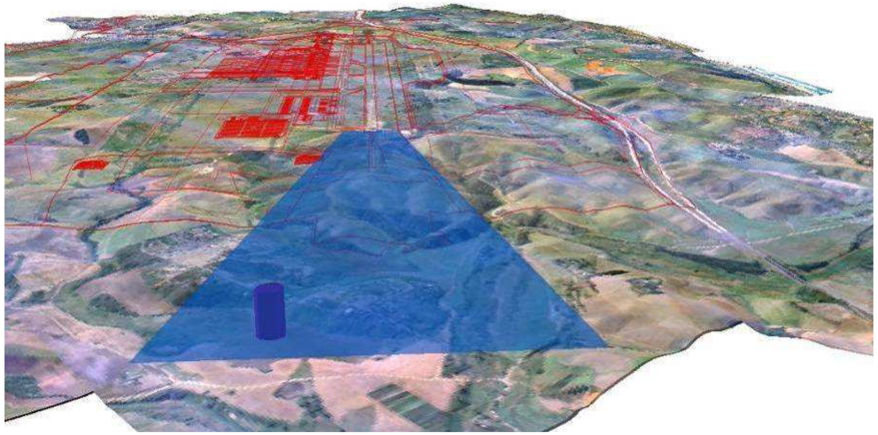
Figure 6: A graphical representation of the aircraft Instrument Landing System approach in relation to barn swallow roost site in the reedbed at Mount Moreland.

Departure heights of aircraft over the reedbed will be much higher and steeper than the approach angles illustrated above thus further minimising the risk as there will be greater separation between the birds and the aircraft.

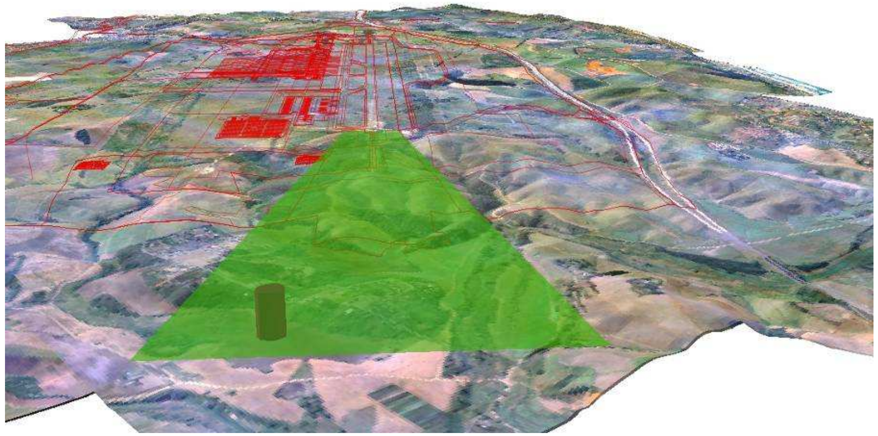
Two dimensional view from above showing runway the 2% obstacle limitation surface and the location of the swallows at the reedbed.



Example of a swallow swarm at 160m above reedbed penetrating the 2% obstruction limitation surface



Example of a swallow swarm at 160m above reedbed with a 3^{o} glide slope approach passing over the top of the swarm



Example of a swallow swarm at 160m above reedbed with a 3.2^{o} glide slope approach passing over the top of the swarm

Figure 7: A 3 dimensional Geographic Information System model used to determine the high of an aircraft on approach using the standard 3 degree and an elevated 3.2 degree ILS approach glide slope.

1. Arrival of the swallows at the roost site - evening swarming

The Barn Swallows approached the reedbed from all directions. The arrival of the swallows happened at all altitudes and the swarms then started forming over the reedbeds.

1.1. Height

The altitude of birds swarming over the reedbed is of a critical concern due to the relationship of high flying birds to aircraft crossing the reed bed on approach to the proposed runway. Maximum altitude was taken from recorded raw data and analyzed on the radar display. The maximum altitude is not representative of the dense part of the swarm; rather it is a measurement of a relatively small fraction of the total swarm, which is highest in the radar beam. Further, the maximum altitude is not achieved consistently throughout the swarm period. Maximum altitudes often represent only a fraction of the total density, but also a fraction of the total time of the swarm period.

