Flying Safety

APRIL 1999

FY-98 Engine-Related Mishap Summaries

OUR ANNUAL FEATHERED-FLIER ISSUE

UNITED STATES AIR FORCE

AIR FORCE RECURRING PUBLICATION 91-1

Flying Safety

APRIL 1999, VOL 55, NO 4

Page 4

Page 16

Page 22

IN THIS ISSUE:

GENERAL MICHAEL E. RYAN
Chief of Staff, USAF

MAJ GEN FRANCIS C. GIDEON, JR.
Chief of Safety, USAF

LT COL J. PAUL LANE
Chief, Safety Education and Media Division
Editor-in-Chief
DSN 246-0922

BOB VAN ELSBERG
Acting Managing Editor
DSN 246-0983

CMSGT MIKE BAKER
Maintenance/Technical Editor
DSN 246-0972

DOROTHY SCHUL
Editorial Assistant
DSN 246-1983

DAVE RIDER
Electronic Design Director
DSN 246-0932

MSGT PERRY J. HEIMER
Photojournalist
DSN 246-0986

Web page address for the Air Force Safety Center:
http://www-afsc.saia.af.mil
Then click on Safety Magazines.

Commercial Prefix (505) 846-XXXX
E-Mail — bakerm@kafb.saia.af.mil

24 hour fax: DSN 246-0931
Commercial: 505-846-0931

DEPARTMENT OF THE AIR FORCE — THE CHIEF OF SAFETY, USAF

PURPOSE — *Flying Safety* is published monthly to promote aircraft mishap prevention. Facts, testimony, and conclusions of aircraft mishaps printed herein may not be construed as incriminating under Article 31 of the Uniform Code of Military Justice. The contents of this magazine are not directive and should not be construed as instructions, technical orders, or directives unless so stated. SUBSCRIPTIONS — For sale by the Superintendent of Documents, PO Box 371954, Pittsburgh PA 15250-7954; $25 CONUS, $31.25 foreign per year. **REPRINTS** — Air Force organizations may reprint articles from *Flying Safety* without further authorization. Non-Air Force organizations must advise the Editor of the intended use of the material prior to reprinting. Such action will ensure complete accuracy of material amended in light of most recent developments.
DISTRIBUTION — One copy for each three aircrew members and one copy for each six direct aircrew support and maintenance personnel.

POSTAL INFORMATION — *Flying Safety* (ISSN 00279-9308) is published monthly by HQ AFSC/SEMM, 9700 "G" Avenue, S.E., Kirtland AFB NM 87117-5670. Periodicals postage paid at Albuquerque NM and additional mailing offices. **POSTMASTER:** Send address changes to *Flying Safety*, 9700 "G" Avenue, S.E., Kirtland AFB NM 87117-5670.

CONTRIBUTIONS — Contributions are welcome as are comments and criticism. The Editor reserves the right to make any editorial changes in manuscripts which he believes will improve the material without altering the intended meaning.

FSM notams

"Dry Dust and Stray Paper…"

(Courtesy *ARS Callback*, Jan 99)

Many pilots would prefer to avoid dealing with aircraft paperwork and logbook. But, as the following report describes, a General Aviation pilot's look into old paperwork yielded a very serious discrepancy.

We were flying on a long cross-country and had to divert and overnight due to weather. We decided to spend some time reviewing the aircraft logs, manuals, 337s [Major Repairs or Alterations], etc. Flying is a technical hobby for us, so we spend a lot more time than most pilots just talking about aircraft documents and the like. While looking through some recent maintenance records, we found an invoice for a fuel bladder replacement showing a standard range fuel tank. The flight manuals, the equipment list, and all documents we could find listed long-range tanks. We had always flight-planned for long-range tanks based on those documents.

A check on the serial number with the manufacturer verified it had been built with standard tanks. For at least 15 years, this plane was flown under the belief that it had long-range tanks. Somewhere down the line, someone made the assumption that the plane had long-range tanks and wrote it down without looking at a written document to confirm the fact. [Then] it was spread…through all the documents associated with the plane.

The longest flight I ever made in this plane was in marginal MVFR/IMC at night [over mountainous terrain]. We planned 5.25 flight time, plus 2.25 reserve based on long-range tanks. Flight time was 5.5 hours. We took on 66 gallons of fuel. Usable fuel is 65 gallons on standard tanks.

