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Special Issue

Fixed-wing aircraft tracking.

For someone new to the field of wildlife telemetry, tracking animals from fixed-wing aircraft may seem a rather unusual approach. For anyone who has actually spent time tracking animals, it is a well known technique to climb up a hill or mountain to extend the range of your telemetry system. The use of aircraft simply extends the principle and provides some added mobility as an extra.

If you're ground tracking a medium-sized animal wearing a collar with a state-of-the-art telemetry receiver (such as the TR-2 or TR-4) the range performance on level ground can be anywhere from 2 to 5 miles. By getting up on a hill and overlooking the animal, ranges can be extended to 5 to 10 miles. However, if it is possible to take your telemetry receiver up in an aircraft, the range is extended even further—typically from 10 to 30 miles.

For many studies, regular aircraft tracking provides the data to remain in constant contact with animals that move over extensive areas. It extends the line-of-sight range and reduces signal attenuation due to vegetation. These two factors, combined with aircraft speed and mobility, provide significant advantages. The technology supports both small studies operating on a shoe-string budget and large statewide efforts to monitor large animal populations.

Conducting research from aircraft is recognized in our field as a dangerous operation. Over the years far too many friends and colleagues have been injured or lost in aircraft accidents. Therefore anything that increases efficiency, and reduces the time spent conducting low level flights, should have a positive influence on our actuarial statistics. This newsletter has been dedicated to providing some options, procedures and hopefully helpful hints, that will make tracking animals from fixed-wing aircraft a little more efficient, and safer process.

Editor

Antenna Mounting Brackets

Step-by-step, here's how to do it.

Tracking wildlife from fixed-wing aircraft has become almost routine and numerous approaches have been tried to solve the problem of connecting tracking antennas to aircraft. There are several treatises in the literature and in technical notes published by various state and federal agencies concerning the "best" technique for attaching antennas to various aircraft. In most instances the resourcefulness of the researcher pays off—and whatever technique is employed usually ends up successful if not always efficient. If you have a favorite technique and it works, continue to use it. We are not going to try and convince you to change and use the approach presented in this issue. Wisdom says never argue with success.

If you're having trouble getting the gear you require manufactured, however, or if the technique you are using seems to be less then consistent, we are going to suggest an alternative approach. The setup and techniques we describe may help make aircraft tracking a bit more consistent, a little less time consuming and perhaps a little safer. In this article we will address the choice of antenna brackets, installation of the brackets on the aircraft, and attachment of the antennas to the brackets.

Our discussion is directed to the use of the Telonics RA-2A antenna and the TAB series of antenna brackets because many researchers have successfully implemented this approach with essentially "off the shelf" equipment. The TAB brackets were designed specifically to secure the RA-2A antenna to the struts of the high wing aircraft without requiring permanent modification of the aircraft. In fact the whole system can be mounted to or removed from an aircraft in a matter of minutes. This works well when rental or contract aircraft are utilized.

Antenna bracket choices range from the TAB-1 (typically fits Cessna 150 and 172 aircraft) to the TAB-6 (fits the Christen/Aviat-Husky). The critical parameter in choosing an antenna bracket is the size of the strut—and measuring the strut is important.

Often a particular model of aircraft will have a larger engine, requiring larger struts. So picking a set of brackets "off the shelf" simply by model number of the plane does not always work. Therefore, in addition to the aircraft model number, actual dimensions of the strut are required. The first strut dimension needed is (A), the distance from leading edge to trailing edge. The second is (B), the thickness of the strut at its thickest point. The third is (C), the circumference. Please refer to Table 1 for more specific information on typical strut dimensions and models of aircraft.

After you have selected the correct brackets, it is time to install the equipment on the airplane. The first step is to gather and identify all of the equipment to be installed (i.e. left and right TAB brackets, RA-2A antennas, coaxial cables, TAC-2 or TAC-7 antenna switch box and, finally, either the TR-2 or TR-4 telemetry receiver).