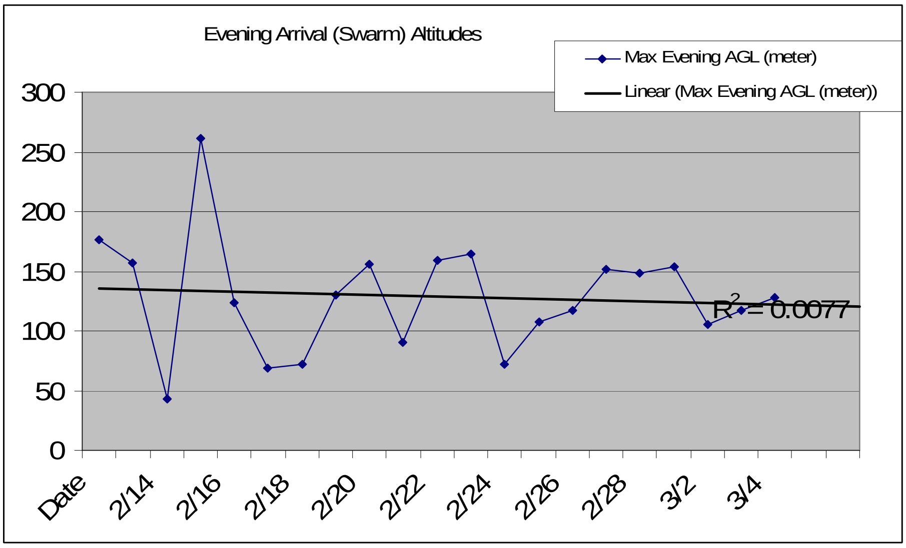


Figure 8: Maximum altitude (AGL) in meters of evening swarming activity above the reedbed between 12 February 2007 and 3 March 2007

Max height above ground level (AGL) by day (Figure 8 above) suggests that during the period indicated, evening swarm height did not change significantly.

i. Max AGL was 261 meters on Feb 16. An analysis of the maximum altitude of targets in five minute intervals for the entire swarming period on this date revealed that birds only achieved this altitude for ten minutes (less than 16% of the swarm period that day). Only 14% of the swarm occurred during that time at an altitude above 225 meters.
ii. Average maximum AGL is 127 meters
iii. Standard deviation of maximum AGL is 47 meters
iv. Trend is not significant, no increase or decrease in altitude over the time interval sampled (R^2= -0.0077)

1.2. Timing

The arrival time of the birds is highly variable, but the start time was based upon the beginning of observable movements on the radar (Figure 4).
i. Start time : Variable, approx 19 minutes before sunset
ii. Duration: 38 minutes (standard deviation is 12 minutes)

iii. End: 19 minutes after sunset (standard deviation is 5 minutes)

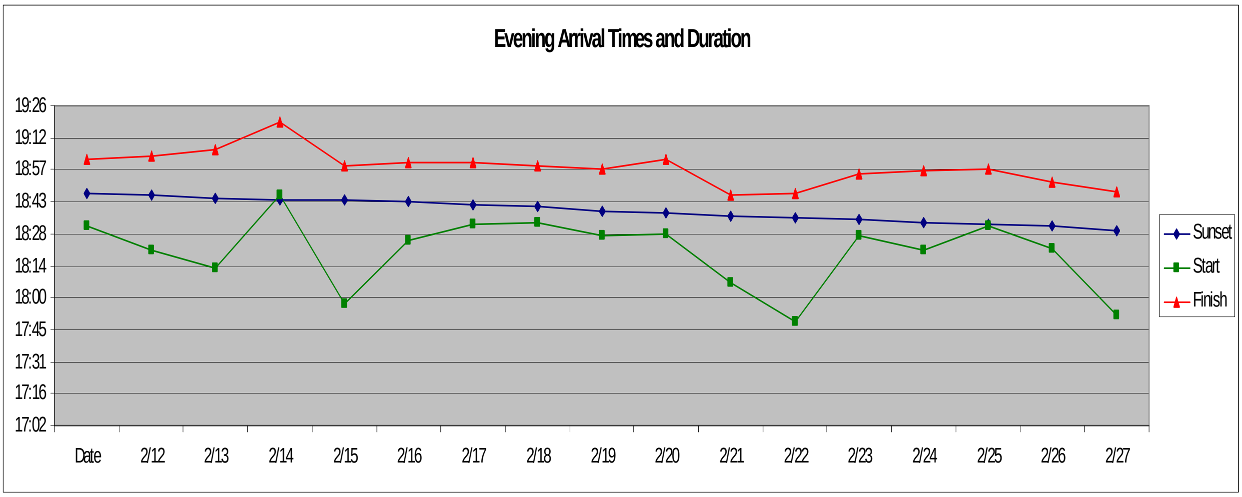


Figure 9: Evening arrival times and duration of the swarming activity over the reedbed

1.3. Vertical swarm profiles:

An analysis of the vertical distribution of birds within the swarm is estimated by the vertical scanning x-band radar. Data collected from Site 1 (Feb 12- Feb 19) were processed to determine how the swallow swarms were vertically arranged. Results showed a highly variable pattern with the densest regions of the swarm generally located at altitudes between 30 and 80 meters (see example below – Figure 10).

