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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.

BASH 1998

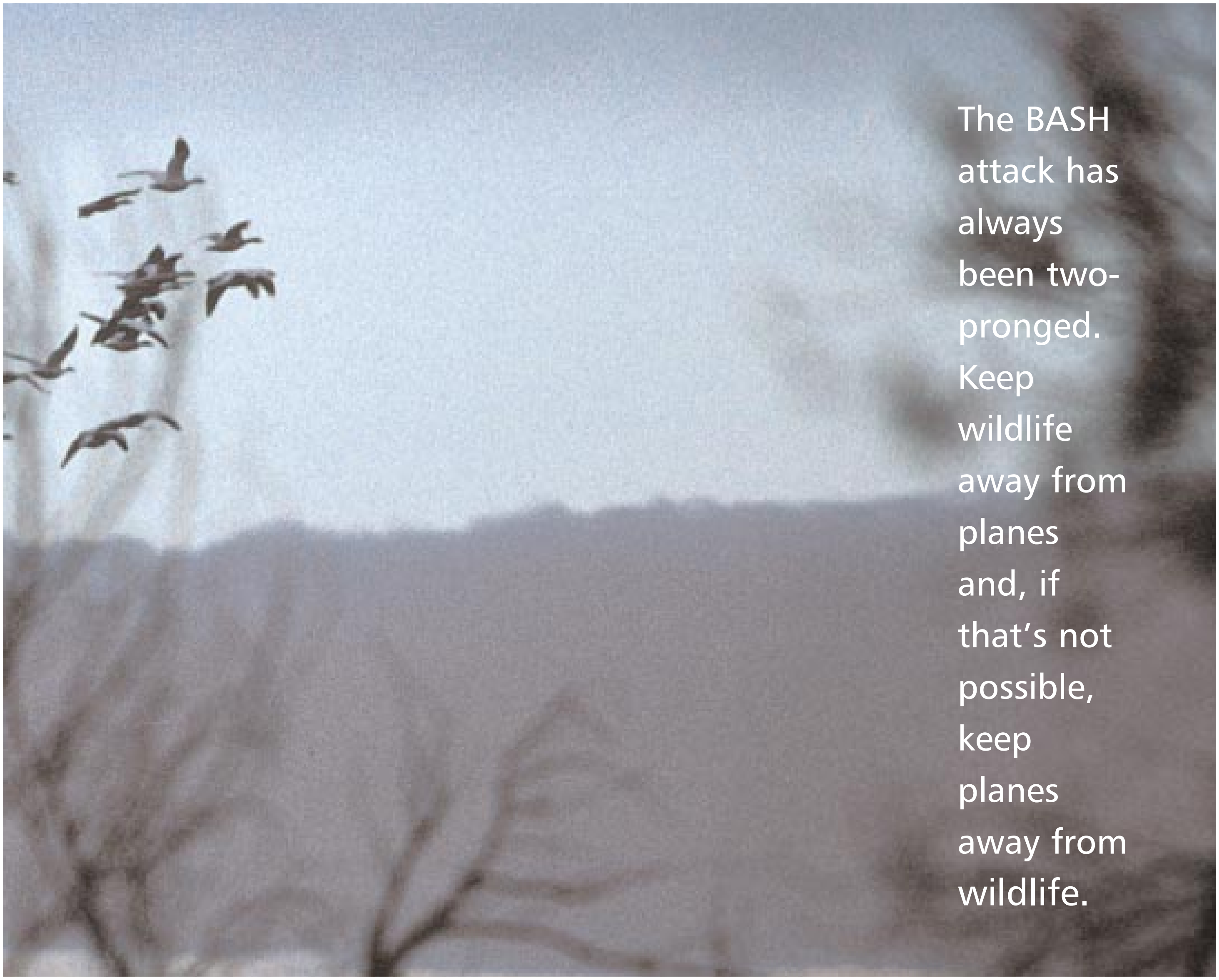
LT CURT BURNEY
USAF BASH Team
HQ AFSC/SEFW

Coming straight out of the gates of pilot training where my stomach finally surrendered its last meal to the spunky -38, I was a common cynic in the Bird Aircraft Strike Hazard (BASH) world. I thought a good old "controllability check" would solve any collision with a feathered foe. My past year on the BASH Team has taught me this reactive ideology has cost lives, not to mention millions of dollars.

The "natural phenomenon" label assigned to such wonders as rain, sleet, and hail has been applied to wildlife strikes. This is unfortunate, because unlike weather, animals perceive and respond to stimuli in their environment. Aristotle wrote, "Nature does nothing uselessly." Because this is true, animals are predictable, which allows them to be deterred, scared off, and/or avoided.

The BASH attack has always been two-pronged. Keep wildlife away from planes and, if that's not possible, keep planes away from wildlife. The airfield provides an environment for effective animal dispersal and habitat control/manipulation. The most common methods used are pyrotechnics, maintaining grass height at 7 to 14 inches, and draining pooled water. However, the best tool in any airfield program has always been a warm body excited about the job. Additionally, tower operators and bird dispersal units need to be synchronized in their responses to hazards.

Airspace between aerodromes incurs the opposite challenge of keeping aircraft away from birds. This task is exponentially more difficult since it obviously entails more coverage and more birds. To tackle this monumental chore, we enlisted the help of millions of American



USAF Photos by MSgt Perry J. Heimer

birders out there. Bird watchers, participating in the No. 1 hobby in America, provided two huge winter and summer data sets to make up the Bird Avoidance Model (BAM). Bird watchers go to specific places to see certain types of birds. This predictability is the backbone behind the bird distributions described in the new map-based BAM. As a side note, if you see the reflection of what seems to be binocular lenses, it may behoove you to pull back on the stick. For more on the BAM, see the "BAM 101" article in this issue.

Another extremely powerful tool recently used by aviators on the east coast is the Avian Hazard Advisory System (AHAS). While the BAM is strictly a historical archive, AHAS promises close to real-time avoidance and daily forecasting. First, general weather forecasts are applied to get 24-hour impact status, then AHAS incorporates NEXRAD (WSR-88D weather radar) imagery to detect and follow flocking birds. Unfortunately, NEXRAD doesn't cover all of the U.S. It's hoped we will soon see it expand, which will allow for greater coverage and forecasting. For more on AHAS, please turn to the AHAS article within these pages.

Scope of the Problem

My first year as a member of the BASH Team coincidentally finished as one of the Air Force's most costly. Although potential causes have started surfacing, a real correlation has yet to be made. In 1998, the number of wildlife strikes didn't rise significantly from past years. In contrast, however, the cost of the damage they caused was triple that of 1997 and proved to be our third highest cost total since 1985. The most significant contribution to 1998's damage cost was an Iowa Air National Guard F-16 that was lost over Nebraska when it struck five American white pelicans. Approximately $16 million of the $29.6 million total for 1998 is attributed to this Class A.

continued on next page

WILDLIFE STRIKE COSTS 1985 - 1998

YEAR	COUNT	COST
1985	2717	$5,452,151.00
1986	2850	$18,081,085.00
1987	2727	$239,343,073.00
1988	2642	$3,353,576.00
1989	3064	$24,408,483.00
1990	2928	$6,471,984.00
1991	2772	$17,656,528.00
1992	2283	$26,001,901.00
1993	2445	$13,150,533.00
1994	2362	$15,811,416.00
1995	2649	$84,864,258.19
1996	3102	$8,773,172.15
1997	2714	$9,810,082.59
1998	3054	$29,602,218.24
TOTAL	**38,309**	**$502,780,461.17**

Data Usage

The statistical significance of these results is limited, but they do give us trend information which can be quite helpful. From this data, we can sense when and where the strikes are occurring. However, rates need to be calculated in order to get a truly accurate and meaningful picture. Without this underlying information, comparisons made between years, months, routes, etc., can be ambiguous. To get the clearest picture, additional information about the actual strike must be collected (flying hours, altitude, and low-level usage, etc.).

Along with the rates, a greater analysis of remains would tremendously improve the products of the BASH database. Identification of remains at the Smithsonian provides priceless information, so please keep sending the scraps to Carla and Roxie. Our predictive ability increases with awareness of the type of animal struck, because that information allows the BASH Team to focus on specific behaviors and/or distribution of birds involved in strikes. See the article "Where *Do* All Those Feathers Go?" also in this issue.

Specific Problems in Reporting

Unfortunately, the current BASH database has fallen victim to the "garbage in—garbage out" principle. Validity of reports and statistics drawn from the database obviously rely completely on strike data entered. However, we are seeing several errors in reporting, and those are hurting our ability to properly interpret the data. So please read on and see if you can help us solve the problems.

Inconsistent Reporting. The most significant problem is inconsistent reporting. We ask that you report each month and that you input all reportable strikes. And please, ensure that all wildlife strikes are reported in accordance with AFI 91-204, *Safety Investigations and Reports.* "All wildlife strikes" refers to damaging *and* nondamaging collisions with any type of animal (excluding bug smears). Databases and statistics become more accurate with more valid entries. The strike record allows us to recognize and address problems.

Duplication. While some strikes don't get reported at all, others are being sent two or three times. It may be that duplicate records are being sent in because of confusion about who should actually report the strike to the BASH Team. AFI 91-204 provides guidance on who should submit the strike report. Please remain aware of this definite possibility when creating or receiving stats based on the strike database. It will help us solve our never-ending process of cleaning the data and checking for duplicates.

Nonstandard Format. Incomplete reports are also affecting the usefulness of the database. This is mostly due to the use of nonstandardized formats for entering strike information. We would prefer everyone use the Access™ database for reporting. However, if this isn't a viable option, use AF Form 853, Air Force Bird Strike Report, to report strikes. Please try to gather as much information as possible about the strike. The BASH database now includes fields for aircraft tail number and unit (wing/group and squadron). These new inputs will, hopefully, allow us to start computing strike rates. Also, if the date of the strike is unknown, please enter your best guess. Even the ballpark date of a strike is extremely helpful. Cost assessment and impact analysis are other fields needing careful estimation and input.

Remember, in the business of wildlife damage control and mishap analysis, knowing the complete outcome of an event is critical in speculating the cause, formulating an effective plan, and assessing priorities. You are our first link as gatherers and reporters of the pertinent data.

Wildlife ID

Animals found on the runway are often easily recognizable. Many strikes, however, leave remains that have parts of, or only a few, feathers. At this level, the process of identification can be misleading and downright tricky. For the sake of uniformity and adhering to regulations, send all remains to the Smithsonian. Using a standard process allows for more precise error assessment and quality control. The cost is (usually) just a 33-cent stamp.

The paid experts in Washington have a library of approximately 600,000 specimens they use for comparison. Please help us take advantage of this very powerful tool.

Software Improves Reporting

The process of reporting wildlife strikes has recently been redefined. This change pertains to those possessing a license to Microsoft Access™ 97 and, more importantly, those having the will to dive into a new system. The BASH Team has moved the strike database into Access™ in order to take advantage of compatibility concerns and to ultimately allow for greater use of archived data.

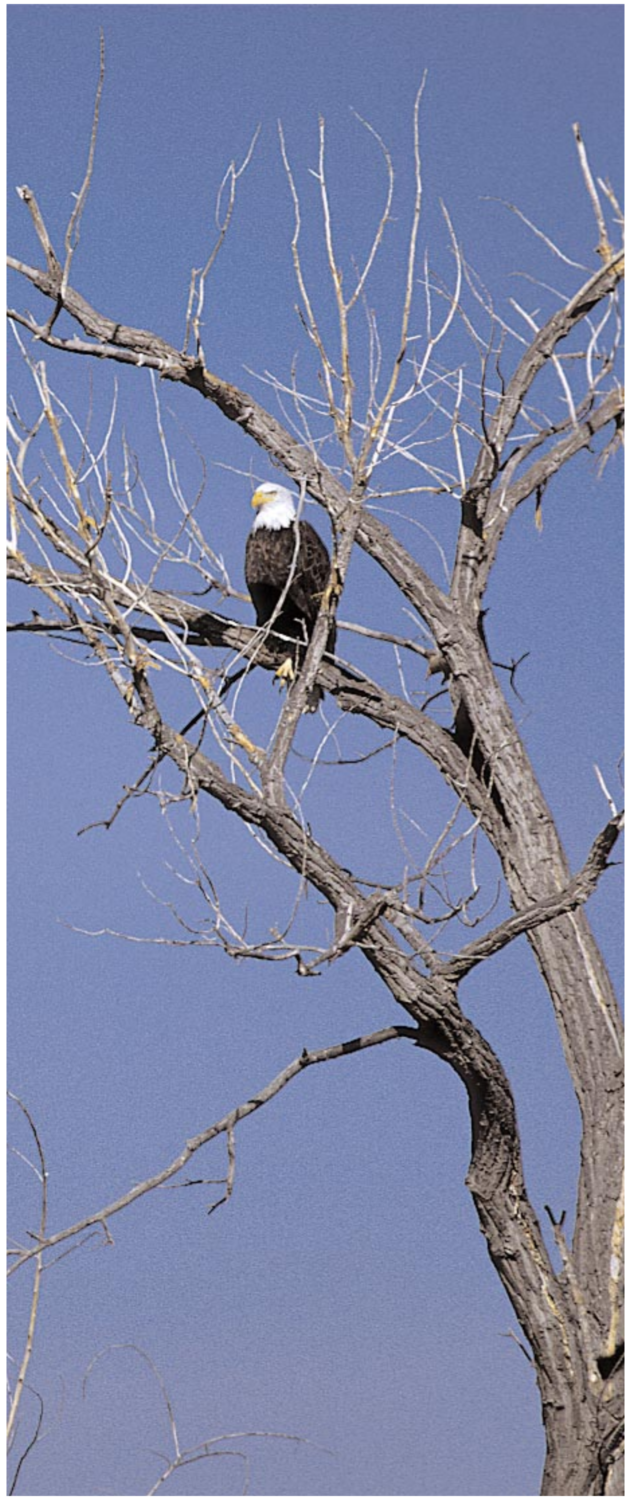
Compared to the database's prior form, the Access™ version is much easier to use. Programming, querying data, creating forms and reports, and editing records have all been made simpler. Unfortunately, the Safety Center cannot provide every user with a copy of Access™ 97. This precludes us from requiring its use. Therefore, it's up to individual safety offices to obtain Access™ 97 and take advantage of this tremendously improved program.