I have found this problem of incorrect data before. During installation of avionics in a plane I owned, someone subtracted the weight of two radios rather than adding them into the weight-and-balance. The total difference was 60 pounds (no major impact in that airplane). The error was made in 1965 and carried through every weight-and-balance up to 1995 when the plane was reweighed. I questioned why [the new aircraft] weight didn't match the old weight-and-balance. Recalculating every weight-and-balance found the discrepancy.

Dry and dusty as they may be, aircraft records often contain a wealth of interesting information—and possibly some discrepancies, too.

An air carrier captain provides a report about a piece of paper that is a frequent source of confusion to pilots—the aircraft MEL (Minimum Equipment List):

I incorrectly interpreted the leading edge flap/slat position indicator light procedure in the MEL. I deferred an item that evidently was not deferrable. I had conferred with Dispatch and the other pilot, and we were all in agreement as to our ability to defer the item. I think the problem was caused primarily by the wording of the MEL title and the unclear verbiage in that section. I should have read it more carefully and called Maintenance on the radio for their interpretation.

Since MELs are generally not written in "plain English," repeated readings may be required for complete understanding of their limitations and allowances. In addition, direct contact with the Maintenance Control Department may provide clarification that a dispatcher or other pilot cannot offer.

The Avian Hazard Advisory System (AHAS)

(And Why You Can't Dodge All of the Birds All of the Time)

USAF Photo by MSgt Perry J. Heimer

MR. T. ADAM KELLY
ACC AHAS Project Manager

That the need to reduce the number of bird strikes is obvious: *Over the past 20 years, bird strikes to Air Force aircraft have resulted in more than 30 aircrew fatalities, 20 destroyed aircraft, and hundreds of millions of dollars in property damage.*

Bird strike avoidance strategies have come a long way in the last few years, and generally speaking, the airfield environment is relatively easy to manage. Individuals are now provided great training in effective bird harassment techniques and how to modify the airfield environment so that it presents unsuitable (or unfriendly) habitat to birds. But these options aren't available on ranges, in military operating areas (MOA), or low-level training routes. So, how do we best manage the risk?

The newly developed Avian Hazard Advisory System (AHAS) was recently tested for suitability as a means of monitoring and predicting potentially hazardous bird activity along selected regions of the Atlantic coast of the United States. The test phase, conducted during the 1998 fall migration, was considered a success and provided insight into future ways to manage bird strike risk. In many respects, AHAS is an entirely new approach to Bird Avoidance Strike Hazard (BASH) risk management for ranges, MOAs, and low-level routes.

How the BAM Helps Reduce the Number of Bird Strikes

Since migratory activity is a leading cause of bird strikes, the United States Bird Avoidance Model (US BAM) concept was conceived in the 1980s. Based on historical data of where large bird concentrations gather, their periods of activity, and migratory patterns, the BAM helps alert pilots and mission schedulers of peak locations and times of bird movement so that missions can be planned around them. The BAM has proven itself to be a very useful tool.

Over the past 5 years we've conducted radar studies in North Carolina (at the Dare County Bombing Range) and in Georgia (at Moody AFB and the Grand Bay Weapons Range) and monitored bird activity year round during all hours of the day and night. We discovered that there was almost no chance an hour would pass without at least one bird flying overhead. In other words, at any given time, *some* bird species will *always* be active. Even with the BAM, we just can't expect to dodge all of the birds all of the time.

So, what can be done to better manage risk, say, on low-level routes? First, we have to decide what we're managing *for* and how much impact on low-level training would be acceptable. If there's always a chance we'll hit a bird while flying low-level routes, then a goal of reducing the bird strike rate to zero is unrealistic. A more realistic goal would be to manage where and when we fly so that we (1) prevent loss of life, (2) prevent the loss of an aircraft, and (3) reduce the cost of any damage.