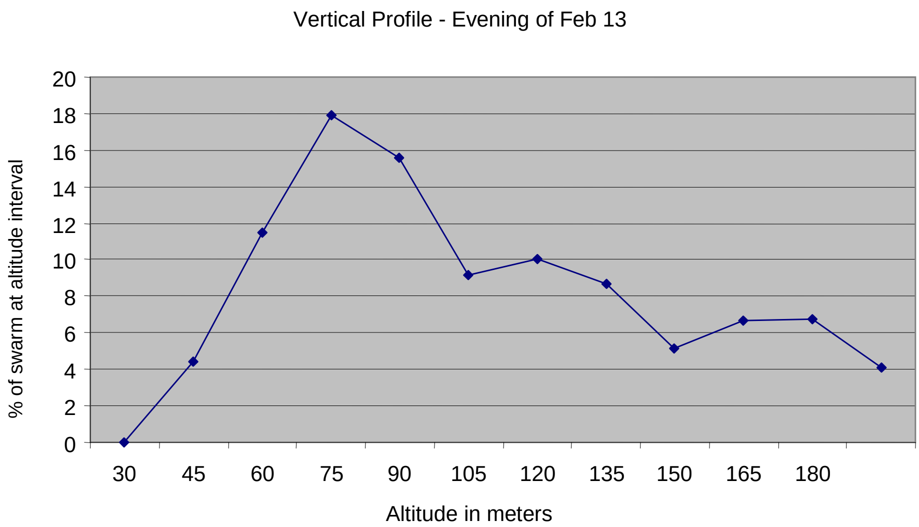


Figure 10: Percentage distribution of swallow swarm at different altitude bands

2. Dispersal of the swallows from the roost site - morning.

Figure 11 depicts the maximum observed altitude during morning dispersal (red line) in meters AGL. Morning dispersal becomes higher above ground level in late February when the radar was moved to site 2 which was located 1400 meters from the proposed runway. Morning dispersals were marked by several swarming manoeuvres above the reed bed to gain altitude and then a climbing trajectory as the birds moved away from the reed bed.

2.1. Max AGL by day

i. Max AGL was 1,389 meters on March 13
ii. Average max AGL is 352 meters
iii. Standard deviation of Max AGL is 268 meters
iv. Trend is not significant, slight increase in altitude over the time interval sampled (R^2= 0.411)

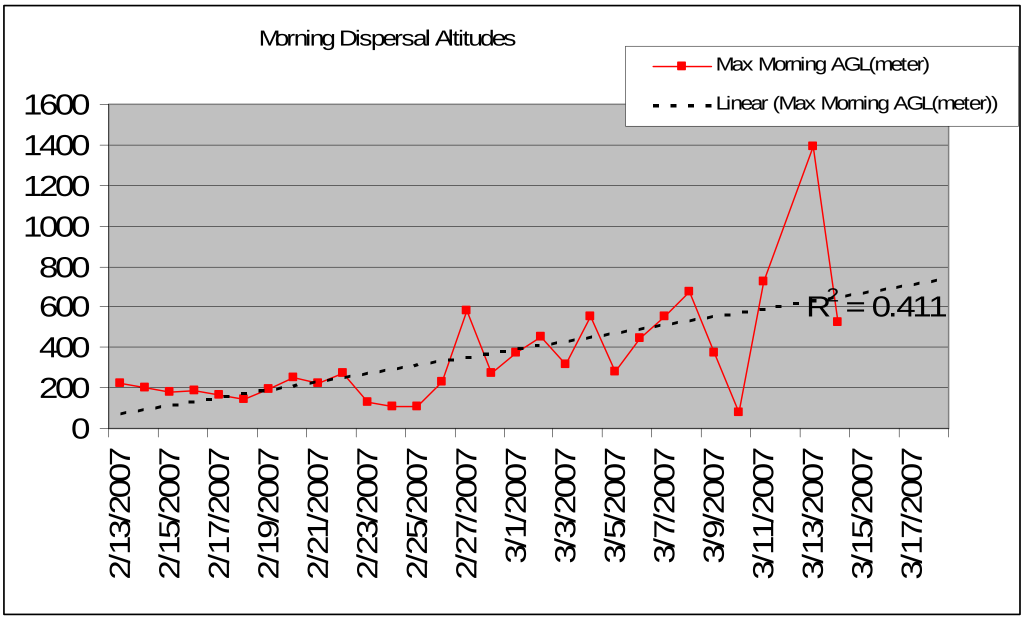


Figure 11: Morning dispersal maximum altitude (AGL)