Advantages of the new reporting system over the old one are numerous. First and foremost, FormFlow™ is "history" for those using Access™. As a result, reporting efficiency has improved enormously. The Microsoft family allows for direct tie-ins between the different applications. Access™, Excel™, and Word™ are all related, which permits easy importing/exporting of material between the three. Also, the new Access™-based reporting system works with MS Exchange™/Outlook™ to automatically create an e-mail when the monthly submittal is due. The new system allows bases to keep records of their strikes in a database similar to one used by the BASH Team. The identical structure of the databases' tables permits an easy exchange of data between bases and the BASH Team. Standardization of archiving wildlife strikes will ultimately lead to improvement of information management. Data retrievals take seconds to complete. E-mail and the BASH web site do away with the need for faxes and other hard copy transfers of info which, in turn, does away with the re-inputting of data at the receiving end.

For those of you who, like me, often struggle with new software, improving your reporting efficiency with this new system may seem out of reach. If so, please consider learning about Access™ via books or on-line tutorials. Also, the new system almost certainly contains unintended workings and bugs which will definitely need to be fixed or adjusted. Subsequent versions will have new features improving the database and, hopefully, making it more user-friendly. Please feel free to provide the BASH Team with any inputs/concerns/problems needing to be addressed for the next update.

Conclusion

The future of the BASH world seems bright indeed. Safety and distribution issues concerning pyrotechnics are steadily getting worked out. The system of reporting strikes is, hopefully, freeing up time for everyone. The BAM and AHAS will certainly increase the level of safety in between takeoff and landing. Stealing a quote from the good man at AETC, "Finer than frog's hair" would describe my outlook on things. Take care and fly safe. ✈



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.

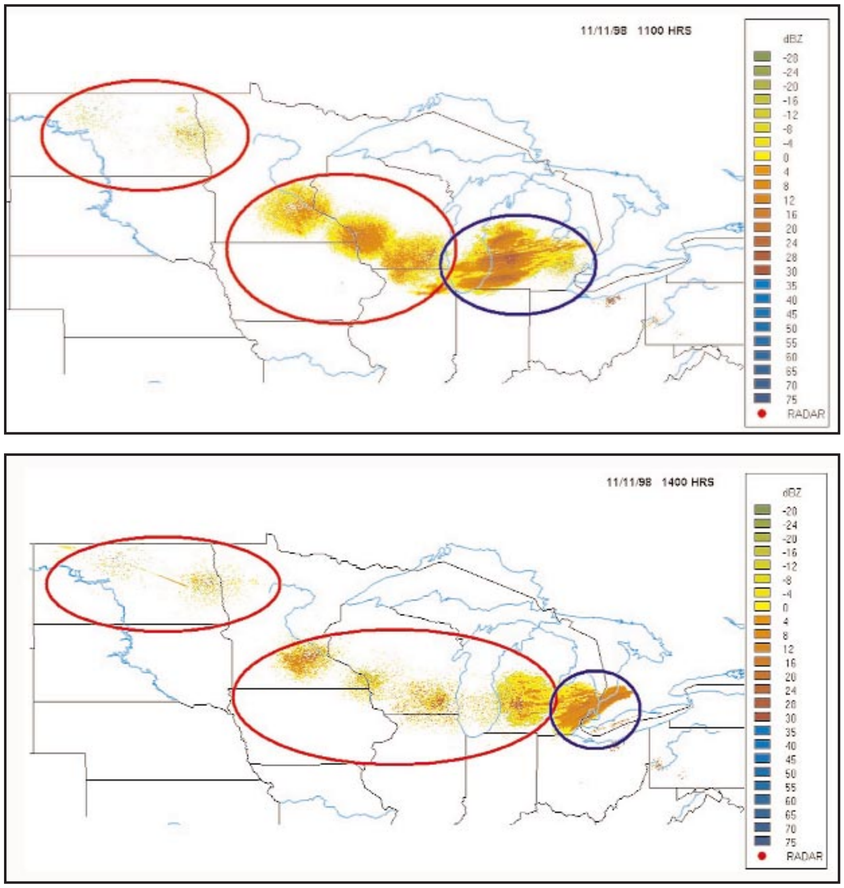
The immutable laws of physics figure prominently in a bird strike, and one of those laws says that the bigger the bird, the greater the impact energy and the higher the probability of damage. Therefore, to achieve the three risk management priorities listed above, we need to reduce the number of strikes 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-

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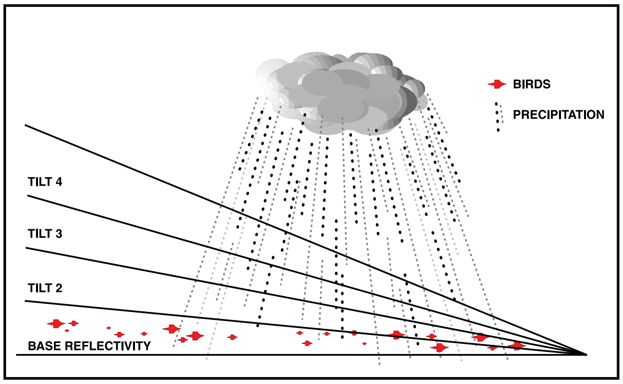

Figure 3
Birds generally fly at one altitude, while precipitation generally permeates multiple altitudes. This illustration gives a simplified explanation of how NEXRAD can be used to distinguish birds from precipitation.

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.

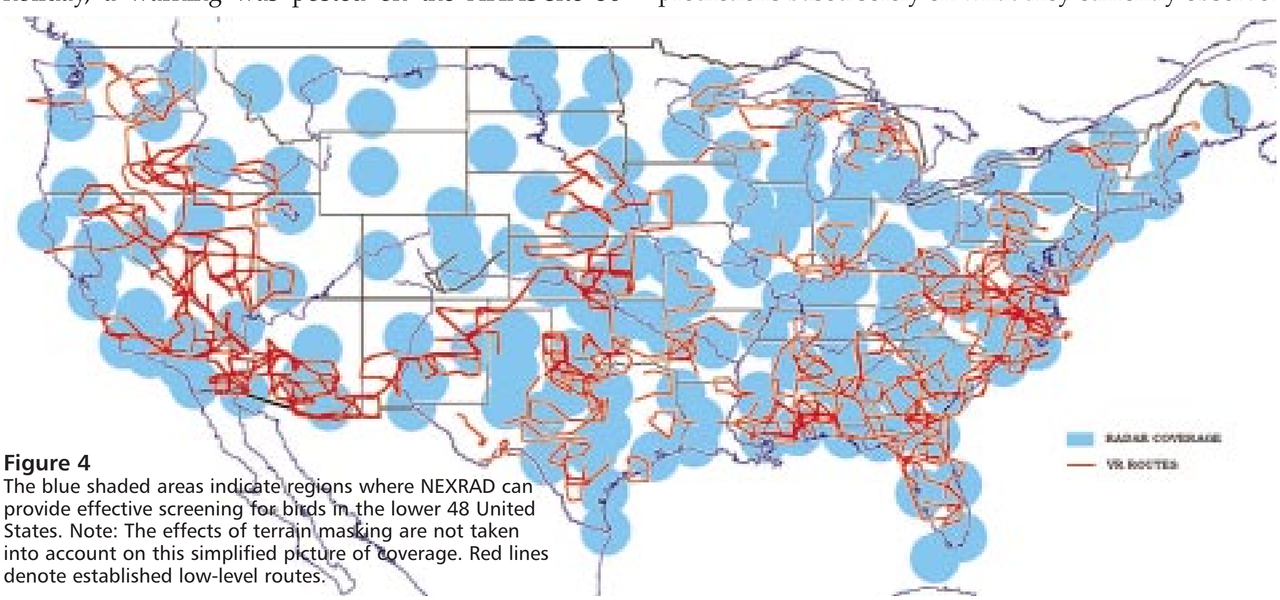

Figure 4
The blue shaded areas indicate regions where NEXRAD can provide effective screening for birds in the lower 48 United States. Note: The effects of terrain masking are not taken into account on this simplified picture of coverage. Red lines denote established low-level routes.

Date	December 1, 1998	
Hour	3z	
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 (H)	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

BAM (Bird Avoidance Model) 101

LT CURT BURNEY
USAF BASH Team
HQ AFSC/SEFW

Air Force aircraft experience bird strikes every day. Since the vast majority of them result in little real damage, we sometimes forget their true destructive potential. But we do get reminders. Just last year, an encounter between an F-16 and five American white pelicans resulted in one destroyed aircraft, an injured pilot, and some very dead birds. And none of us will ever forget the 1995 Class A mishap where just a few Canadian geese brought down an E-3 AWACS aircraft, causing the death of all 24 crewmembers. That AWACS mishap focused a lot of attention on the potential for similar bird/aircraft conflicts in the future and became a catalyst for several new initiatives, including the current Bird Avoidance Model (BAM). Does your BASH Team take bird avoidance strategies seriously? You bet we do!

Because this is *Flying Safety* magazine's "BASH/Wildlife Hazards" issue, we thought it would be helpful to give you an overview of how the current version of the BAM was developed. We'd also like to include answers to some of the questions we're most commonly asked and help you better understand the BAM, so that you can use it more effectively.

The BAM: Then and Now

Constructing any wildlife model is challenging, but creating bird models is especially daunting because birds are so incredibly dynamic. Whether involving seasonal migrations or just daily activities, their movements can cover great distances.

The previous BAM output product (figure 1) combined lots of data sets into a graph that depicted bird strike risk for a particular area or route in X/Y coordinate fashion. The month and period of the day (the X axis) was plotted against the number of expected bird strikes per one million nm (the Y axis). The intent was noble, and it helped with mission planning, but it wasn't very user-friendly and didn't really indicate where avian activity was most (or least) concentrated. Now fast-forward to our current BAM.

The development of the BAM we use today began in the summer of 1996, and represents a major evolution in bird modeling. Modern Geographic Information Systems (GIS) have provided the improved modeling tools that enable more detailed products. The new GIS-based BAM furnishes a representation of bird density (based on total bird weight) *overlaid on a standard map* with a resolution of 1 square kilometer. This output product (figures 2a, 2b, 2c, 2d) allows the user to see bird density levels in color—three shades of green (low hazard), three shades of yellow (moderate hazard), three shades of red (severe hazard)—all plotted on a map. ***Please note:*** *The current BAM erroneously labels them as "Risk Levels." They are* ***hazard*** *levels. This is further explained in the section titled "What You Should Remember About BAM Limitations."* It even divides the year into 26 two-week intervals with selection of 4 daily periods (dawn, day, dusk, and night) possible, creating a total of 104 different coverages for the lower 48 states. *(Editor's note: The CD version of the BAM depicts 4 daily periods, while the internet version of the BAM depicts only day and night.)*

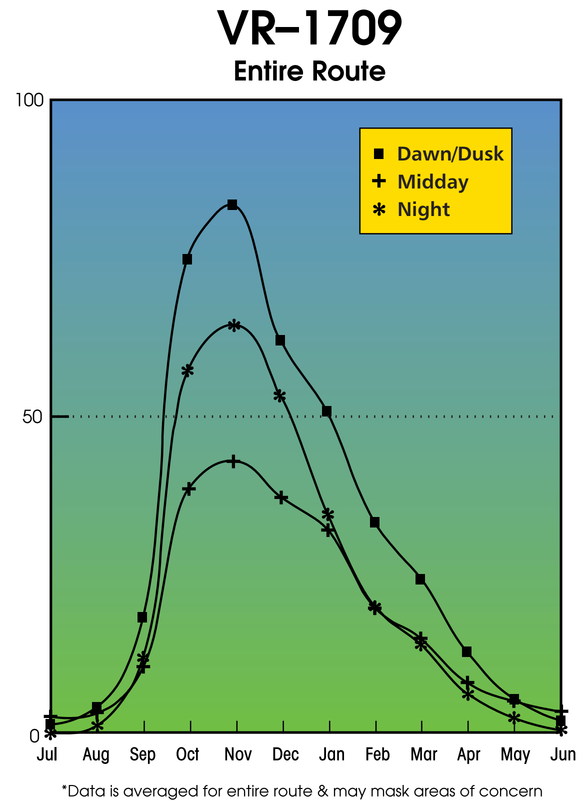

Figure 1

Data found in the old BAM model was very limited. It encompassed mostly waterfowl bird species and had very little raptor data. Through the incorporation of GIS, the new BAM represents 60 species of birds (table 1) that are most likely to pose a threat to aircraft flying at low levels. Selection of those species was based either on those that were previously involved in bird strikes, as registered in the BASH database, or on analyzing their attributes, including flocking tendency, bird mass, migration background, and flying behavior, and postulating their potential hazard to low-level flight. The 60 species were grouped into 16 composite types according to behavior, in order to simplify the modeling process.