If the aircraft is a rental and the coax cable installation is temporary, the cable installation should be delayed until after the brackets and antennas have been installed. If the aircraft is dedicated to the project, the best place to dress the coax cables is through the wing into the cabin. In this manner, you assure the longest operational life of the cables since they won't be exposed to wind, sun, and precipitation. An installation such as this can be made by installing a bulkhead connector (CON-BNC/BNC-THN) in an inspection plate in the wing, routing the coax up into the wing on both sides of the aircraft and then into the cabin. When this type of work is done, be sure that a certified A&P mechanic either works with you, or inspects your work, and then signs it off in the log book. *If your aircraft is pressurized, you should take special care to use pressure rated bulkhead connectors when going from the wing into the cabin.*

Each antenna bracket is individually marked "right" or "left" with respect to a person sitting in the cabin of the aircraft. Install the brackets on their respective wing struts centered between the fuselage and the attachment point of the strut to the bottom of the wing (see Photos 1 and 2). The "V" sections of the brackets must be on the outboard side of the strut, making

Continued on page 2.

Continued from page 1.

certain the strut and strut clamp profiles match. *This is critical since this interface provides stability for the bracket and antenna assembly.*

Adjust the "V" of the bracket so that the strut clamps mount squarely on the strut. The brackets should be mounted identically on each side of the aircraft. At this time the rear strut clamp screws can be tightened (if so equipped) and then the front strut clamp screws can be tightened. Do not over-tighten the screws. The brackets should now be securely mounted to the strut.

Mount both antennas with the BNC connectors facing up and outboard from the aircraft (see Photo 2). Tighten the antenna lock nut until it is snug and then use nylon cable ties to secure the antenna to the bracket panel (see Photo 3). Tighten each element securely with a small wrench, being careful not to over-tighten the elements since a broken element causes great aggravation! Tape each element joint tightly with electrical tape so the elements don't rattle loose and get lost during the flight (see Photo 4).

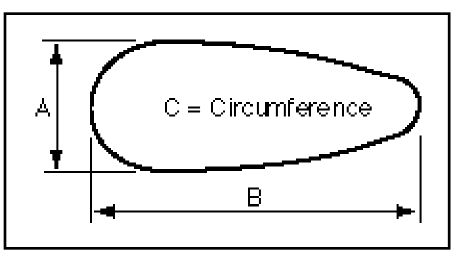
For those doing a temporary installation, you can now attach the coaxial cables to the antennas and route the cables over to the strut and down the trailing edge of the strut, securing the cable every 6 inches with nylon cable ties (see Photo 5). Use duct tape to secure the cable to the outside of the fuselage before entering the cabin through a door, window or air vent. Make certain that the cable will not be crushed when the door or window is closed. *It's advisable to purchase or make a spacer that will prevent the cable from being crushed.* The cable integrity is crucial and if the cables are damaged or smashed, the success of the mission may be jeopardized.

Once the cables are inside the cabin, route them to the area where they will be connected to the TAC-2 or TAC-7 switch box. Be careful that the routing of the cables does not interfere with other control cables or wiring (see Photo 6).

Now that the installation is finally done, it is a good idea to inspect the brackets, cables, and antennas for proper installation. Conduct a short test flight to check for flutter or vibration. A flight test can be done by placing a spare transmitter close to the airport in a known location—so that you can fly a test pattern around the beacon and test the function of the switch box and antennas before flying 100 miles to your research area. Flight characteristics of the aircraft should be normal, with a slight amount of parasitic drag.

REMINDER Regulations governing the attachment of equipment to aircraft vary depending on ownership, use and location. Users should check with appropriate authorities regarding current regulations. The International Association of Natural Resource Pilots is a source that can make suggestions based on practical experience. You may also wish to refer to the Federal Aviation Regulations concerning type certification requirements.