2.2. Timing

i. Start Time: 19 minutes before sunrise (standard deviation = 4 minutes)
ii. Duration: 21 minutes (standard deviation = 5 minutes)
iii. End: 2 minutes after sunrise

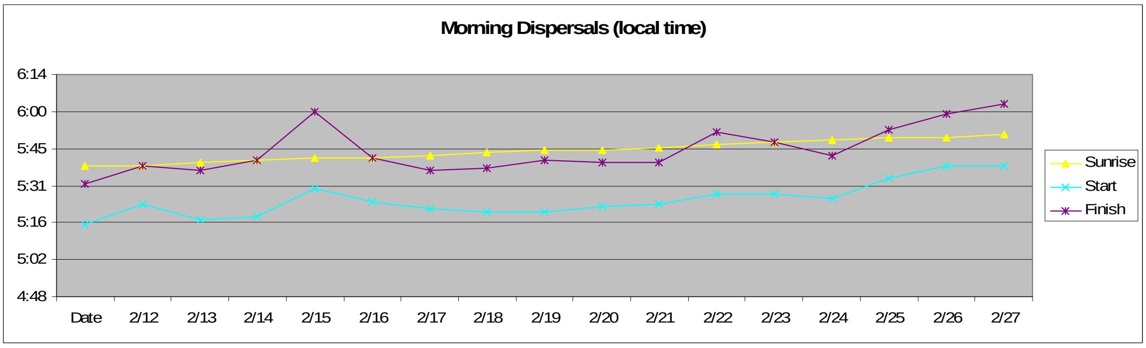


Figure 12: Timing (start and finish) of morning dispersal in relation to sunrise times.

2.3. Morning dispersal directions:

Morning dispersal directions were determined using the horizontal scanning S-band radar. Data were compiled over a one hour period (30 minutes prior to sunrise to 30 minutes after sunrise) and tracks assigned to their associated compass headings. The results from the first week of data analysis indicated that birds dispersed in all directions from the reedbed, with a slight tendency for birds to depart towards the north/northeast.

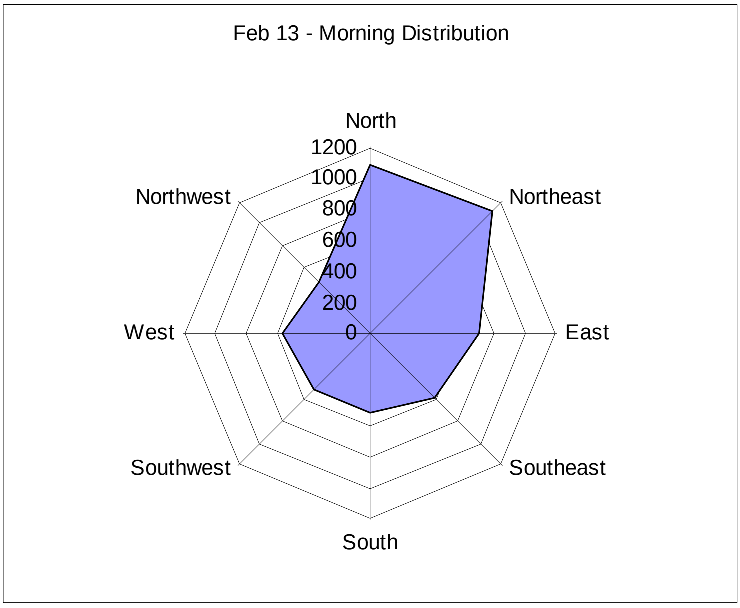


Figure 13: Direction of the morning distribution from the roost

- ***Barn Swallows at Durban International Airport – a comparative assessment***

The radar was setup near the runway at Durban International Airport for a two day demonstration beginning on the afternoon of March 25th and running through mid morning March 27th. During the demonstration the following were identified:

- Radar confirmed the location of a barn swallow roost approx 1 km from runway (between the airport and the refinery to the east) See figure 14 – Map showing location of roost in relation to the existing Durban International Airport runway.

Figure 14: Location of an existing swallow roost near Durban International Airport

- Swallows left the roost in the early morning around sunrise (as they do at Mt. Moreland site)
- Morning dispersal is moderately high over the airfield with altitudes ranging from a minimum of 115 meters to a maximum of 722 meters.
- Swallows did not leave the roost to immediately flock to the airfield to feed or loaf there during the period of this demonstration. The radar data

indicated that the birds moved over the airfield in a south westerly, westerly and north westerly direction.