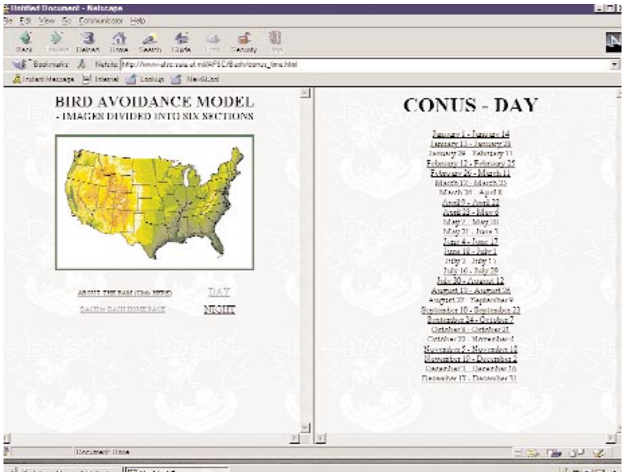

Figure 2a
This is how the BAM web page appears to the user. By choosing "Day" or "Night," and then the 2-week period in which you're interested, the BAM will provide images of the expected bird densities for the lower 48 United States.

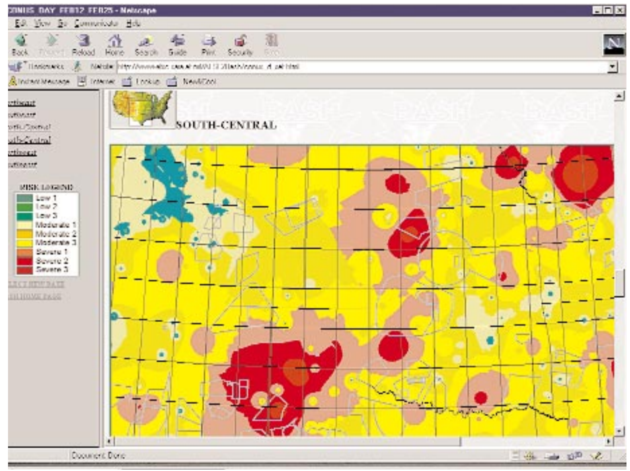

Figure 2b
This image shows expected bird densities for the south-central US for the period 12-15 February. The legend (left) depicts the hazard from low to severe.

Summer and Winter Bird Counts

Gathering the necessary data for 60 different bird species was the first and most monumental task in the current BAM's development. While many sources of data were used, the U.S. Geological Survey's (USGS) data sets on summer and winter bird populations were the two main ingredients.

The Breeding Bird Survey (BBS), sponsored by the USGS is the primary tool used to establish summer distributions and the 26 two-week interval component parts of the BAM. Instituted in 1965, the BBS was organized to develop a reliable index of North American bird populations to help monitor fluctuations in counts and distribution. The BBS is conducted during the busy period of the nesting season—primarily June in most regions of the United States—and is based on roadside surveys performed by observers. These observers stop every half-mile along a 24.5-mile BBS route and spend 3 minutes at each of the 50 stops, counting all birds heard or seen within one-quarter mile. By 1966, there were more than 600 established survey routes. Today the BBS encompasses 3,700 routes, of which 2,900 are observed/updated annually.

BBS data is compiled and sent each year to the USGS's BBS office at Patuxent Wildlife Research Center in Laurel, Maryland, where it is computerized and continental-scale "relative abundance" maps are created. BAM developers similarly used the same data to create the bird mass aggregates that make up the "risk surface" depicted on maps found on the BAM web site. Although it's a complex task, acquiring, processing, and analyzing BBS data provides the best source of information on bird populations.

However, limitations do exist. The BBS tends to distort bird range boundaries; therefore, the abundance maps can provide only an approximation of range edges. As with all statistical analyses, sample size is a big player on precision, too. And, as one would expect, BBS regions with fewer routes are less precise than BBS areas with more routes. The BBS seems to be attracting more and more interest and promises to be with us for a while. Growth in its coverage will lead to increased accuracy for the BBS and, in turn, the BAM.

The USGS receives its winter data set for bird distributions from the National Audubon Society, which sponsors the annual Christmas Bird Count (CBC). As its title implies, the CBC is administered within 2 weeks of 25 December. Thousands of volunteers participate in these annual bird counts and put in several million hours of observation. Unlike the BBS roadside methodology, the CBC sample area is based on a 15-mile-diameter circle. CBC participants spend 24 hours observing and counting the birds located within their assigned circle. Total number of observer hours is recorded too, since the number of birds seen is also a function of effort. Since its inception in 1900, the CBC has grown to over 2,500 circles.

Although the National Audubon Society's CBC is a very large survey, it has many limitations that must be taken into consideration. One of the main factors is the varying ability of survey volunteers. It's one thing to factor observer party sizes and number of hours of observation into the equation, but assigning a value to each observer's *ability* is a shade more difficult. Another limitation is that the CBC circles aren't uniformly the final product. For the relative abundance maps, the areas with "remote" circles (survey points with substantial spacing between neighboring counts) required a lot of extrapolation and "smoothing." Obviously, these regions will tend to be less accurate and have edges that are less well defined. As with the BBS, we hope the increasing interest in bird watching will lead to expansion in coverage and greater accuracy for the CBC and, in turn, the BAM.

continued on next page

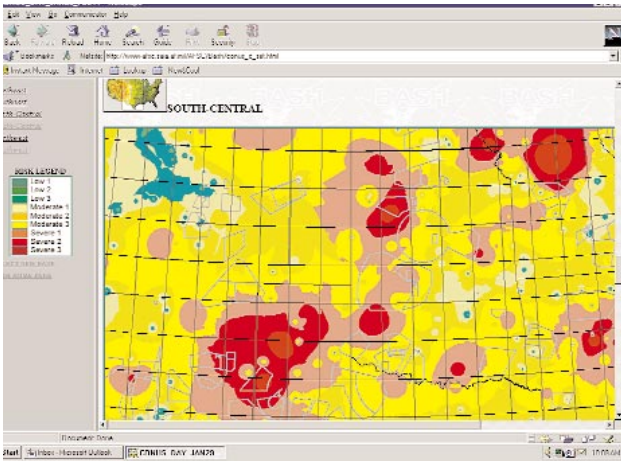

Figure 2c
This image also shows the south-central United States, but for the period 29 January-11 February. Note the subtle differences in bird densities here and in figure 2b.

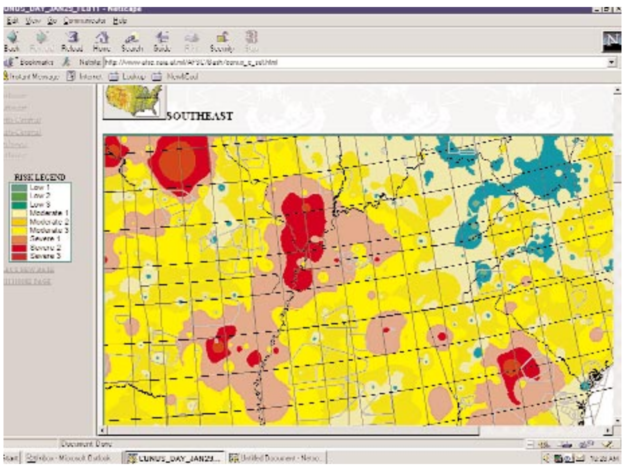

Figure 2d
Here's an image of the southeastern United States for the same period as figure 2c, 29 January-11 February.

Why There Are No Spring and Fall Bird Counts

Because bird movements are so highly dynamic in the spring and fall, it's not possible to obtain BBS/CBC-style survey data on bird populations. Therefore, to provide a BAM that covers the entire year, spring and fall data is *extrapolated* from the summer and winter BBS/CBC data. This helps to provide an aggregate weight layer for the "transitory" spring and fall seasons. You may wonder how accurate this data is since the BBS and CBC data have some built-in assumptions. Even with those assumptions built in, the BBS and CBC data represent the most accurate bird count information available.

Extrapolating nonuniformly distributed, widely spaced data was probably the most formidable challenge that the BAM developers faced. To determine spring and fall bird distributions, the biggest questions are (1) When do they arrive and when do they depart? and (2) What path do they take during their migrations?

The answers to the "When do they arrive and depart?" questions came mostly from the U.S. Fish and Wildlife Service, since their refuge system provides a fairly adequate log of arrivals and departures for many types of birds. However, migratory dates can vary widely from year to year due to weather conditions, local food availability, predator relationships, and other factors. Since the BAM is based on strictly historical data, an average of all the available migratory dates was used.

Answering the "What path do they take during their migrations?" question was somewhat harder. Through the evolutionary process, many bird species have developed general travel paths from point A to point B. We recognize this and have included it in the BAM. While these paths haven't been identified for *all* species, examining such environmental factors as hydrography, land use, and land cover have provided help in identifying them. We're very hopeful that current studies involving radar, satellite telemetry, and other remote sensing devices will more sharply define migratory corridors for all birds. We can then incorporate this improved data into subsequent versions of the BAM.

What You Should Remember About BAM Limitations

By now, you should appreciate that the BAM is based on information derived from literally dozens of sources, much of it historical, while some of it is based on projections or interpretations. As you use the BAM, please keep these points in mind:

First and foremost, *the BAM is derived from fixed, historical data, so it doesn't adjust for real-time bird movements or population fluctuations.* Keeping the model current involves updating the BAM as new bird distribution data becomes available and migratory corridors are better defined.

The BAM models *hazard*, not *risk*. When using the BAM, aggregate coverage is often referred to as the "risk layer." This is misleading because the model incorporates only bird *weight*, which poses a *hazard* to flight. The BAM is used to assess the hazard to flight based on the bird mass in the area through which flight will occur. An assessment of *risk* requires that many more factors are represented, such as type of aircraft, flight profile, and altitude. With the bird mass assessment as the critical building block, past strike data and other resources can be used to estimate the risk due to birds.

The current BAM is *not* bird-specific. Sixty species are pressed together to create a single "layer." The capability to assess the contribution of a single species, or group of species, to the overall weight doesn't exist yet, but it's under development. Future versions of the BAM will extend this valuable option to all users.

Since only 60 bird species are represented, the hazard layer isn't a *true* measure of the total bird mass per square kilometer. *Only those species considered hazardous to low-level flight are included in the model*.

Even though the BAM does model the nocturnal behavior of many birds that migrate at night, such as waterfowl and songbirds, it does *not* include truly nocturnal species like owls and nighthawks. Furthermore, the

Table 1

Pelecaniformes
1. Brown pelican *(Pelecanus occidentalis)*
2. American white pelican *(Pelecanus erythrorhynchos)*
3. Double-crested cormorant *(Phalacrocorax auritus)*

Anseriformes
1. Tundra swan *(Cygnus columbianus)*
2. Canada goose *(Branta canadensis)*
3. Snow goose *(Chen caerulescens)*
4. Mallard *(Anas platyrhynchos)*
5. Northern pintail *(Anas acuta)*
6. American wigeon *(Anas americana)*
7. Blue-winged teal *(Anas discors)*
8. Green-winged teal *(Anas crecca)*
9. Cinnamon teal *(Anas cyanoptera)*
10. Redhead *(Aythya americana)*
11. Greater scaup *(Aythya marila)*
12. Ring-necked duck *(Aythya collaris)*
13. Canvasback *(Aythya valisineria)*

Charadriiformes
1. Killdeer *(Charadrius vociferus)*
2. Least sandpiper *(Calidris minutilla)*
3. Semipalmated sandpiper *(Calidris pusilla)*
4. Upland sandpiper *(Bartramia longicauda)*
5. Glaucous gull *(Larus hyperboreus)*
6. Herring gull *(Larus argentatus)*
7. Ring-billed gull *(Larus delawarensis)*
8. California gull *(Larus californicus)*
9. Greater black-backed gull *(Larus marinus)*
10. Laughing gull *(Larus atricilla)*
11. Franklin's gull *(Larus pipixcan)*
12. Mew gull *(Larus canus)*

Gruiformes
1. Sandhill crane *(Grus canadensis)*

Falconiformes
1. Turkey vulture *(Cathartes aura)*
2. Black vulture *(Coragyps atratus)*
3. Golden eagle *(Aquila chrysaetos)*
4. Sharp-shinned hawk *(Accipiter striatus)*
5. Cooper's hawk *(Accipiter cooperii)*
6. Northern goshawk *(Accipiter gentilis)*
7. Northern harrier *(Circus cyaneus)*
8. Red-tailed hawk *(Buteo jamaicensis)*
9. Swainson's hawk *(Buteo swainsoni)*
10. Ferruginous hawk *(Buteo regalis)*
11. Rough-legged hawk *(Buteo lagopus)*
12. Broad-winged hawk *(Buteo platypterus)*
13. American kestrel *(Falco sparverius)*

Ciconiiformes
1. Great blue heron *(Ardea herodias)*
2. Little blue heron *(Florida caerulea)*
3. Great egret *(Casmerodius albus)*
4. Snowy egret *(Egretta thula)*
5. Cattle egret *(Bubulcus ibis)*
6. Wood stork *(Mycteria americana)*
7. White ibis *(Eudocimus albus)*

Passeriformes
1. Horned lark *(Eremophila alpestris)*
2. American robin *(Turdus migratorius)*
3. American crow *(Corvus brachyrhynchos)*
4. European starling *(Sturnus vulgaris)*
5. Yellow-headed blackbird *(Xanthocephalus xanthocephalus)*
6. Red-winged blackbird *(Agelaius phoeniceus)*
7. Tricolored blackbird *(Agelaius tricolor)*
8. Rusty blackbird *(Euphagus carolinus)*
9. Brown-headed cowbird *(Molothrus ater)*
10. Common grackle *(Quiscalus quiscula)*

Columbiformes
1. Mourning dove *(Zenaida macroura)*

BAM is based almost completely on distribution and abundance data.