Gary Jones



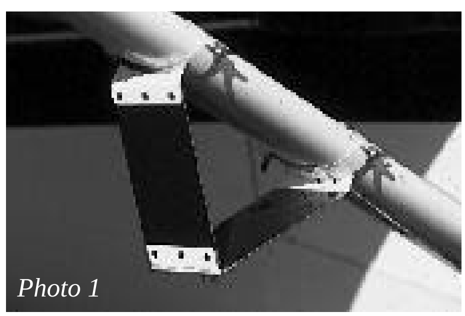


Photo 1


Photo 2

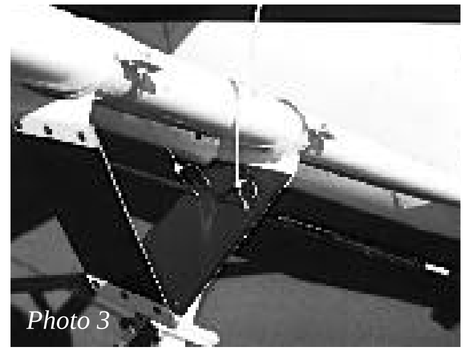


Photo 3

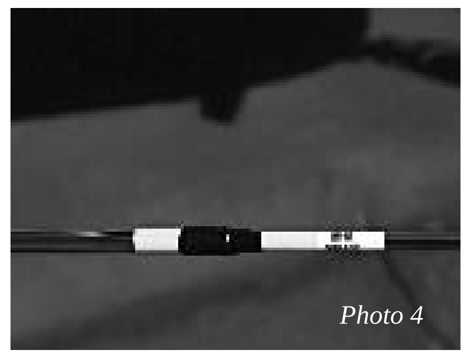


Photo 4


Photo 5


Photo 6

Table 1: Bracket Dimensions and Aircraft Models

BRACKET NUMBER	DIMENSIONS A	B	C	COMMON AIRCRAFT
TAB-1	4.75"	2.06"	11.00"	Cessna 150, 172
TAB-2	5.75"	2.44"	13.50"	Cessna 206, 207, 185
TAB-3	3.88"	1.63"	8.75"	PA-22 (Tri Pacer), BC-12 (Taylor Craft), PA-18 (Super Cub)
TAB-4	2.38"	1.38"	6.00"	J3 (Piper Cub)
TAB-5	5.00"	2.19"	12.00"	Cessna 182, 150-Aerobat
TAB-6	3.37"	1.43"	8.00"	Christen/Aviat-Husky

Aircraft Audio Distribution Systems

Using aircraft to track wildlife instrumented with conventional VHF telemetry units has become a standard practice in wildlife research. Many studies rely on getting weekly, monthly or, at least, occasional updates providing the position of study animals from aircraft monitoring flights. Aircraft tracking is an absolute necessity in a number of instances—when studying migratory species, animals with large home ranges, species that travel great distances in, on or over large expanses of water, or when working in wilderness areas without roads.

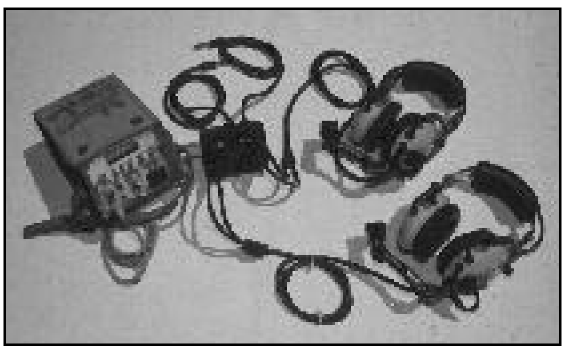
Unfortunately, setting up the aircraft to conduct a tracking study does not always receive proper attention. Tracking systems are often thrown together in a make-shift manner. Sometimes aircraft designs are pressed into service for tracking applications simply because they represent the "lowest bid." For example, efficiency and safety can be compromised by using a low-wing aircraft.

On the other hand, many researchers rely heavily on the use of properly equipped tracking aircraft. They have developed sophisticated systems permanently or semi-permanently installed into their aircraft. These systems are often customized to meet the specific needs of the tracking protocol and the equipment is selected for efficiency and safety.

Some researchers are pilots who fly the aircraft and track wildlife simultaneously. In other instances, the biologist sits in the right-hand seat and does the tracking while the pilot flies the aircraft. To many this division of labor helps ensure that the pilot is paying attention to flying and the biologist to tracking. Sometimes there is a joint effort. When a joint effort is required, it helps if both pilot and biologist can hear the telemetry radio signals and communicate effectively with each other without yelling over the noise of the aircraft or making obscure hand signals indicating the direction that the plane should take. Thus, we enter the world of aircraft audio distribution systems.