- The timing of the morning dispersal corresponds to sunrise, as does the Mt. Moreland bird roost dispersal. This dispersal is typically before sunrise (within 30 minutes prior to sunrise). The morning dispersal throughout the summer is generally therefore before the first commercial aircraft departure at around 06:00. The afternoon arrival started approximately 30 minutes before sunset and continued until sunset – see Table 5 below.

Table 5: Morning and afternoon swallow activity at Durban International Airport recorded by the Merlin bird detection radar

Date	AM/ PM	Start	End	Duration	Sunrise/ set	Differential	Max AGL	Min AGL
3/26/2007	AM	5:53	6:03	0:10	6:03	sunrise -10	722	269
3/27/2007	AM	5:59	6:11	0:12	6:04	sunrise -5, +7	243	115
3/25/2007	PM	17:23	18:02	0:39	18:00	sunset - 37, +2	141	17
3/26/2007	PM	17:39	18:03	0:24	17:59	sunset - 20, +4	219	22

- Bird strike analysis of barn swallows at Durban
  - By month (all years)

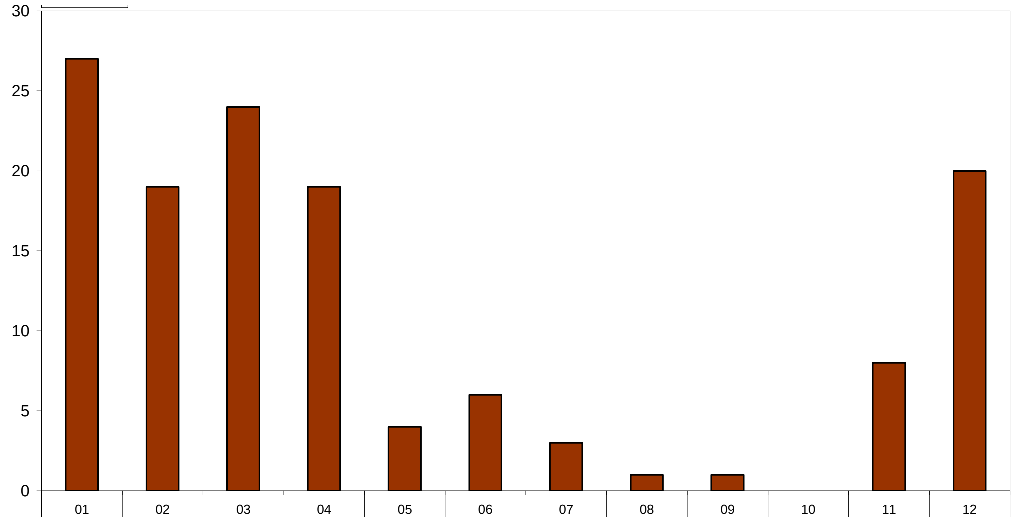


Figure 15: Swallow strike data per month at Durban International Airport (1999 - 2006)

  - By hour

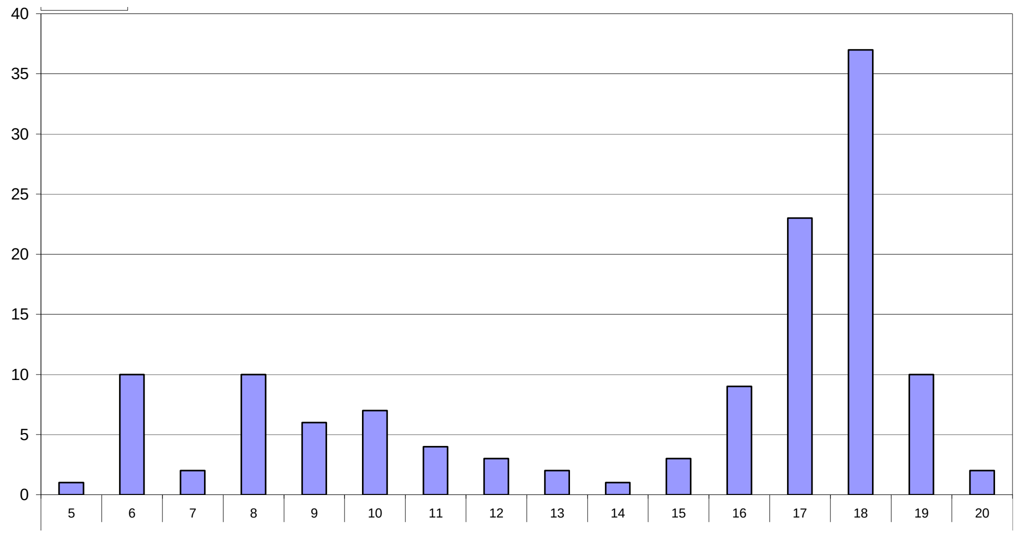


Figure 16: Swallow strike data per hour at Durban International Airport (1999 - 2006)

  - Single *vs.* multiple strikes – 52% of incidents were with more than one bird.
- Conclusions
  - The Durban International Airport is an example of coexistence between a swallow roost located near an airport
  - The low strike risk is due to temporal and spatial separation of the morning bird movements and aircraft movements
  - The low strike risk is also due to low mass of birds and the thinning distribution of the birds as they leave the roost.
  - The demonstration also provides an example of how remote sensing technology (such as radar) can detect hazardous conditions.