Other than what we classify as "daily activity assignments"—that is, deciding if a particular species of duck is active at night or not—bird *behavior* isn't a player in the model.

Finally, altitude data for birds is very limited. As a result, the model equates birds on the ground to birds in the air and doesn't differentiate between the two. Though listed here as a limitation, it's also a good thing. Two hundred thousand snow geese on the ground don't pose risk to an aircraft. But 200,000 snow geese spooked into the air by a coyote would!

BAM Today

The U.S. BAM can be accessed on the internet at www-afsc.saia.af.mil/AFSC/Bash/report_wmenu.html. It divides the lower 48 United States into six areas—the northeast, southeast, north-central, south-central, northwest, and southwest—for ease of viewing and provides day and night analyses for those areas in 2-week intervals. Although the current image files provide a great representation of the threats, resolution is low. Future plans call for posting more detailed images, as well as enabling interactive use of the images (i.e., zoom in/zoom out, pan, etc.). We have many things in store for the BAM to enhance its usefulness to you.

BAM Tomorrow

For most users, the BAM internet site will soon be a backup to the new *FalconView* system. *FalconView* is the digital mapping extension of the relatively new PC-based mission planning tool, Portable Flight Planning Software (PFPS). By adding the BAM to the PFPS, aircrews will have "one-stop shopping" for all phases of flight planning, with the BAM hazard layer added as a see-through coverage that allows the user to view the employed map underneath. PFPS and its successors will eventually become the Air Force standard for flight planning software.

When it comes to reducing bird strikes, today's BAM is the most complete planning tool available. Our goal is to continue validating, updating, and improving its accuracy so that you can avoid unpleasant encounters with "feathered aviators." Please stay educated on the avian threat and **FLY SAFE!** ✈

WHERE DO ALL THOSE FEATHERS GO?

Roxie Laybourne among some of the 650,000 specimens housed in the Smithsonian Institution's Bird Division. Photo by Chip Clark.

DR. CARLA J. DOVE
Smithsonian Institution
Division of Birds

Reporting bird strikes is paramount to a successful BASH Program—but where *do* all those bits and pieces of smelly, mangled, dirty feathers that are carefully collected and placed into ziplock bags actually go? And how are species of birds identified from their feathers alone? The answers to these questions are found in the Division of Birds at the Smithsonian Institution's National Museum of Natural History in Washington, D.C. That's where Forensic Ornithologists Carla Dove and Roxie Laybourne work diligently in the only laboratory in the country specifically set up to analyze bird strike remains. Although over 2,000 bird strikes are reported to the USAF BASH Team each year, only about a third of these have associated "feather evidence" that may make species identification possible.

Identifying species of birds from feather remains provides essential baseline data needed to implement habitat management plans on airfields and provide warnings to pilots of bird strike dangers. Knowing the weight of a bird specie also assists engineers in designing windscreens and engines that are more resistant to damage from bird strikes. So, although reporting *every* bird strike is essential, providing even the tiniest bit of feather evidence may be crucial in identifying the bird that actually hit the aircraft. It's only when we know what the problem is that we can successfully manage to avoid it in the future.

What to Send

The Best Rule. The more feathers the better. But we can also use beaks, feet, and talons to help solve the mystery of what type of bird hit the aircraft. Sometimes even the smallest bit of fluffy down can lead us to the culprit, so look carefully when searching for feather evidence. And please! Send *all* of the available evidence.

Bird strikes often leave feather evidence near the damaged area, but we sometimes find they're overlooked (or disregarded) because the remains are so minute. For example, on the night of 12 November 1998, a C-141C flying from Robins AFB, Georgia, to March ARB, California, suffered a bird strike. The following morning, the maintenance crew found damage to a wing No. 7 leading edge panel. Close inspection revealed a small, brownish feather with a white edge and some attached "fuzz" still clinging to the damaged wing. The small sample was collected and sent to us for identification. Because waterfowl have unique microscopic structures, it was possible to use that tiniest bit of feather and identify a canvasback duck as the bird that caused over $11,000 damage to the aircraft. However, the more feathers we receive, the faster we can make an identification and the faster you will get the results. So please, send all you find (even if it makes a smelly package!).

Feather Identification

The top floor of the Natural History Museum houses one of the largest collections of bird specimens in the world. Over 650,000 specimens of all types, ages, and sexes of birds line drawers in a collection that is over 150 years old. It's ideal to work in such a large collection because many species of birds (such as the red-tailed hawks in the photo) exhibit extreme variation in sex, age, and geographic plumages.

The identification of feathers combines several techniques to identify what's left of birds after they've been sucked into engines, smashed through windscreens and wings, or found dead on the airfield. After receiving remains, feathers are washed and dried to allow them to assume their natural shape and color. If enough feather material is present, identification can be made by comparing the unknown sample directly to museum specimens to find the perfect match.

In some cases, only a few feather barbs or nondiagnostic materials are available. These cases require much more detailed study using light microscopy to search for diagnostic family characteristics. Often, a combination of microscopic and whole feather characters, along with circumstantial evidence (such as the location and date of the strike) are used to make a positive identification.

What's New

Beginning this year, a new electronic reporting system has been set up at the Smithsonian Feather Lab. It is in line with the new Access™ database/reporting programs available to you at http://www-afsc.saia.af.mil/AFSC/Bash/report__wmenu.html. Safety offices can now e-mail bird strike reports as an attached Excel™

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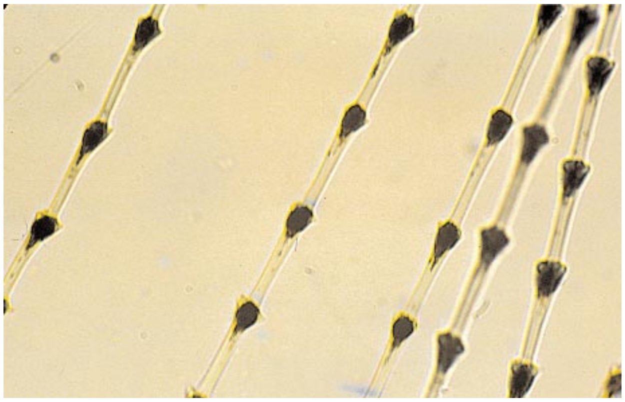
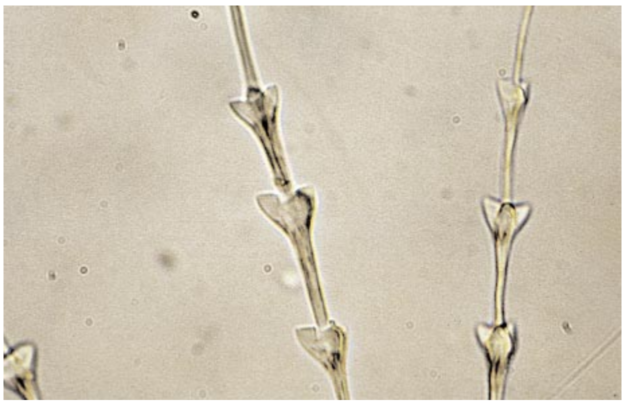
Chris Milensky (Smithsonian Specimen Preparator) displays examples of the different ways in which specimens are prepared for use in feather identification.
Photo by Don Hurlbert.

Dr. Carla Dove compares tail feathers from a bird strike that occurred at Howard AFB, Panama, to a museum specimen of Common Pauraque (*Nyctidromus albicollis*).
Photo by Don Hurlbert.

Carla examines a drawer full of the various plumages of red-tailed hawks.
Photo by Don Hurlbert.





Photomicrographs showing downy feather structures typical of ducks (Anatidae) and (below) blackbirds (Icteridae) 400X.
No photo credit.

spreadsheet directly to Carla Dove (dovec@nmnh.si.edu), instead of sending the information to the Air Force Safety Center (AFSC) at Kirtland AFB. Carla holds the e-mail report in suspense until feather evidence is received from the base that sent the report. When the feathers arrive, the identifications are made, and a hard copy of the report is mailed to the base. This new system has decreased turn-around time on identifications from an average of 2 months to less than 1 week. It also allows direct contact with field personnel and eliminates processing times at AFSC. For information about the new electronic reporting system, contact Lt Curt Burney at the AFSC, DSN 246-5673, or e-mail him at burneyc@kafb.saia. af.mil.

What Can You Do to Help?

Although we have access to a huge collection of birds, we're always in need of additional specimens. We are now preparing specimens in a variety of ways (i.e., spread wings) to allow better access for feather comparisons. Also, future research will concentrate on DNA analysis for identification, so it's necessary to start building a tissue collection from fresh specimens. You can help us by salvaging birds found on the airfield in good condition or by saving specimens that have been depredated. Place the bird in a zip-lock bag with a label containing the date, location, and name of the collector. Please contact Carla for mailing instructions.

By working together, we can continue to upgrade our bird strike database with more precise information on species lists and monitor species composition changes, ultimately making the skies safer for all! ✈

PROPER FEATHER COLLECTION

Feather identification is almost always done using whole feathers. The more feathers or evidence we have, the quicker we can do the identification. There are special cases where we identify species based on the microscopic structures of the downy part of the feather. Therefore, it's important to send any tiny feather fragment that's found. But remember—if the whole bird or many feathers are found, it's very important to send all of the material for identification. Some folks hear that we can identify feathers from microscopic examination, and so they send only a part of the feather when they actually have the whole carcass in front of them.

What to Collect

- Any and all feather material that is found in an engine or on an aircraft.
- Any feathers or parts of feathers found on an airfield.
- Any bird parts, i.e., feet, talons, bones.
- Send as much material as possible—even if it's smelly.

How to Collect

- Place unknown material in a zip-lock bag. Do not put very small samples in large bags because it's difficult to find the feathers.
- Tiny bits and pieces of feathers can be placed in a clean white envelope and then put in a zip-lock bag.
- Include all information pertaining to the strike, i.e., *date, locality, time of day, altitude, damage amount, number of birds seen, etc. on AF Form 853.*

When to Send

- Send the material as soon as possible before it decomposes.

What *NOT* to Do

- Never use scotch tape on feathers. Downy barbules get tangled and glued and are impossible to remove.
- Never use post-its. Feathers get stuck in the glued edge.
- Never cut feathers off of the bird or cut the tips away from whole feathers. Sometimes it's necessary to examine the fine structures in the fluffy part of the feather. If that part has been cut away, it's impossible to do the analysis.

Where to Send

Include AF Form 853
Mail to: Carla Dove
Smithsonian Institution
Division of Birds, NHB, MRC 116
10th and Constitution Ave., NW
Washington DC 20560

IS BIRD AWARENESS MISSION ESSENTIAL?
It is at Aviano!

TSGT C. METZGER
31 FW/SEF
Aviano AB, Italy

(Even though this article was printed in the June 1998 *Combat Edge*, the theme—taking a personal interest in flight safety—is timeless. Please note: TSgt Metzger's article encourages 31 FW members to call the 31 FW Flight Safety Office to warn of large bird gatherings on or near Aviano AB's confines. But your local Flight Safety Office may have different notification procedures in place, so consult your local installation policy guidance on the Bird Aircraft Strike Hazard (BASH) Program.) —Ed.

We are now in one of the busiest times of the year for bird activity. And guess what—whether you're a pilot, a security force member on patrol, TDY to the local area, or a maintainer who discovers a bird strike during an inspection, you can make the airfield and surrounding community a safer environment for your installation's aircraft and pilots. I'm sure you're probably thinking to yourself, "Me? How can I be of any help?"

Well, consider what we do here at Aviano. Anytime someone sees a large gathering of birds around the area of our base, we encourage them to contact the Flight Safety Office or Base Operations. This type of information can be very helpful in reducing the hazards of bird strikes at any air base. This is because identifying and plotting the type as well as location of birds are key to developing an effective Bird Control Program.

Notification is the first and most important step in the bird control process. Although it might not appear to play an important role in bird control, it does play a major role in bird avoidance. Notifying the appropriate personnel will increase the odds of removing the hazard (such as changing the airfield habitat so it is no longer attractive to that species) which ultimately will reduce the probability of a bird strike. Reducing bird strikes to the aircraft in your surrounding area is the main objective.

By now, I'm sure you're also probably thinking, "How does my notification of birds in Area-1, Area-2, or other locations around my base affect the aircraft in the flight-line area?" Well, let me tell you how. Take, for example, the situation here at Aviano. We are still in the process of identifying the types of birds in the area and the factors that attract local birds. When we are notified of the presence of birds, we immediately respond by identifying the birds and collecting data as to what type of area is attracting the bird (i.e., the feeding and nesting peculiarities, characteristics of that particular species, as well as the habitat). This data is used to develop a Bird Avoidance Model for Aviano Air Base. Along with that, we are concerned with bird movement in the area over the airfield.