Perhaps the first subject we should address involves what the pilot and the observer are "wearing on their ears" while in the aircraft. This leads us to some terminology—the difference between headphones and headsets. It is important to know that most telemetry receivers have a low impedance audio output (2 to 20 ohms). When you plug into that output, it requires low impedance headphones. The term HEADPHONE is used because there is no microphone to talk into, simply speakers that allow you to listen to the signal.

In the aircraft world, convention has resulted in the use of high impedance HEADSETS which include the speakers, as well as a microphone you can talk into to communicate with others. In general, headsets are high impedance and headphones are low impedance. Headphones plug directly into the telemetry receiver, while headsets plug into the aircraft audio distribution system, such as an intercom. If you use the headsets plugged directly into the telemetry receiver or headphones plugged directly into the intercom, your performance is reduced.



A basic aircraft audio distribution system consists of SPO-22 Intercom, TR-2/TS-1 Receiver-Scanner and TAH-2 Headsets.

Aircraft intercom systems have been around for a long time and most planes are equipped with intercoms to allow passengers to talk to each other and the pilot. The early ones, generally speaking, did not allow you to put a low impedance input into the system. No provision was made for you to listen to a stereo or tape deck in your aircraft. There was no place to plug in such a system. It also meant there was no place to plug in the output of your telemetry receiver.

By the mid-1970s we recognized this to be a severe restriction. It essentially meant there were two systems—one for the pilot to communicate with the people in the plane, a second system for telemetry, and never the two should meet.

In those early years, we worked closely with Sigtronics to develop low impedance intercom inputs specifically for aircraft telemetry tracking. These early intercoms allowed pilots and passengers to talk freely. The pilot could talk through his VHF radio to ground control and either one or two inputs were available for the telemetry receiver. The system allowed everyone to plug their headsets into the intercom, listen to the telemetry receiver and talk to the pilot.

A version was also made that allowed the pilot to turn off the telemetry to his headset so that if he was in an important conversation with ground control, he was not confused by the telemetry signal or conversation among passengers. These early, specialized intercom systems allowed monitoring of telemetry with little or no reduction in sensitivity in the transfer of the signal to the observer. In other words, you got basically the same range when you plugged the receiver into the intercom as when you listened to the receiver directly with headphones. This was absolutely critical because many who tried to copy this circuitry did so ineffectively, resulting in attenuation of the signal.

Today there are numerous choices for intercom systems and often the system built into the aircraft has an integral low impedance input where you can put the output of your telemetry receiver—so everyone in the cabin can listen through the headsets. If you don't have such a system, and are still waving hand signals to your pilot, you may wish to consider using one. One option is the SPO-22 audio distribution and intercom system.

This system is portable and you can use it in any fixed-wing aircraft you rent for a tracking mission without permanent installation. The intercom is powered by a 9v battery installed in the intercom itself and can be plugged into the VHF voice radios of the aircraft. Set-up takes only a short period of time. The intercom system allows everyone to hear the telemetry, and the biologist and pilot to work together when tracking wildlife. We believe this adds to the safety of the flight and certainly saves time and money in most tracking applications.

One last insider's note concerning headphones and headsets—if someone tells you that you have a short between the headphone or headset, it's not a compliment but at least you will understand the technical distinctions.

Stan Tomkiewicz

Ultralight Tracking

How to select and install antennas and receiving subsystems

The past two decades has seen a dramatic increase in the availability of ultralight and kit built aircraft. These personal aircraft are available to the general public all over the world. Spawned by the ever increasing prices and scarcity of new commercial built aircraft, ultralight and kit planes have become very popular as personal aircraft for people on a budget. In addition to the relatively low sticker price, the total operating costs are generally low in comparison to factory built aircraft.

Ultralight and kit aircraft can be well suited for animal tracking if the species being studied does not migrate far during the study period. Although the range of these aircraft can be restrictive, the lower airspeed can actually be advantageous when tracking. Both ultralights and kit built aircraft have a wide variety of models to choose from with varying degrees of performance and capabilities.