It is important to note that the swallows roosting near Durban International Airport find sufficient foraging opportunities in the urban landscape of the airport, refinery, and surrounding commercial and residential developments.

- ***Risk assessment.***

Operational risk is generally defined as the probability of an event occurring, multiplied by the severity of the outcome of such an event. Subsequently, the operational risk associated with the barn swallow roost at Mt. Moreland is related to the probability of an aircraft encountering the birds, which is a function of distribution in time and space, and the probability of serious damage which is a function of the bird's mass (or combined mass in the event of a multiple strike). The swarming activity that occurs on summer evenings in the vicinity above the reed bed is generally of greatest concern, due to the number of birds that participate in the behaviour. However, several factors must be considered when determining the extent of this perceived risk. Firstly, it is important to understand the several factors associated with the exposure of aircraft to these birds.

1. Temporal Exposure:

This component of risk involves the amount of time an aircraft would be exposed to a potentially hazardous condition. Essentially the shorter the exposure, the lower the risk will be. Several biological factors contribute to a measure of exposure –

i. **Swallows are seasonal at Mt. Moreland:**
The large concentration of swallows at the reed bed occurs only during summer months (mid-October through mid-April). For the other half of the year, the birds are not present and therefore not an issue.

ii. **Swallow movements at the roost have a distinct daily pattern.**
While the swallows are present throughout the summer, they are only assembling in the vicinity of the airport during the morning departures from the roost and the evening arrivals.

- Morning dispersals begin near sunrise (average 19 minutes before sunrise until 2 minutes after sunrise) and last for approximately 25 minutes. For most of the summer, this activity is occurring well before the first commercial aircraft departures and arrivals. In fact, from the observed data, morning dispersals would only overlap with aircraft movements for two weeks at the end of March and the first few weeks of April and then for approximately 5 to 10 minutes each day during that 4 week period. The morning temporal exposure would be approximately 280 minutes per year or 0.05% of the total year. Radar also detected bird movements within an hour after initial dispersal that showed birds returning back over the proposed runway platform. These bird movements, however, were generally at altitudes much higher than the earlier dispersal altitudes, and much less dense.

- Evening arrivals usually last longer, and generally occur around 30 minutes prior to sunset and lasting until approximately 30 minutes after sunset. The average temporal evening exposure would be approximately one hour per day for the six month period. This would result in an evening temporal exposure of 10,800 minutes per year, or 2% of the year.

2. **Spatial Exposure.**

Even if the birds and aircraft share exposure in time, they must also share exposure in space for risk to occur. Understanding how the birds move across the landscape relative to aircraft movement areas will further refine the risk assessment.

- As we have seen, the morning dispersals have a very limited temporal overlap with aircraft movements. The distribution of birds in the airspace during morning movements also limits exposure to aircraft. Most dispersal activities involved a swirling behaviour above the reedbed to gain altitude and then departure movements that indicated climbing to altitudes of 200 meters and above. This high altitude departure behaviour placed the birds well above the runway platform as the birds moved away from the roost. This layer of bird movement would intersect the approach and departure corridors for very short distance as aircraft passed through.

- Evening spatial exposure is a function of altitude distribution as well as density of birds at the reedbed. The density estimate of birds at the reedbed continues to be problematic due to the dense swarming behaviour of the birds which makes visual counts highly questionable, and radar tracking extremely difficult as well. The density component, however, is only relevant to risk, when the birds are at an altitude where they would encounter aircraft. During the initial phase of the radar study, swarming birds were only detected by the radar on one evening at altitudes that would place birds into the glide slope of an approaching aircraft. A more detailed analysis of this one night event further indicated that birds only were at the critical altitude band for ten minutes on this one evening. Assuming that these high altitude events occur at approximately the same rate throughout the summer (one every 16 days), the spatial conflict would occur on only 11 days.

3. Bird mass.

The mass of the bird is an important factor in determining the severity of a strike. The average mass of a barn swallow is approximately 17.9 grams. Impact energy is generally defined as ½ mass multiplied by the velocity squared. A review of barn swallow strikes at Durban International Airport indicated that there was no reportable damage from any of the 132 strikes. Additional concern may be associated with multiple strikes, however, 69 multiple strikes (52%) have been reported with barn swallows, none of which resulted in reportable damage.