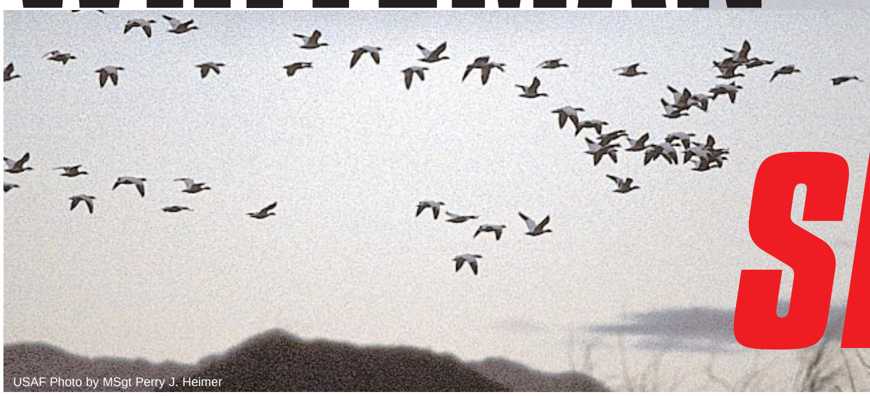
The total number of bird strikes in the Air Force since 1985 has been over 30,000. Total damage cost was $473 million, a 13-year average of $36.4 million per year. Ninety-eight percent of all bird strikes occur at or below 2,000 feet AGL, and most of these are at or below 500 feet AGL. Aviano had 16 bird strikes last fiscal year. Fortunately, only two of those were damaging. There are several man-hours spent removing, cleaning, and inspecting areas where the birds impact. Likewise, when an engine ingests a bird, there are considerably more man-hours spent borescoping the internal workings of the engine.

Since a goal of the Bird Aircraft Strike Hazard (BASH) Plan is to eliminate the bird strike hazard, we need to focus our efforts on the airfield itself. Air Force instructions and pamphlets suggest keeping the grass height at 7 to 14 inches on and around the aircraft movement area. If you should see an area growing out of control, contact your local safety office. Building custodians should keep their areas within the recommended requirements set forth by HQ Air Force Safety Center (AFSC). If possible, reduce overgrowth, grade and seed bare areas, and eliminate standing water by filling in low-lying areas.

We all play a key role in an effective BASH Plan. You're the eyes and ears of the base. Each of us can be in only one spot at a time; but as a whole, we can effectively cover a much larger area. Your base flight safety office will appreciate any service or contribution you provide the BASH Program. Remember—no matter how much work is done to get our aircraft mission ready, it takes only one bird to impact mission effectiveness. ✈

DEFENDING WHITEMAN SKIES

Photos by Ms Shana K. Hibler
509 BW/SEF, Whiteman AFB



USAF Photo by MSgt Perry J. Heimer

(Use of radio-controlled aircraft to harass birds and decrease their presence around airfields originated at least as far back as the 1970s. However, the practice is experiencing a renaissance. We salute 509 BW leadership in general, and TSgt Loud in particular, for thinking “out of the box” with respect to implementing strategies—like the radio-controlled aircraft—to reduce aircraft and wildlife conflicts/collisions. But please note! Radio-controlled aircraft aren’t a silver bullet, and they won’t “solve those pesky bird problems once and for all.” As the author states, and as *Flying Safety* magazine continues to emphasize in BASH-related articles, radio-controlled aircraft are *only* one part of an integrated wildlife hazard management program. Any bird/wildlife management program dependent on one method of control is little better than no program at all.) —Ed.

MS. SHANA R. HIBLER
509 BW/SEF
Whiteman AFB, Missouri

B-2s, A-10s, T-38s, and Cobra attack helicopters all play significant roles in our nation’s safety and security. In order to better protect these national assets from the hazards posed by bird strikes, the 509th Bomb Wing has become the first unit in Air Combat Command to use a small fleet of radio-controlled (RC) aircraft to help scare birds from the airfield.

Under the watchful eye of TSgt Mark Loud, 509 BW Flight Safety NCO and Bird Aircraft Strike Hazard (BASH) program manager, RC aircraft now defend the skies over Whiteman from our feathered adversaries, enhancing the base’s BASH Program.

The 509 BW Flight Safety office works hand-in-hand with the resident United States Department of Agriculture wildlife biologist, Noel Myers. He collaborates with base environmental officials as well as Flight Safety, to ensure the airfield environment doesn’t present a desirable home for birds and other animals that would otherwise pose a threat to aircraft. Among his other duties, Mr. Myers also traps and relocates wildlife to homes that are safer both for them and flight operations.

According to Mr. Myers, “We use an integrated wildlife damage management approach to keep Whiteman’s airfield as unattractive and uninviting to animals as possible.” In addition to the RC aircraft, Whiteman AFB employs a spectrum of wildlife scaring/harassment methods to deter wildlife from making the airfield their home. These methods include the firing of propane cannons, playing bird distress calls over loudspeakers to simulate a bird under attack by predators, and, as circumstances dictate, firing pyrotechnic devices that produce loud bangs or screaming noises.

Whiteman has found that RC aircraft are versatile, reliable, and more affordable than some other bird harassment methods. The balsa wood RC aircraft used here are purchased in near ready-to-fly condition, with time from assembly to "mission capable" taking just a few days. There are currently four 8-foot wingspan aircraft operational in Whiteman's RC fleet, one of which is used for training. TSgt Loud plans to experiment with a 10-foot wingspan aircraft that will increase the RC pilot's ability to maintain situational awareness with the aircraft.

The RC aircraft's .75-cubic-inch engines produce 2.18 horsepower at 15,600 RPM that can propel the aircraft to speeds of 87 knots. Each aircraft is fitted with a ram air "sonic screamer" that emits a loud, high-pitched shriek which, operational testing suggests, birds find extremely unpleasant. The aircraft are highly maneuverable and can ascend to altitudes in excess of 2,000 feet above ground level. The RC transceiver gives the RC pilot a range of up to 2.5 miles, but range and altitude are limited mainly by the pilot's ability to track the attitude and flightpath of the aircraft. Naturally, safe operation of RC aircraft requires the pilot to be in continuous radio contact with the airfield's control tower.

With its wings off, the RC aircraft easily fits in the back of a pickup truck and can be put together and launched within minutes. Takeoff and landing require less than 100 feet. They may even be flown between departing (or arriving) full-scale aircraft, reducing the bird strike potential right up to the point of takeoff (or landing). "Intercepting raptors over the runway and seeing them bug out is…gratifying… knowing you just diverted a potential disaster," Loud said.

TSgt Mark Loud, 509 BW Flight Safety NCO and Bird Aircraft Strike Hazard (BASH) Program Manager with the RC aircraft used to defend Whiteman's skies against feathered adversaries.

From a practical standpoint, the RC aircraft, tools, and support equipment require little area for storage, and the only special requirement is that the glow fuel be kept in a flammable materials storage locker. Approximately 30 minutes of maintenance is required for every 10 hours of flight to keep the RC aircraft in excellent working condition.

As with all aircraft, safe operation begins with a good ground school. TSgt Loud has established a four-step training program that takes a pilot trainee with no experience from classroom to proficient flying in about 2 months. Like other pilots-in-training, RC trainees have benefited from a computer-based simulation program designed to give them real-life experience behind the controls. Simulation greatly enhances the trainees' experience and reduces the instruction time required to make a trainee a fully qualified RC pilot.

During training flights, the instructor pilot and trainee radio controls are linked. This enables the RC instructor to resume control with the flip of a switch in the event the trainee has problems. According to TSgt Loud, "Training a prospective RC pilot candidate is a challenge, but it is also very rewarding, not to mention a lot of fun."

During program design at Whiteman, the BASH team conducted extensive planning and coordination with all affected agencies on base and drafted a comprehensive wing policy, which thoroughly spells out safety guidelines, restrictions, and concerns. For example, the resulting policy prohibits RC flight over full-scale aircraft, the weapons storage area, and hangars.

To date, Whiteman's RC aircraft have been highly effective in keeping the airfield clear of raptors and other large birds. RC aircraft were also one of the primary bird harassment tools used last year in a successful effort to disperse the base's huge migratory redwing blackbird roost. The blackbird roosts, which can contain 125,000 individual birds, have been a recurring problem here the past few years, and RC aircraft have again this year proven very effective at dispersing them.

The real key to our successful BASH program is non-stop employment of as many different harassment and deterrent techniques as practical. This multifaceted approach has resulted in no reportable damaging bird strikes at Whiteman AFB in the past 19 months. *Whiteman skies may be a lot less hospitable to birds these days than they used to be, but they've been made a lot safer for the people who have to fly there!* ✈

For more information, contact TSgt Mark Loud, DSN 975-7411, e-mail him at mark.loud@whiteman.af.mil, or see the Whiteman AFB Flight Safety and BASH web pages at http://wwwmil.whiteman.af.mil/safety/Flight.html.

FY98 Engine-Related Mishap Summary

USAF Photos by MSgt Perry J. Heimer

BILL BRADFORD
RICH GREENWOOD
BOB BLOOMFIELD
MAJ STEVE ROSE
HQ AFSC/SEFE

As Major General Gideon pointed out in the January/February issue of this publication, FY98 was the Air Force's safest year ever. However, as mentioned in the closing comments of our FY97 Engine-Related Mishap Summary, there is always room for improvement. While reading this article, you may experience a sense of *dèja´ vu.* The root causes of some mishaps rear their ugly heads year after year.

Component Improvement Programs are in place to improve engine designs, making them safer and more reliable, but without the everyday diligence of each and every maintainer, our engines will continue to be a major driver of Class A and B mishaps. As you read this article, see if some of the mishap causes identified in the ensuing paragraphs could have occurred where you work. If so, look at the final segment of this article, titled "What You Can Do," for ideas on how to eliminate them before they result in *your* unit suffering a mishap.

FY98 Engine-Related Mishap Overview—A Look at the Numbers

So how did we do last year regarding engine-related mishaps? Actually, pretty well. Figure 1 shows the percentage of all Class A and Class B mishaps that were en-

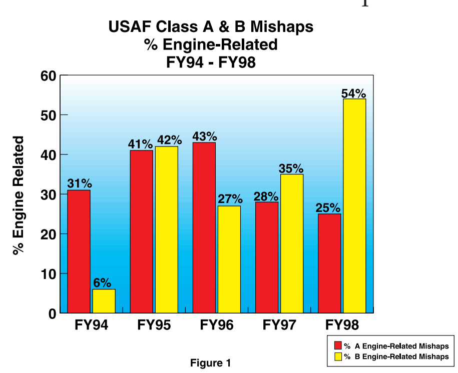
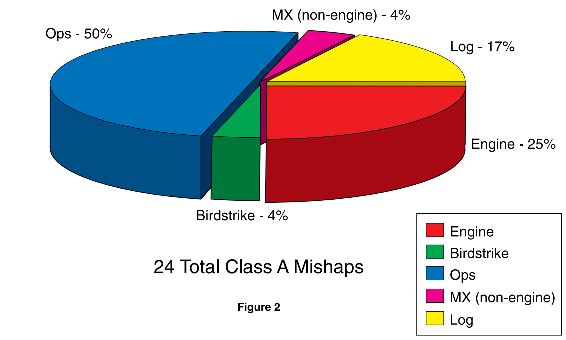


Figure 1

gine-related for the last 5 years. For those who recall last year's article (*Flying Safety,* Feb 98), engine-related failures accounted for 28 percent of all Class A mishaps and 35 percent of all Class B mishaps in FY97. During 1998, the percentage of engine-related Class A mishaps decreased to 25 percent (6 of 24) while the Class B portion grew to a staggering 54 percent (7 of 13). If you'd like a little more detail, see figures 2 and 3 for the breakout of engine-related versus other factors contributing to these Class A and B mishaps.

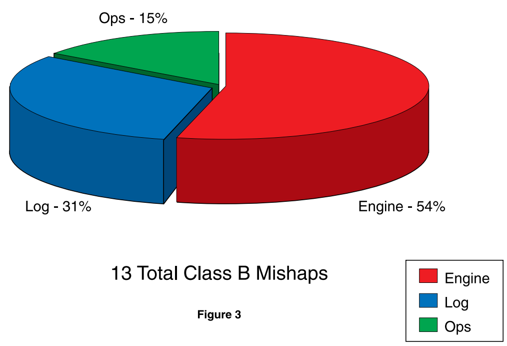
FY98 Class A Mishaps - All



24 Total Class A Mishaps

Figure 2

FY98 Class B Mishaps - All

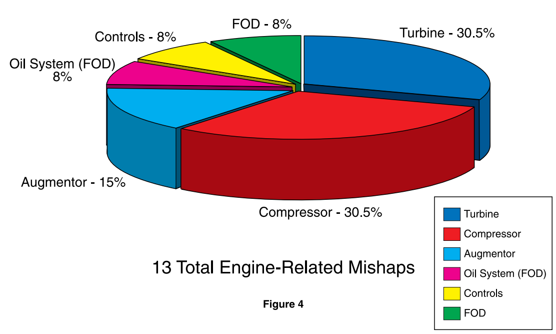


13 Total Class B Mishaps

Figure 3

Let's take a closer look at the FY98 data to see just what type of engine problems we are having. Figure 4 shows which engine components drove the Class A and B engine-related mishaps. It shouldn't be surprising that turbines and compressors lead the list, each accounting for 30.5 percent, as these are the most complex and highly stressed sections of the engine. It may be helpful to learn if there are any common themes adversely affecting these components.