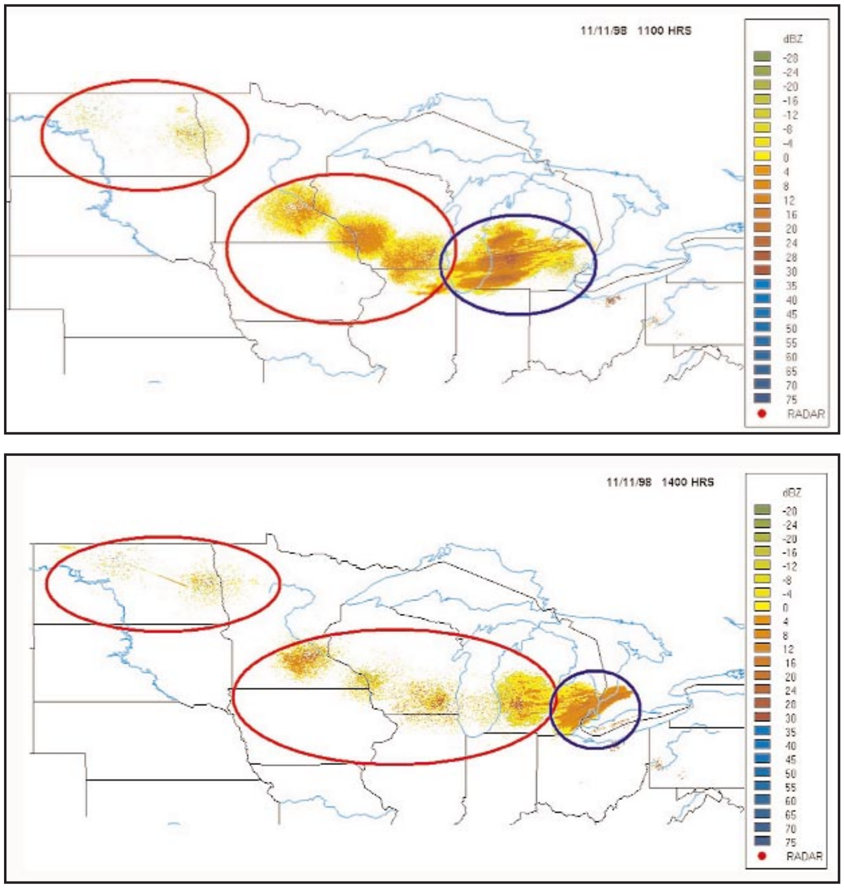
The immutable laws of physics figure prominently in a bird strike, and one of those laws says that the bigger the bird, the greater the impact energy and the higher the probability of damage. Therefore, to achieve the three risk management priorities listed above, we need to reduce the number of strikes from large birds. Graphic representations of bird strike data from North America clearly depict peaks in strikes during the spring and fall migratory periods. Many species, such as waterfowl, are more frequently hit during the migration season.

Factors That Influence Bird Strikes

About 10 years ago, I started research on where and when Air Force aircraft were hitting two large bird species, turkey vultures and red-tailed hawks. These two species account for nearly 27 percent of the identified strikes and 53 percent of the risk (probability of damage) to aircraft flying low-level missions. A careful analysis of the data indicated a higher strike rate with turkey vultures in late summer. Why? That's when juveniles leave the nest and turkey vulture population density is at its highest. The more vultures present, the higher the bird strike rate. In contrast, red-tailed hawk strike rates peaked in the *spring,* which represents the time when mated pairs establish territories and the time of year when they spend much of their time on the wing.

The US BAM can describe the X/Y distribution of large birds and the day-of-the-year and time-of-day components. However, to precisely describe the behaviors that bring birds into conflict with aircraft requires knowledge of the weather, too. Weather conditions help determine how high and how far birds will travel. Weather also determines if birds will leave an area to migrate.

Key weather factors, like thermal depth, which drive the circumstances of a strike, vary for all of the larger bird species that are regularly struck by aircraft and influence bird strike rates. As thermals increase in height, they enable birds to soar to greater heights. Because turkey vultures generally follow those thermals up, it takes them *above* the altitudes that aircraft typically fly on low-level routes, *decreasing* the incidences of turkey vulture bird strikes. On the other hand, the number of strikes remains the same for red-tailed hawks. Even though they use thermals too, if a hawk soars too high over its territory, it runs the risk of provoking a retaliatory attack from neighboring birds for encroaching on their turf!



Figures 1 & 2
Using clever imagery processing, NEXRAD captured the movements of some tundra swans through the North Central U.S. in figure 1. Figure 2 depicts movement of the same grouping of birds 3 hours later. The areas circled in red indicate those regions where NEXRAD was looking for bird returns, while the areas circled in blue indicate regions where NEXRAD was painting precipitation. The scale on the right indicates water density (lowest to highest).

It would be impossible for a pilot alone to process these and the many other factors that drive bird strike rates and then apply them to risk management principles before each flight.