Numerous requests have been received over the years to help researchers outfit ultralight aircraft with antennas and receiving subsystems for tracking purposes. Usually the pilot (often the newly graduated pilot) is just seeking advice or sometimes a missing piece of equipment to complete the tracking set-up. About a year ago we received such an inquiry from the field. The actual request was to build antenna brackets for mounting to an ultralight. This request led to the development of the TAB-7 antenna brackets designed to fit a multitude of aircraft in the ultralight/kit plane category.

The TAB-7 brackets are specifically designed for high-wing aircraft that are equipped with two round lift struts per wing. The bracket can be fitted with virtually any sized clamp to fit any size strut. The first set we ever made was for the Zenair CH 701 stol aircraft. That particular aircraft had a strut diameter of 1.25 inches for both front and rear wing struts.

A critical design criteria for the entire assembly involved keeping weight and drag to a minimum. This is particularly important in ultralights with small engines and limited power. To help achieve the design goals the brackets are constructed using well-accepted high grade aircraft materials.

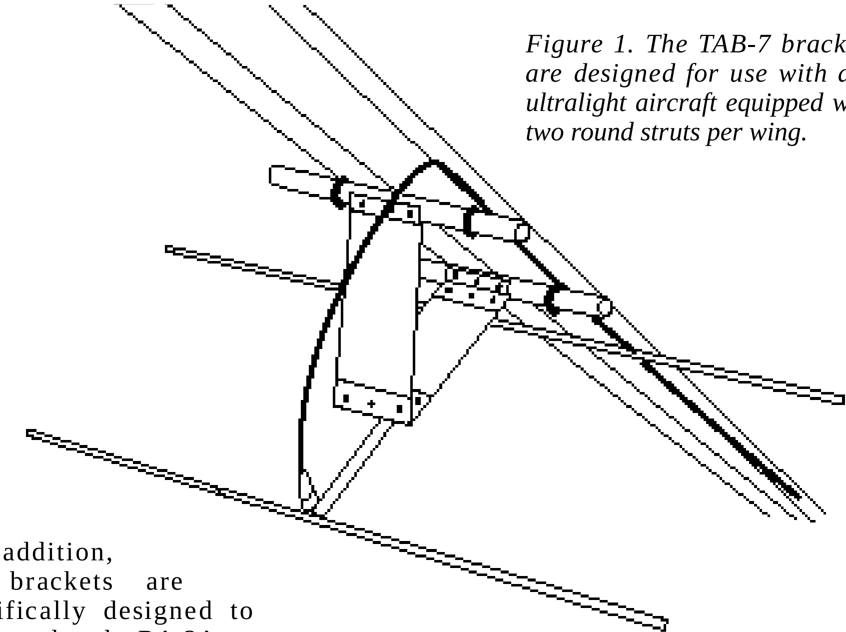


Figure 1. The TAB-7 brackets are designed for use with any ultralight aircraft equipped with two round struts per wing.

In addition, the brackets are specifically designed to accommodate the RA-2A antennas, commonly known as H-antennas. The H-antennas have been shown to have significantly less drag than the 3, 4 and 5 element antennas sometimes used in aircraft tracking. Fiberglass and phenolic materials are used along with rubber cushioned clamps to keep antenna signal losses to a minimum. Further, the general positioning of the antennas relative to the rest of the airframe optimizes performance and helps ensure that a consistent and reproducible reception pattern will be achieved.

The tracking setup employs two antennas to increase searching efficiency. The left and right brackets are designed to allow the antenna's coax cable to exit in the up direction. Each bracket consists of two heavy wall fiberglass tubes mounted in line with the airflow and attached under the wing strut by use of cushioned clamps. Attached to these tubes are two phenolic plates which meet at a hinged junction. Under this hinge, a stainless steel angle is riveted to the assembly to which the RA-2A antenna is mounted. The coax cable can be mounted along the wing strut and routed into the cabin (or, in the case of an ultralight, the pilot's seat) to the RLB switchbox (TAC-2 or TAC-3). From the switchbox a single coax cable leads to the receiver.