FY98 Class A and B Mishaps Engine Component Failures



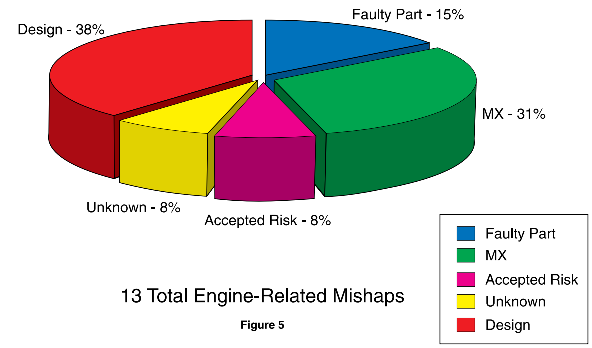
13 Total Engine-Related Mishaps

Figure 4

Contributing Factors

Digging a little deeper, in figure 5 you'll see which factors contributed to these component failures. While de-

FY98 Class A and B Mishaps Contributing Factors



13 Total Engine-Related Mishaps

Figure 5

sign deficiencies accounted for 38 percent, preventable maintenance errors were responsible for 31 percent, and faulty parts played a role in 15 percent of our engine-related Class A and B mishaps.

Be aware that a mishap usually involves the interaction of several factors, any of which, if removed from the equation, could drastically reduce the severity of the mishap, or altogether prevent it from occurring. For example, mishaps caused, in part, by an inadequate design or a faulty part may well not have occurred if the required inspections were properly performed.

Design deficiencies and faulty parts still play a significant role in our mishaps. As mentioned earlier, engine Component Improvement Programs are in place to make our engines safer and more reliable. Unfortunately, due to budgetary constraints, we aren't always able to incorporate new or redesigned hardware to replace aging and unreliable components nearly as fast as we would like. Therefore, we still rely on shortened-interval inspections and refurbished hardware to keep our aircraft flying safely. *It's the quality of our work and inspections that will drive our engine mishap rates until relief finally does arrive*.

Once again, avoidable maintenance errors spoiled the party. Poor documentation and communication of build status, as well as failure to follow published T.O.s, are the most common threads running through most of these maintenance failures. Sadly, the poor communication of lessons learned within the engine community may have played a role in the loss of at least one aircraft. No doubt, however, there have been many, many saves (of our people and aircraft) due to the vigilance of our exceptional maintenance crews.

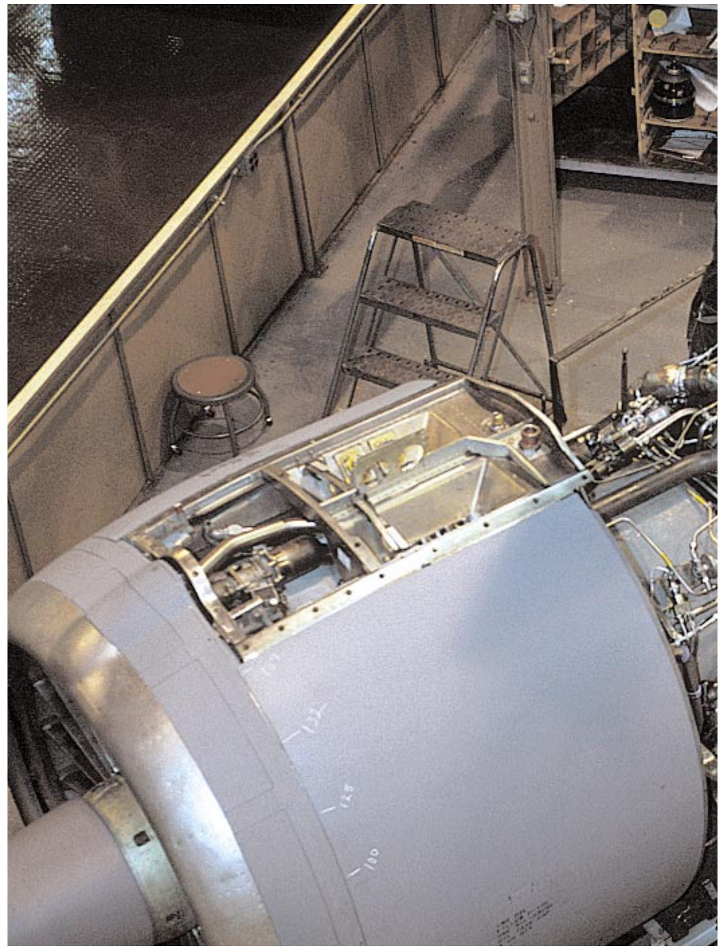
Classes Changing With Costs

Here's a quick refresher of the factors that define a mishap as a Class A, Class B, or Class C. A cursory look at the FY98 figures might lead you to conclude we had the best Class A rate and the worst Class B rate of the last 5 years. As usual, when using statistics, we need to know

continued on next page

what goes into the numbers. Remember: Severity of injury and the dollar cost determine the classification of a mishap. The cost thresholds for mishap classification haven't changed since 1989. Class A—property damage equals or exceeds $1 million; Class B—property damage greater then $200,000 but less than $1 million; and Class C—property damage greater than $10,000 but less than $200,000.

It is reasonable to assume that normal inflation has affected mishap rates over the last 10 years. However, more recently a larger factor has been introduced. The engine depots have changed their method of computing repair costs for engines and modules. For example, exchange cost of an F100-PW-229 Low Pressure Turbine (LPT) Module rose from $114,453 in FY97 to $228,443 in FY98, a 100 percent increase. In 1997, a mishap which required the exchange of an F100-PW-229 LPT would be a Class C. In 1998, it's a Class B. Exchange prices have increased again in FY99, so expect this trend to continue. Besides the impact on budgets, you can see how these factors tend to skew mishap rates and complicate meaningful comparisons of year-to-year mishap figures.



Class A and B Summaries

The following sections summarize the engine-related Class A and B mishaps we've suffered this past fiscal year. This releasable information was extracted from either Part I of the Safety Investigation Report or from the AFI 51-503 Accident Investigation Report. It is hoped you'll be able to glean some lessons learned from last year's mistakes and use them to make this year even safer.

F-15 SUMMARY

Table 1 is a comparison of how the F-15 did this year as opposed to FY97. Things held pretty steady for the F100-PW-100 and -229 engines, while the six-quarter Class A mishap rate for the -220 dropped over 50 percent. What follows is a breakout of these mishaps by engine model.

Table 1
F-15 Engine-Related Class A Mishap Statistics *

	FY97			FY98		
Engine	Class A Mishaps	FY97 Rate	6 Qtr Rate End of FY97	Class A Mishaps	FY98 Rate	6 Qtr Rate End of FY98
F100-PW-100	1	0.5	0.33	1	0.47	0.31
F100-PW-220	1	1.01	1.18	0	0.00	0.51
F100-PW-229	1	**	**	1	3.37	3.99
All Engines	3	0.89	0.75	2	0.52	0.71

* Rates based on number of Class A mishaps per 100,000 flight hrs.
** Insufficient flight hours on this engine application to compute a meaningful mishap rate.

F110-GE-129

Once again, there were no engine-related Class A, B, or C mishaps for the two -129-powered F-15s this past fiscal year. This engine successfully completed its Field Service Evaluation and Qualification Program for use in the F-15.

F100-PW-100

There was one engine-related Class A mishap in the F100-PW-100 fleet for FY98. During a military power takeoff, the pilot heard a noise, felt a loss of thrust, and noticed the right engine nozzle swinging to full open. The pilot continued the takeoff, but at an excessively high pitch angle, with only military power selected on the left engine. After retracting the gear, the aircraft began to sink. The pilot selected afterburner on the left engine, and the mishap aircraft began an uncommanded roll to the right as the pilot lost control of the aircraft. He then performed a successful low-altitude ejection. The investigation indicated that most likely an engine electronic control malfunction down-trimmed the right engine, causing the nozzle to pop open, resulting in a reduced thrust condition.

Four engine-related Class B mishaps were recorded this fiscal year. They were:

• Failure of the rear compressor variable vane bushings
• Damage to an LPT
• Oil tank foreign object damage (FOD)
• Fourth-stage compressor abradable seal deterioration

Component Improvement Programs are in place to improve engine designs, making them safer and more reliable, but without the everyday diligence of each and every maintainer, our engines will continue to be a major driver of Class A and B mishaps.

F100-PW-220

There were no engine-related Class A mishaps in the -220-powered F-15 fleet for the reporting period. However, there was one Class B mishap due to an augmentor nozzle loss. Inspections are in place to reduce the risk of future occurrences.

F100-PW-229

Consistent with the previous fiscal year, the -229-powered F-15 fleet suffered one engine-related Class A mishap during the reporting period. For the Class A, the right engine sustained an uncontained third-stage turbine disk failure during takeoff due to an improperly installed fourth-stage turbine inner airseal. The pilot aborted the takeoff roll and stopped the aircraft on the runway. While the aircraft wasn't destroyed, subsequent fire damage to the engine and airframe exceeded the $1 million Class A threshold. Hardware and tooling redesigns are being implemented to eliminate the possibility of improper installation in the future.

F-16 SUMMARY

Table 2 shows how we did this year compared to FY97. As you can see, we cut last year's number of mishaps in half. Congratulations to all the maintainers and others who are responsible for this positive trend.

Table 2
F-16 Engine-Related Class A Mishap Statistics *

	FY97			FY98		
Engine	Class A Mishaps	FY97 Rate	6 Qtr Rate End of FY97	Class A Mishaps	FY98 Rate	6 Qtr Rate End of FY98
F100-PW-200	1	5.57	3.01	0	0.00	4.73
F100-PW-220	2	1.86	1.21	0	0.00	0.00
F100-PW-229	0	**	**	0	**	**
F110-GE-100	3	2.09	2.25	2	1.34	1.79
F110-GE-129	0	**	**	1	1.60	1.06
All Engines	6	1.78	1.68	3	0.79	1.09

* Rates based on number of Class A mishaps per 100,000 flight hrs.
** Insufficient flight hours on this engine application to compute a meaningful mishap rate.

F100-PW-200/220/229

There were no engine-related Class A mishaps in the Pratt & Whitney powered F-16 fleet (F100-PW-200/220/229 engines) during FY98. This is in part due to key hardware redesigns being incorporated into engines at the field and depot levels and periodic engine inspections performed by our diligent field maintainers.

There was one Class B mishap in the F100-PW-220-powered F-16 fleet this year that involved the loss of an afterburner duct and nozzle assembly (same failure mechanism as the -220 powered F-15 noted above). The pilot was able to land his aircraft safely. A T.C.T.O. directing local engine shop and depot-level inspections is in place to mitigate this risk.

F110-GE-100

There were two Class A engine-related mishaps in the F-16 F110-GE-100-powered fleet for FY98. This is an improvement compared to the three Class A and the single Class B FOD engine-related mishaps for FY97. The first mishap occurred when the mishap pilot heard a bang, felt a loss of thrust, and then was notified by his flight lead "…you have some flames coming out your back." After several unsuccessful attempts to restart the engine, the pilot successfully ejected. Inspection of the mishap engine revealed the high pressure turbine stationary inner seal (commonly known as the CDP seal) was omitted during assembly. Omission of this seal allowed excessive air pressure to overload the high pressure rotor, causing the No. 3 bearing to seize, resulting in a loss of thrust. A one-time inspection was conducted on candidate engines that had the CDP seal exposed (e.g., upon combustion diffusion nozzle case removal). As a result of this inspection, one other F-16 was found to be operating without the CDP seal, and another engine awaiting assembly did not have the seal installed. By following tech data and documenting, tracking, and communicating which steps were accomplished during teardown and assembly, this mishap may well have been prevented.

The other Class A occurred when the pilot was forced

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to eject after an unsuccessful attempt to restart the engine during a loss of thrust condition. The pilot was subsequently recovered uninjured by a civilian fishing vessel. Investigation of this mishap revealed the No. 4 bearing had failed. This is a known failure mode compounded by the tendency for visible bearing chips and flakes to be trapped in the bearing housing, thus preventing them from collecting on the Master Chip Detector (MCD). Efforts to eliminate or reduce the risk of this failure mode continue. For example, inspection of the MCD using a scanning electron microscope to detect minute bearing particles and possibly predict impending bearing failure, is currently undergoing a Field Service Evaluation at Cannon AFB, NewMexico.

F110-GE-129

There was one Class A engine-related mishap for F110-GE-129-powered F-16s in FY98. This compares to no Class A or B mishaps in FY97. The Class A occurred when the pilot experienced an abnormal engine response and low RPM. After several unsuccessful attempts to restore sufficient thrust for safe flight, the pilot successfully ejected. Inspection of the mishap engine revealed the left-side Variable Stator Vane (VSV) spherical bearing had backed out of its housing flange due to excessive wear of the bearing for an unknown reason. Subsequently, the VSV torque tube and position feedback assembly liberated from its support. With an inaccurate VSV position feedback signal, the VSVs remained in a closed position. This reduced airflow to the engine core and precluded sufficient thrust to maintain flight. A one-time inspection of the left-side VSV spherical bearings has been accomplished for F110-GE-100, -129, -100B, and F118-GE-101 and -100 engines. Additional recommendations regarding proper maintenance and inspections of the VSV assemblies are pending approval. Investigation into the root cause for the excessive wear of the VSV spherical bearing continues in order to determine if there was a material or manufacturing deficiency. Meanwhile, vigilant adherence to T.O. procedures for installing and inspecting VSV torque tubes is paramount in preventing similar failures.