Evolution of the BAM

Think of the Avian Hazard Advisory System as a dynamic version of the US BAM. It takes current weather data into account and calculates the risk large bird species present, based upon the relationships we've found between behavior and strike rate with each species. Test results show that AHAS can predict bird conditions 24 hours in advance. These 24-hour predictions are often less restrictive than the US BAM because AHAS forecasts recognize that birds don't migrate with strong headwinds or soar without thermals. In some cases, the AHAS forecast may identify higher risks than predicted from the historical US BAM data.

AHAS also uses the WSR 88-D Next-Generation Weather Radar (NEXRAD) system to monitor bird activity in near-real time. In simple terms, birds are bags of water, so sensitive radars such as NEXRAD can't differentiate between "bags of water wrapped in feathers" and the same volume of water distributed as precipitation. But rain tends to have both horizontal *and* vertical distribution—a storm can be 20,000 or 30,000 vertical feet in size and cover many square miles on the ground—whereas large movements of birds tend to lack any significant vertical distribution. Also, most birds on the East Coast fly below 4,000 feet because terrain there is relatively flat, but may fly to 12,000 feet in other parts of the United States because of terrain. These distinctions, along with some clever weather data processing to "remove" the vertical distribution of the precipitation from the radar display, makes it possible to show only the returns from birds.

This technique was developed specifically for the AHAS project and enables turning on and turning off the risk levels presented in the US BAM in near-real time, providing for regular updates of current bird conditions that are 20 to 35 minutes old. These would be posted at hourly intervals on the AHAS web site and provide the real picture on current flying conditions to a SOF or pi-

continued on next page

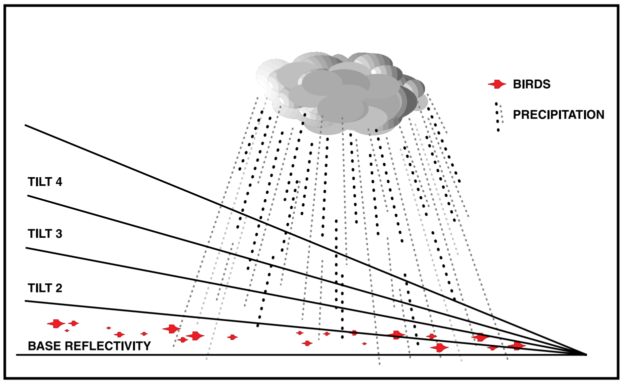


Figure 3
Birds generally fly at one altitude, while precipitation generally permeates multiple altitudes. This illustration gives a simplified explanation of how NEXRAD can be used to distinguish birds from precipitation.

lot. Please note. Good bird detection is available where there is significant NEXRAD radar coverage overlap. See figure 4.

The forecast data generated by AHAS, along with the observed weather conditions, were posted on the AHAS internet at http://www.ahas.com/during the Phase I test period. In Phase II, which is now underway, the AHAS is being expanded to cover two-thirds of the lower 48 states. Within 2 years, it should cover all of the lower 48 states. In the first quarter of CY99, we'll start posting real-time updates and forecasts. By the end of the year, coverage will expand to cover all VR and IR routes, MOAs, ranges, Latin American areas, and military airports in the eastern one-third of the US.

So, how well did AHAS work during the test phase? Due to exceptionally mild weather conditions during the fall of 1998, many migrant waterfowl stayed in Canada until well after they would normally have been expected in the northern United States. When the weather abruptly turned cold in November just before the Veteran's Day holiday, a warning was posted on the AHAS site 36 hours before the bulk of migrating birds hit the East Coast.

Based on the AHAS warning, HQ ACC/SEF issued a bird warning via e-mail to all flying units as their members returned from the Veteran's Day holiday. The forecast system showed probabilities of "One," *the highest possible,* for this significant event. *Twenty-four hours after the warning was posted, most of the migration corridors in the lower 48 states were saturated with migrating waterfowl.* Birds normally stop over in the northern states, but since 6 inches of fresh snow covered the ground, they pressed on further south.

Considering that it was undergoing test and evaluation, the system also performed well during the rest of the test period. Fine-tuning was (and still is) required to achieve higher levels of accuracy, but the predictions are reliable. Observations and predictions made from the Panama City, Florida, base were validated in the field by biologists equipped with a mobile radar system and thermal imaging camera, a system capable of very accurately monitoring and describing bird activity day and night.