Consultation sessions with aircraft engine manufacturers confirmed that no damage has been reported as a result of swallow strikes in South Africa. Internationally one event was mentioned where an engine ingestion resulted in some damage – it was however indicated that a metal part in the engine dislodged which caused the damage, uncertainty exists over the cause over the part dislodging as it could have been the effect of an earlier other event and only loosened by the bird ingestion. Further to the above during 1987 a Boeing 737-200 ingested several swallows during the take-off run out of Port Elizabeth. The aircraft's no. 2 engine stalled briefly and as a precautionary measure the aircraft aborted the take-off, following a satisfactory engine ground run the aircraft was again released for service not no damage reported whatsoever.

The concern from a bird strike perspective is also not so much the potential direct damage that single swallows would do to the aircraft but more so the cumulative effect of potentially ingesting several hundreds of swallows into an aircraft's engines. Large numbers of small birds have the chance of blocking critical air pressure sensors used to control the fuel scheduling for engines and could result in a loss of thrust. On a twin engine aircraft a large flock of swallows could even result in a considerable loss in power if both engines were to ingest the birds. A compressor blade failure may occur and this would in all probability result in a loss of thrust. During takeoff and landing a power loss is considered very serious and although pilots are trained to deal with such a situation for a twin engine aircraft scenario, it could be very dangerous if a large dense flock were to be ingested in both engines (G Ross, SAA technical, pers. Comm.). The probability of this occurring at this site or elsewhere internationally is extremely low.

The ACSA bird strike database indicates that swallows are relatively often involved in bird strike occurrences (17.5%). There has however not been any damage reported as a result of a bird strike incident with swallows.

4. Conclusion.

Bird strike risk associated with barn swallows roosting at the Mt. Moreland reed bed is low to moderate. Although extremely dense flocks of birds are often observed over the reed bed near sunset on summer evenings, these events are short in duration, and rarely result in birds soaring high enough to conflict with aircraft movements. Further, aircraft will not always be approaching the runway over the reed bed as prevailing winds often indicate landing from the opposite direction. At a wind speed below 10 knots aircraft will be able to take-off in either direction runway heading 06 or heading 24. During the time intervals that the swallows swarm due consideration should be given to changing the runway in use so as to allow aircraft to land from the north i.e. runway 24 in use which would result in aircraft taking off over the reedbed further increasing the separation between the swallows and aircraft. Additionally, half of the aircraft movements at the airport are departure profiles which place aircraft at much higher altitudes over the reed bed. Morning dispersals are both spatially and temporally separated from most aircraft movements further reducing risk. Finally, the low mass of barn swallows, even in the event of multiple strikes, has never resulted in any reportable damage to aircraft operating at airports in South Africa. Extensive consultation with aviation industry stakeholders, airline safety mangers and pilots confirmed that swallows pose a low risk to aircraft and in the event of dense swarms if there is an early warning system in place the risk of ingesting multiple birds could be avoided (see below – risk mitigation)

- ***Risk Mitigation***

Several options exist to further reduce potential bird strike risks associated with barn swallow activity in the vicinity of the proposed La Mercy airport. These options range from operational considerations to management and design practices. Risk reduction measures include:

1. **Model and Advise:**
   Following extensive analyses of bird activity at the reedbed throughout the summer season, a basic risk model could be constructed to predict periods of time in the morning and evening when elevated risk conditions occur. This model could include such variables as sunrise, sunset, wind speed and direction, cloud cover, precipitation, barometric pressure, ambient light, etc. From these variables a block of time when risk would be expected to be higher could be predicted. This would become the basis for an advisory that could be passed from air traffic control to aircrew directly or through the Air Terminal Information System (ATIS) or similar methods such as daily Notice to Airman System (NOTAMS).

2. **Model and Restrict:**
   A variation on the above concept would include actual restrictions to aircraft movements during periods when risk would be estimated to be highest. Restrictions could include holding take-off and landing operations, or restricting approaches and departures over the reed bed. Flight restrictions based upon modelled risk requires the model to be very robust, as false restrictions may have severe economic impacts.

3. **Monitor and Advise:**
   This option would require a remote sensing system that would identify increased activity at the reedbed and provide a quantitative measure of risk. The increased level of activity could be used to establish thresholds that would result in providing advisories similar to those in paragraph 1.) above.

4. **Monitor and Restrict:**
   With a remote sensing system e.g. radar, extreme conditions could be identified and advisories upgraded to actual restriction of aircraft movements. Again, these restrictions could include stopping all aircraft movements, or directing movements away from hazardous conditions (i.e. select runway headings for departures and arrivals to minimize exposure over the reed bed).