B-1B SUMMARY

F101-GE-102

There was one Class B engine-related mishap for the F101-GE-102-powered B-1B fleet in FY98. This compares to zero Class A or B mishaps in FY97. The mishap occurred when the crew heard a loud thud, followed by illumination of the No. 3 engine “Vibration High” light. The pilot shut down the mishap engine according to emergency procedures and conducted a successful emergency landing at home station. Inspection of the mishap engine revealed the entire first-stage LPT shroud had *not* been installed. Missing the required shroud, the first-stage LPT nozzle support failed. This snowballed into a catastrophic engine failure that penetrated the cowling and was followed by a high-intensity, short-duration fire.

C-141 SUMMARY

TF33-P7A

There was one Class A engine-related mishap during the reporting period. The Class A was due to a FOD-induced first-stage fan blade fracture resulting in an uncontained failure of the No. 2 engine during a planned go-around. Both the aircraft and the No. 1 engine sustained collateral damage, driving the mishap cost past the $1 million Class A threshold.

T-37 SUMMARY

J69-T-25

There were no engine-related Class A or B mishaps in the T-37 fleet for FY98. However, it may be instructive to look at the 67 engine-related Class C mishaps. (See figure 6.) The oil system leads the parade with 38 percent of the mishaps. Of these, 60 percent were due to problems with the oil tank pendulous hose, all of which required an inflight shutdown of the affected engine. Although technically classified as an airframe part as opposed to an engine part, the pendulous hose is the oil pickup device found in the oil tank and provides oil to the engine. Its flexible design allows it to swing and access oil under any flight attitude. When the hose breaks or kinks, the engine is starved for oil, and the pilot is forced to shut down the engine after getting a “zero” oil pressure indication. Fortunately, there have been no simultaneous hose failures that would result in shutdown of both en-

FY98
T-37 Engine-Related Class C Mishaps

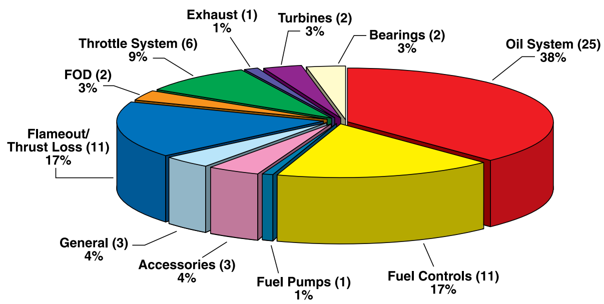


Figure 6

gines. Currently, a new pendulous hose is undergoing test and evaluation to resolve this frequent, and potentially serious, problem.

What You Can Do

Now that we've completed our safest year in flight safety, let's take the opportunity to reflect back on why this happened and what we could have done to prevent the mishaps we did suffer. More importantly, what actions can YOU take to preserve limited Air Force assets and make sure FY99 will be even safer?

Build on those safe practices and lessons learned that have proven themselves in the past. Your unit's aircraft and the well-being of your friends depend on it! Please remember, even if an aircrew safely lands at a nearby airfield after suffering a nonrecoverable in-flight engine shutdown, the engine failure needs to be reported and thoroughly investigated, whatever the mishap class! This will minimize the risk to other aircrews who may not have the option to land if they suffer a similar engine failure. Hindsight is *always* 20/20, but consider the following thoughts as we fly toward the new millennium:

• Technical manuals change, and they must be used! Using them has proven to be a winning strategy. Because these manuals aren't infallible, submit those AFTO Forms 22 and AF Forms 847 when they do fall short of the mark. *The Air Force relies on you to make sure these manuals are accurate and that you use them in your day-to-day operations.* When was the last time you performed an assembly operation without having the proper manual open at your side because you "thought" you didn't need it? Also, how well does your shop document which T.O. steps and paragraphs have been completed during disassembly and buildup of an engine? How is this status tracked and passed on to the next shift? Will your practices hold up to that Hangar Queen engine that has been cannibalized because it has been sidelined for 3 months awaiting a part? Reducing preventable maintenance errors represents an area of "low-hanging fruit" that we should fully exploit to reduce our mishap numbers.

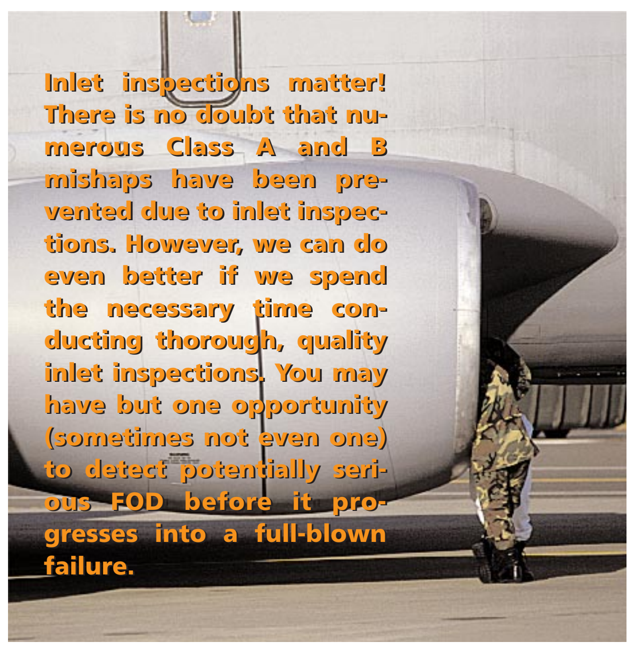
• How much of your blood, sweat, and tears went into making that engine (or jet) perfect, only to see it severely damaged by FOD or poor shopkeeping practices? Your quality FOD walks, good shopkeeping, and vigilant tool and part inventory practices are paying off by preventing mishaps. An ounce of prevention goes a long way here.

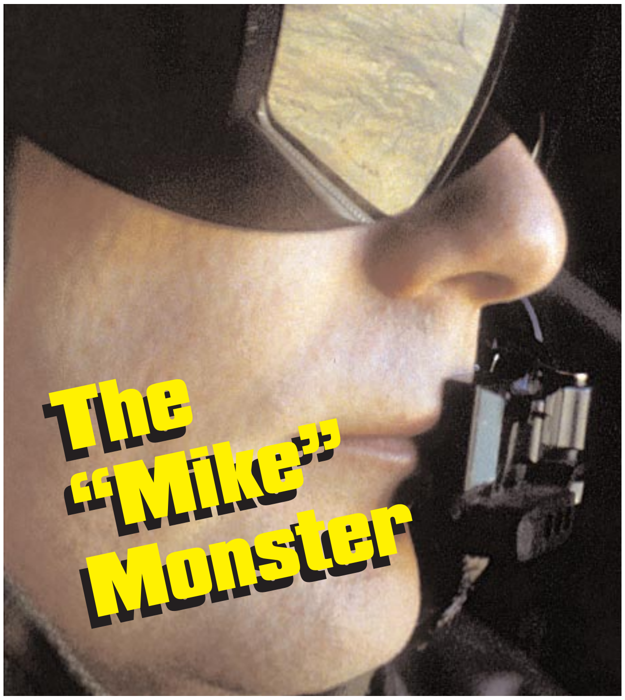
• Inlet inspections matter! There is no doubt that numerous Class A and B mishaps have been prevented due to inlet inspections. However, we can do even better if we spend the necessary time conducting thorough, quality inlet inspections. You may have but one opportunity (sometimes not even one) to detect potentially serious FOD before it progresses into a full-blown failure. How much time did you (or your people) spend down the inlet on that last inlet-blade inspection? Does the work card target the blades, and does it provide for sufficient time for a quality inspection?

• As you would expect, training and job proficiency are crucial factors in preventing mishaps. This is even more important in view of the strain that operational tempo and personnel retention issues are having on our people. How effective is your unit's training program? How's that newly assigned member progressing? Is he or she being properly mentored?

• As usual, budgetary pressures slow the incorporation of new parts to replace aging components and redesigned hardware to fix known design deficiencies. Thus, risk mitigation is accomplished by those important and seemingly all-too-frequent inspections. New parts are making it into the logistics system, but meanwhile, recognize it is *your* high-quality inspections that enable the fleet to fly safely.

• On a final note, the statistics show we're doing a pretty good job. However, there's always room for improvement and the absolute requirement that we not rest on our laurels. Let's all endeavor to make FY99 even safer! ✈





USAF Photo by SSgt Andrew N. Dunaway, II

The "Mike" Monster

CW4 DON C. THOMSON
Missouri ARNG
Courtesy *Flightfax*, Aug 97

At the end of the hearing-test portion of my annual Class II flight physical, the technician handed me the chart. My eyes focused on "-70" in the 6000 Hertz section for my right ear. (I had hearing loss in my other ear as well.)

"Minus 70?" I thought. The previous year it had been -55, and year before that it was -50. I was obviously losing my hearing, but I didn't know why. I knew that most of the high-time aviators in my unit had some hearing loss. The loss was substantial for a few of them. Now I was joining their ranks. Some of them were approaching 8,000 hours, but I had only about 4,000.

On the drive home, I began to think about how I was damaging my hearing. I'm conscientious about wearing earplugs, changing my helmet earcup seals before they become hard, and keeping the elastic straps behind the earcups tight. I wear bayonet stems on my glasses and make sure they go above the earcups and don't penetrate the earcup seal. I carry earplugs at all times and use them any time there is an aircraft turning on the flightline, when encountering loud music, when driving with the windows down, and when using power tools or lawn mowers. For pistol qualification, I use both earplugs and earcups. What more could I do? I knew that I had better do something fast or I would be going the route of hearing waivers before very long.

I knew I must reduce my noise exposure to prevent further hearing loss. But to do this, I needed to identify the source of my maximum exposure. I decided to try to be alert for any harsh, shrill, or loud noises. It didn't take long.

During startup on my very next flight, I noticed a shrill whine, the sound of my helicopter's turbine engine. But why was it so loud? I had on my well-fitted helmet with new earcup seals and the chin strap pulled tight.

The answer was that the pilot must keep the mixer panel mike switch in the "hot mike" position during startup to make required calls to the left seat when both hands are occupied on the starter switch, collective, throttle, and throttle idle detent release button. I had known that this hot-mike switch created a noise problem and had asked my left seaters in recent months to leave their mike switches off during startup and instead use the foot switch. This kept the number of open mikes to a minimum. I also always turn my hot-mike switch off as soon as possible during the starting sequence to minimize our exposure to the one open (hot) mike.

As I began to think about hot mikes, several things became apparent. First, although we had increasingly been trying to limit their use, there had still been a number of times when we had one to three mike switches in the hot-mike position for up to 2 hours at a time during difficult missions.

An open switch for the boom mike on an aviator's helmet totally bypasses all the hearing protection provided by the flight helmet. The only possible salvation here is earplugs. If you do not wear them, your hearing days are surely numbered.

Using the hot-mike position also creates a length-of-exposure problem. The loud whine of the transmission and engine can be heard every time a crewmember keys the mike, even for a moment. The *theory* is that the microphone is right up against the crewmember's lips and is designed to receive only the crewmember's voice. But the *fact* is that if the volume is set high enough to hear other crewmembers' communications, then the high-pitched and shrill cockpit background noise is being picked up and amplified anytime a crewmember keys the mike. Perhaps a future solution to this problem will be use of a "notch filter" in the amplifier, or downstream of it, to totally block out the primary frequencies which comprise the engine whine.

My sole purpose here is to address the problem of the inadequacy of some of our equipment and to caution young aviators of the certainty of things to come if they do not use every possible means to protect their hearing. ✈

Editorial Note: Noise is a primary cause of high-frequency hearing loss as is age. As one ages, hearing deteriorates naturally. Both may be a factor in this case. Each aircrew member should take every precaution possible to reduce noise exposure, including procedural alterations as described here. Noise exposure off duty is frequently not considered, so don't forget to wear hearing protection during loud off-duty activities as well.

Major Greg Lengyel
58 OG/OGV
Kirtland AFB, NM

There I Was...

Photo by Major Greg Lengyel

We were on the second day of a redeployment from a Joint Special Operations Readiness Exercise. I was aircraft commander of the No. 4 aircraft in a 14-ship formation consisting of 10 MH-53J Pave Low helicopters and 4 MH-60G Pave Hawk helicopters. It was well into the evening, so it was dark, and we were flying on night vision goggles (NVG).

We had a significant distance to cover that day and needed multiple air refuelings from MC-130P Combat Shadows. All had gone well during both daylight refuelings, and we needed one more on NVGs to make it home. The weather had been good all day, and our pretakeoff forecast contained nothing to alarm us. NVG air refueling was nothing to get excited about because we flew about 70 percent of our missions on NVGs anyway. We had three MC-130P tankers to support the refueling and had broken into three elements, as briefed. I was in the last of four MH-53s on the first tanker.