What's Next for the AHAS?

Now that we can reasonably predict bird activity with AHAS, do we still need the US BAM? Absolutely! The US BAM and the AHAS go hand-in-hand. Remember that the US BAM is *the* historical record of birds hazardous to aircraft, and it underpins the AHAS forecast and current condition assessments. And the AHAS dynamically drives the US BAM. In the next few years, the US BAM will be refined, based in part on observations made by AHAS. As an example of the relationship between the two, consider this: Weather forecasts are based on the historic trends and relationships of observed conditions and what they will become in the future. We would no more expect our weather forecasters to forecast from the historic record without current data and forecast models than we would expect them to make predictions based solely on what they currently observe.

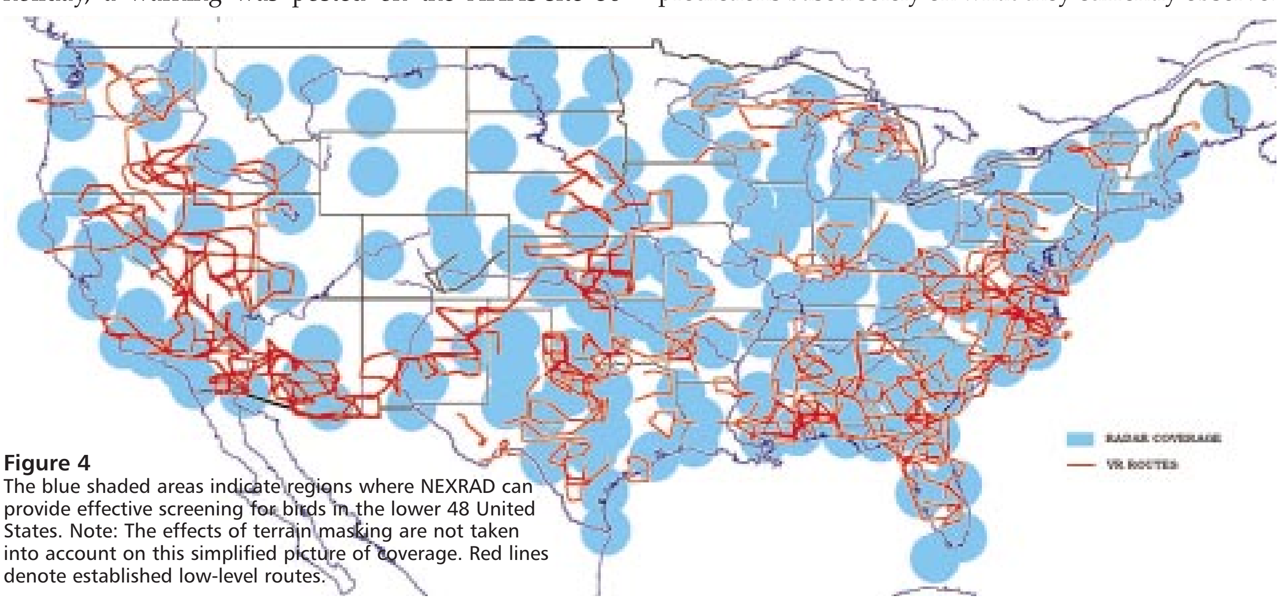


Figure 4
The blue shaded areas indicate regions where NEXRAD can provide effective screening for birds in the lower 48 United States. Note: The effects of terrain masking are not taken into account on this simplified picture of coverage. Red lines denote established low-level routes.

Date	December 1, 1998	
Hour	[illegible]	
Low Level Routes		
VR 1074 A-B	LL Route	Moderate
VR 1074 B-C	LL Route	Moderate
VR 1074 C-D	LL Route	Moderate
VR 1074 D-E	LL Route	Moderate
VR 1074 E-F	LL Route	Moderate
VR 1074 F-G	LL Route	Moderate
VR 1074 G-H	LL Route	Severe
VR 1074 H-I	LL Route	Severe
VR 1753 A-B	LL Route	Low
VR 1753 B-C	LL Route	Low
VR 1753 C-D	LL Route	Low
VR 1753 D-E	LL Route	Low
VR 1753 E-F	LL Route	Low
VR 1753 F-G	LL Route	Low
VR 1753 G-H	LL Route	Low
VR 1751 A-B	LL Route	Low
VR 1751 B-C	LL Route	Low
VR 1751 C-D	LL Route	Low
VR 1751 D-E	LL Route	Low
VR 1751 E-F	LL Route	Low
VR 1751 F-G	LL Route	Low
VR 1751 G-H	LL Route	Low
VR 1751 H-I	LL Route	Low
VR 1751 I-J	LL Route	Low
VR 1751 J-K	LL Route	Low
VR 1751 K-L	LL Route	Low
Airport areas within 15nm		
Seymour Johnson AFB	AFB	Low
Airspace		
R5314 East Alligator River	Range	Low
R5314 West Alligator River	Range	Low
Farmville MOA (4B)	MOA	Low
Gamecock B,C,D	MOA	Moderate