Remote sensing systems reduce the likely hood of a false alarm which is always a possibility with modelling variables.

In order to refine the measurement of swallow behaviour and to develop a robust bird avoidance early warning advisory system, integrated into the operational plan of the proposed airport, as much data as possible should be gathered. It is therefore recommended that such information gathering using radar technology commence as soon as possible i.e. the next swallow season which will allow for the development, refining and testing of such a system during the following three swallow seasons before the airport becomes operational.

5. **Construction/Design:**
   If runway length is determined to be somewhat flexible in the initial design phase, further altitude separation between swarming birds over the reedbed and the approach corridor can be achieved by shifting the runway threshold towards the 06 end. For each 500 meters of linear movement away from the reed bed an additional altitude separation of 26 meters is achieved (3 degree glide slope).

   It is however recommended from a precautionary approach that a higher glide slope approach i.e. 3.2 or even 3.5 degrees be considered as this would create a greater separation between the aircraft and the swallows thus minimising the risk.

6. **Habitat Management – On-site:**
   Aggressive habitat management at the proposed airport will be required to reduce perching sites for barn swallows. These birds currently find power lines, and associated structures for perching very shortly after leaving the roost in the mornings and when arriving back in the evenings. Additionally, standing water associated with storm water management or architectural features should be carefully designed and coordinated with wildlife biologists to ensure that birds and other wildlife are not attracted to the airport. Airfield vegetation, especially turf grass, must be selected to minimize maintenance as well as wildlife attraction.

7. **Bird/Wildlife Control:**
   The new La Mercy airport will have to continue and expand the excellent program currently implemented at the Durban International Airport. This program will require additional manpower and equipment to cope with the expanded area of the facility as well as the increased wildlife activity that currently exists in that region. Additionally, as development activity continues in the areas around the airport, birds and wildlife will seek refuge in the open areas that are common to all airports.

8. **Habitat Management – Off-site:**
   The proposed airport location is already situated near one wildlife attraction, the Mt. Moreland reedbed. While extensive efforts have been made to study this situation and develop mitigating measures, it is very important that additional bird and wildlife attractions are not developed in close proximity to the airport. Current proposals in terms of the establishment of additional waste water treatment works to service the area, alongside the Umdloti River needs to take careful consideration of how they are designed so as to minimise their attractiveness to high risk bird strike species. Similarly due consideration is required for the proposed Zimbali lakes development to the north of the proposed La Mercy airport. The lakes and water bodies which will form an integral part of the proposed development should recognise that their

proposed design and biophysical characteristics (area of open water, edge character/vegetation, presence of islands etc.) will determine the suite of bird species which will be attracted. If both these developments i.e. the proposed waste water treatment works and the proposed Zimbali lakes development attract large high bird strike risk species which would potentially move between the two sites across the proposed La Mercy airport which then would elevate the bird strike risk.

Community planning activities should be closely monitored and coordinated with the airport wildlife control team to ensure peripheral land uses do not increase bird and wildlife attraction at the airport. Long term management and control of the Mt. Moreland reed bed may become a contentious issue depending on ownership and involvement with other environmental conservation organizations. It will be important to have an airport representative participate in the long term management and development of this site.

- ***Potential impact of aircraft on the swallow swarms***

Despite the impact that the birds could have on aircraft discussed in detail above consideration should also be given to whether or not the aircraft passing over the reedbed would have any potential negative impact on the swallows.

Birds are a common problem at airports all over the world and the noise of aircraft does not scare them away or negatively affect them in any way whatsoever. Numerous other methods (often involving other noises) are often also used to try and scare birds away but it is common knowledge that birds get habituated very quickly to these and they too eventually have no effect on the birds.

Barn Swallows are naturally associated with humans in their northern hemisphere breeding grounds and are regularly exposed to various sorts of anthropogenic factors and disturbances. It is therefore unlikely that the passage of aircraft overhead will have any negative effect on the swallows roosting in the reedbed. The existing swallow roost at the current Durban International Airport located between the airfield (<1000m away) and the petroleum refinery further supports the fact that the birds will not be negatively affected by the noise and overflying aircraft.

Another potential disturbance factor to consider is the air turbulence created in the wake of a passing aircraft and how that could potentially affect swallows in flight. As is the case at other bird roosts near airports e.g. starling roosts at both Nashville International Airport and Dallas Fort Worth Airport (Ron Merritt – DeTect Inc, Pers. Comm.) the birds tend to take avoidance measures i.e. dive down and out of the zone where turbulent air is present in a similar fashion as what they would avoid areas of higher wind speed in the upper air.

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