Everything was proceeding according to plan. Two Pave Lows refueled on the left hose, while chalks 3 and 4 crossed over to get fuel on the right hose. Elements 2 and 3, who were 2 and 4 miles, respectively, behind us, were also refueling as planned. Just as I was taking on the last few hundred pounds of fuel, the radios started to get busy. Aircraft in the elements behind us were confirming fuel requirements over the VHF-FM interplane before releasing the tanker (this gas had to get us home). Some of the aircraft needed to top off one last time, and the element leads were coordinating with the tankers on VHF-AM. The tankers could smell the barn and were calling ahead on SATCOM with estimated arrival times and aircraft maintenance status.

I finished taking fuel, backed off the hose, rejoined on No. 3, and we both crossed over to the left side of the tanker to join lead and No. 2. We were about 95 percent complete with the rejoin into a four-ship, left echelon formation on the left wing of the tanker, when we started to hit inadvertent IMC. No one saw it coming. When on NVGs, you often don't see weather until you're "in it," especially during periods of low moon illumination. During normal en route flight, we probably would have seen it, but we were all focusing on the tanker and the formation.

Flight lead saw ground lights and executed a descending right turn, hoping to get under the weather. Nos. 2 and 3 followed, and so did I in chalk 4. A few seconds into the turn, I lost sight of 3. I gave about a 2-second pause hoping he would reappear, but he didn't. I then executed inadvertent IMC breakup procedures…well, kind of.

We have very specific procedures for inadvertent IMC, but we were in an unusual situation. Under normal circumstances, I would have notified flight lead over interplane radio, received a base heading, airpeed, and MSA. I would then turn 40 degrees left of base heading, maintain base airspeed, and climb to MSA plus 800 feet. In this case I called lead, but heard no reply. The radios were still very busy, and I had no idea if the other 10 helicopters and 2 tankers behind us knew about the wall of weather they were approaching.

I was in a steep turn, in a rapid descent, when I went inadvertent IMC. I came inside and went to the attitude indicator in order to level the aircraft and then turn away from the formation. I was doing all I could do to not roll inverted at this point. By the time I recalled the IMC breakup procedures from my 40-megabyte cranial hard drive, I had no idea what airspeed, altitude, or heading I was on when this whole mess started. So I turned away from the formation (what seemed to be a reasonable amount) and climbed away from the ground I had been descending towards. I knew my instrument cross-check was a little slow getting started when my copilot asked me what the hell I was doing! In a few hundred feet we popped out on top, and (fortunately) we still had the helicopter in an upright position. We were in a level attitude climbing at about 500 fpm.

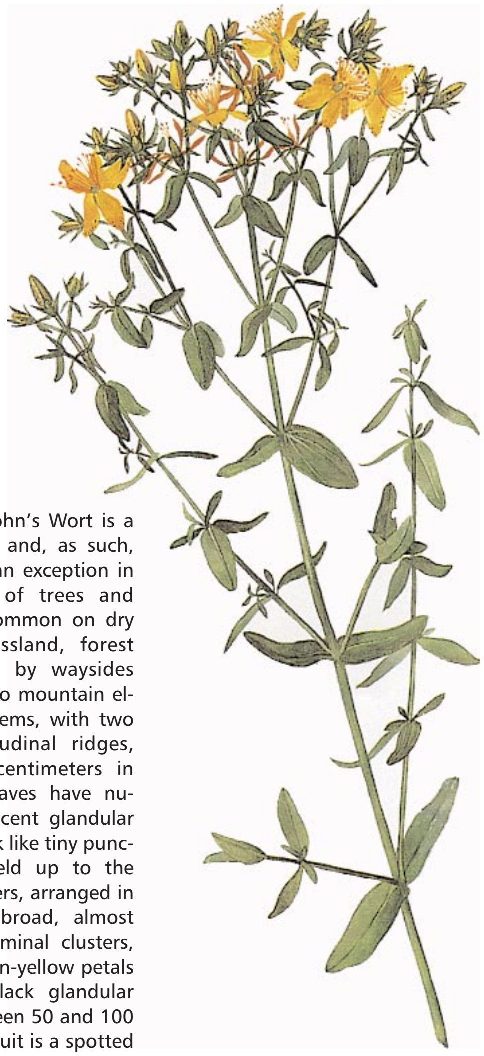
Only a few seconds after we came out of the top of the clouds, my flight engineer manning the right scanner position screamed, "BREAK LEFT, CLIMB!" It seems that the No. 3 aircraft (in front of us!) also executed IMC breakup procedures. He didn't hear my radio call and assumed I was still on his wing. And he didn't make his own radio call for the same reason flight lead didn't respond to me—excessive radio traffic. He came out of the clouds just after us, in a climbing left turn, and on a direct collision course. I broke, climbed, and looked to my right as we turned left. I saw the tips of his rotor blades miss us by a matter of feet as he passed under us.

I share these lessons with my students about that memorable night:

1. My right scanner saved everyone on board both aircraft by staying at his crew position and remaining vigilant.
2. Inadvertent IMC breakups almost never go as planned, and there is no cookbook answer for all circumstances.
3. Poor radio discipline could get you or someone else killed. ✈

Is St. John's Wort the Miracle Pick-Me-Up?

FREDERICK V. MALMSTROM, Ph.D.
Certified Professional Ergonomist



Perforate St. John's Wort is a perennial herb and, as such, something of an exception in a family full of trees and shrubs. It is common on dry banks, in grassland, forest clearings, and by waysides from lowland to mountain elevations.The stems, with two narrow longitudinal ridges, grow to 80 centimeters in height. The leaves have numerous translucent glandular dots which look like tiny punctures when held up to the light. The flowers, arranged in dense, short, broad, almost flat-topped terminal clusters, have five golden-yellow petals edged with black glandular dots and between 50 and 100 stamens. The fruit is a spotted capsule containing numerous dark, cylindrical seeds.

Editor's Note: *We're living in an era when "all-natural" vitamins and dietary supplements often become synonymous with "Take them, they're beneficial." Not necessarily.*

Just because a product is touted to be all-natural and is sold over the counter at your local health-food store doesn't mean it's good for you. As the author states in the following article, evidence that many of these all-natural products have any effect at all is often anecdotal rather than scientifically proven. And they may even cause adverse side effects.

Before taking any supplemental product—be it St. John's Wort, melatonin, or any of the other dozens of "well-being" products on the market today—consult your flight surgeon or other medical professional first.

Suppose you are an advocate of herbal, naturopathic remedies, preferring to visit the flight surgeon only for your mandatory annual flight physical. If you are such a person, have you wondered whether these remedies will either enhance or interfere with your flying duties? If your answer is yes (or even no), then read on for some entertaining, fun-filled facts.

From time to time, humans find it necessary to rediscover their past. There are thousands upon thousands of herbal remedies which humans have anointed, ingested, inhaled, or injected into themselves in an unending trial-and-error effort to cure what ails them. Melatonin (see the October 1997 issue of *Flying Safety* for an excellent review of this hormone), *Gingko biloba*, ginseng, blue-green algae, and St. John's Wort are enjoying current popularity as the rediscovered naturalistic Drug-of-the-Year cures which seem to promise much—or do they? Let's narrow in on the herbal remedy St. John's Wort.

Good Grief. *Klamath Weed?*

Finding St. John's Wort in the wild isn't difficult. Even though not one of the dozens of herbal remedy books I researched would admit to it, this herb is known in the U.S. as none other than the common Klamath weed! This plant is a noxious European import which 50 years ago was on the brink of overrunning millions of acres of valuable pasture and ranchland in the United States and Australia. Fortunately, plant pathologists then intentionally imported European parasitic beetles to control its spread. Likewise, in 1995, Canadian phycologists imported parasitic fungus to control this weed.

St. John's Wort (a.k.a. Klamath weed) in large doses (i.e., grazing) has the unhappy property of causing photodynamic action in most mammals, including humans. If an animal eats enough St. John's Wort, its unpigmented body areas are susceptible to severe sunburn. Both farmers and stockmen have a well-founded and strong dislike of this plant.

The most popular U.S. species of the genus St. John's Wort (*Hypericum perforatum*) stands about 1/2 meter high and is easily identified by its yellow, aromatic and trumpetlike, five-pointed flower with its signature reddish, bloodlike blossom sap (see the figure). Many of the 23 different brand-name bottles I found in my local health food stores proudly displayed the yellow blossoms on their labels.

Miracle Claims Are Ancient

St. John's Wort has a long and dubious medicinal history going back at least to the Roman times. In the year 1653, Nicholas Culpeper wrote in his *The Complete Herbal*

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and English Physician that extract of St. John's Wort had medicinal properties good for "fits of chills, falling sickness, sciatica (i.e., low back pain), palsy, bites or sting of any venomous creature," healing of external or internal wounds, and cures "for those who cannot make water." According to Hyla Cass, M.D., herself an enthusiastic supporter of herbal remedies, the most recent medicinal claims for St. John's Wort are relief from AIDS, antibacterial and antiviral action, relief from premenstrual syndrome (PMS), and use as an antidepressant. These are indeed claims for a miracle drug!

Standards Aren't Controlled

St. John's Wort is actually a mixture of compounds, usually taken from the mashing up of immature flower blossoms. Therefore, the ratio of ingredients will vary from bottle to bottle, but most of the extracts contain at least 10 active organic ingredients. You've probably gotten the idea that the ratios and ingredients aren't as tightly controlled as for Food and Drug Administration (FDA)-approved drugs—in fact, the FDA classifies it as a "dietary supplement." And there certainly are no such things as U.S.P. (United States Pharmacopoeia) standards for St. John's Wort. I've seen capsules that contain anywhere from 100 to 350 milligrams of flower extract, its hypericin (main active ingredient) content unspecified.

Is It an Antidepressant?

The most highly touted active substance in St. John's Wort is a red pigment called hypericin which is claimed to act primarily as a psychotropic-type monoamine oxidase inhibitor (MAOI) antidepressant medication. Antidepressants aren't addictive; furthermore, they don't make you happy, they just help to keep you from getting sad. Nevertheless, most psychiatrists consider MAOIs the antidepressant of last resort because of a number of side effects. Patients taking MAOIs should avoid foods rich in tyramine, such as red wine and cheese. In addition, there are many unpleasant interactions with other medications. And in case you *still* don't have enough to worry about, antidepressants commonly interfere with sexual functioning.

Expensive? You Betcha !

St. John's Wort capsules contain anywhere from 0.1 to 0.3 milligrams of hypericin—about the volume amount equal to the head of a pin. This is another way of saying there isn't very much of it in each capsule. I've priced these capsules, and I find they can cost anywhere from 7 to 20 cents apiece. Furthermore, the most frequently recommended dosage is three times per day. Therefore, a true advocate of St. John's Wort will be spending an outrageous $6 to $18 for a month's worth of therapy (30 milligrams). You'd be financially better off making the dried blossoms into tea, as indeed many naturophiles do.

What's the Proper Dosage?

Well, more complications. Hypericin is believed to be absorbed into the body quite slowly. That is, it doesn't pass the blood-brain barrier easily, so the user must take St. John's Wort from 2 to 6 weeks before an antidepressant effect (if any) is noted. Therefore, anyone who believes he or she can pop them like aspirin to chase away momentary blues is probably imagining effects. Indeed, most of the antidepressant support hypericin gets is testimonial, not scientific evidence. Researchers have a deep distrust of stand-alone testimonial evidence as some of the worst evidence available. People are masters of delusion, especially when it comes to judging themselves.

Mixed Reviews From the Medical Community

The 50 or so medical and psychiatric journal articles I reviewed give hypericin a very mixed review indeed. Three out of five studies appear to say that hypericin seems to offer some antidepressant promise, and the rest state that results were inconclusive.

Reports from the *British Medical Journal* state that moderately strong doses of hypericin (2.5 mg daily) seemed to be mildly effective in combatting a rather rare type of depression called seasonal affective disorder (SAD). A particularly interesting article in the March-April 1998 *Harvard Review of Psychiatry* suggested that skepticism about St. John's Wort is justified because much more research is needed.

Here's the problem: Drug research and subsequent approval by the FDA is pretty expensive. In the United States, it usually takes over 3,000 subjects, carefully controlled double-blind experimental and clinical trials, and a long, long 7 years from the time a drug is discovered until it's FDA approved. Even then, only about one in five drugs makes it over the legal hurdles and into the marketplace. St. John's Wort is nowhere near that kind of approval process.

It's true many European physicians, especially in Germany, prescribe St. John's Wort; however, keep in mind that many European and Slavic countries also have a historical proclivity and tolerance to "natural" remedies, not necessarily because they work, but because the public demands them. Most physicians are well aware St. John's Wort has a strong placebo effect. But if the patient insists the drug works (and it's harmless), who's to argue with a satisfied customer?

There's No Such Thing as a Drug Without Side Effects!

So then, what's the harm in taking St. John's Wort? Probably very little—if you take it by itself in such dilute quantities as are commercially available (0.3 mg hypericin content). However, if you are taking this herb in any greater quantity, then I offer several suggestions.

- Don't mix it with alcohol. Antidepressants are especially sensitive to multiplier effects.
- Avoid direct exposure to sunlight because of photodynamic action.
- Don't mix with other antidepressants unless you clear it with a physician. Better yet, why not check it out with your flight surgeon first? ✈

FOOTNOTE: The author is indebted to his late mentor and colleague, plant pathologist John H. Standen, Ph.D.


"We don't give a hoot about your BASH plan so you'd better!"