Figure 5
This figure shows an output from the AHAS's "Current Conditions" web page. The first column indicates the name of the air space evaluated, the second column gives the air space type, and the third column provides the risk assessed from NEXRAD data. AHAS will also provide a "Forecast Conditions" web page.

The distinction between the US BAM and the AHAS to an end user will soon begin to disappear. The server at the AHAS web site will be set up to deliver output from the US BAM for long-range predictions, furnish AHAS forecasts within 24 hours of a flight, and provide NEXRAD observations of current conditions. Anyone with a computer, a web browser, and an Internet connection will be able to access the data, eliminating the need for expensive software and platforms currently required to use the US BAM. The more refined BAM for the Dare County Bombing Range, North Carolina, will be ported to the AHAS web site, and the Moody AFB and Grand Bay Weapons Range BAMs will be written from the outset to be hosted on the web site or from a CD-ROM.

The AHAS concept was developed and funded by HQ Air Combat Command (ACC) primarily to minimize the risk to ACC aircraft since, due to the nature of their mission, that command's aircraft have the greatest exposure to bird strikes. Even though developed primarily for low-level, fast-moving aircraft, the AHAS model does have value for large aircraft operators as well.

The Air National Guard has contributed additional funds to begin linking data from AHAS into the US BAM. As the US BAM and AHAS systems converge, two research teams will continue to refine them: The US Air Force Academy will supervise the US BAM; and a contractor team based in Panama City will oversee the AHAS.

With guidance from the USAF BASH Team at the AF Safety Center, the two research groups will concentrate on their areas of expertise and continue the innovation that has brought us so far over the past few years. Five years ago, there were no Geographic Information System (GIS)-based BAMs. Four years ago, before the Dare BAM, there were no BAMs available for a pilot to use on a desktop PC. Today, we can monitor bird migration in near-real time and predict bird behavior. With these new tools, we can synthesize the information to effectively manage the bird strike risk and help relieve aircrews, SOFs, aircraft schedulers, and commanders from becoming bird experts.

I'd like to leave you with some final thoughts. To achieve the low-level mission risk management and the mission training goals outlined above, we may have to trade a higher bird strike rate (number of hits) for hitting fewer large birds. At times we'll have to fly in areas where small birds are active, rather than on routes passing through active waterfowl migration corridors. We can't dodge all of the birds all the time, but with AHAS, we'll be able to avoid hitting the big birds most of the time. ✈

About the Author. Mr. Kelly has 18 years of experience in the BASH Program. He started his career as a falconer and bird control specialist with the USAF 3d AF BASH Program in the UK. After obtaining his masters degree with a thesis on Bird Avoidance Modeling, he moved to North Carolina and developed the Dare County BAM for HQ ACC. He is currently directing the development of the AHAS project and the Moody AFB BAM.

Hi! I am a bird in Africa, which has the highest bird strike rate in the world. This is not surprising considering the number of unmanned strips humans have erected in our natural habitat. Even the major airports are located in rural areas.

We have been flying a lot longer than you have, and yet we have two simple rules: We always take off into wind, and the fastest that we travel is straight down.

A few years ago, I sent this same letter to the aviation fraternity in South Africa, and through cooperation, we have reduced coming into contact with one another.

If you see us on the ground and circumstances allow, then fly downwind of us. If you see us in the air, do not dodge and weave, since we do the same to avoid our natural predators. In the air, if you pull up and away from us, we will dive straight down and away from you. If you stick to these simple rules, we will stop damaging your aircraft and live to look after our families.

Contributed by:
LTC Lex Rock Heemstra
South African Air Force