For installation refer to Figure 1 for guidance. Position the bracket against the strut slightly inboard of the jury strut location. The antenna mounting tab should be pointing down. Clamp the fiberglass tubes to the strut using the clamps provided.

The distance between the fiberglass tubes will determine the downward angle at which the antenna is pointing. The optimum angle should place the antenna pointed downward at about 15-20 degrees. Other angles may be preferred in some applications due to tracking altitude, airspeed, aircraft type and distances to animal being tracked involved. These angles may be adjusted to suit your needs. Both the left and right brackets are generally deployed at the same angle. Before tightening the bolts to the clamps, verify they are located between the struts fore and aft. Install the other bracket following the same procedure.

Assemble the RA-2A antennas and mount them to the bottom side of the brackets with the coax connector pointing up and the short element of the antenna away from the aircraft. Use nylon cable tie straps to secure the rear element to the phenolic through the holes provided. Attach the coax cables to the antennas and route them to the cockpit. Secure the cables with nylon ties, cable ties or electrical tape. To prevent the antenna elements from loosening up, wrap each element connection with electrical tape. Connect both cables to the appropriate connector on the switchbox and connect the receiver. Inspect the mounts before each flight to make sure all nuts and bolts are tight.

The TAB-7 was designed for use on the CH 701 aircraft with the intent that with just a change in the size of the clamp around the lift struts, this bracket design could be used on many different kinds of aircraft employing round struts.

Rob Callahan and Darrel Crow

Aircraft Tracking

Recommended aircraft general search pattern.

In recent years we have noted an increasing application of fixed-wing aircraft in radio location studies. The flight pattern described below represents a standard procedure developed and recommended for radio location of terrestrial animals. This pattern is by no means the only successful one currently in use. Many variations exist that incorporate specific geographical features or animal behaviors, or that take advantage of previously acquired information about the species in question. However, for those individuals who have been experiencing less than successful aircraft relocation efforts, or those just beginning to utilize aircraft in radio telemetry work, an examination of this basic pattern may be worthwhile in time, effort, and dollars expended.

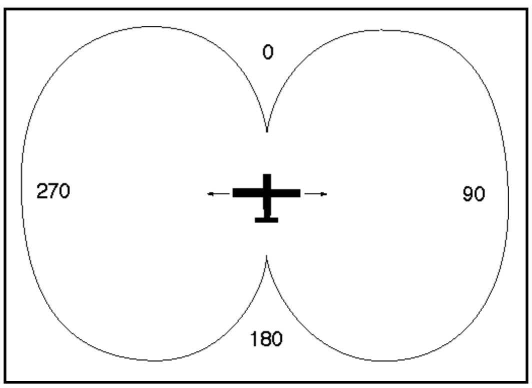


Figure 1. Aircraft Antenna Pattern Utilizing Paired Side-Looking RA-2A Antennas

General search efforts for terrestrial species are usually conducted with the Telonics TR-2/TS-1 scanning receiver, TAC-2 RLB antenna control unit, and a pair of RA-2A "side-looking" antennas (see Figure 1). The expected range for signal acquisition depends on several factors—one primary factor being altitude above ground level (AGL). The theoretical relationship between range and AGL is defined in Figure 2.

Such range performance can be achieved using a high power option and a dipole antenna on large animal transmitters. For standard transmitting subsystems with monopole antennas, the range is approximately one half of that predicted in Figure 2, and range may be less when using low power or small animal transmitters. The following steps offer a general description of the search pattern as illustrated in Figure 3:

A. When a signal is detected, the scanner is stopped on the frequency of the incoming signal. The TAC-2 is then used to determine whether the signal is on the right or the left of the aircraft by monitoring first the left antenna, and then the right, to determine which is receiving the strongest signal.

B. Assuming the signal is strongest on the right side, the pilot begins a slow 360° turn. This results in tilting the left wing down by 30°, thus placing the maximum gain of the right antenna on the horizon. The signal is monitored from the right antenna only during this period and a note of the bearing direction is made when the signal strength is at its maximum. The plane is brought out of the 360° turn on the noted bearing.

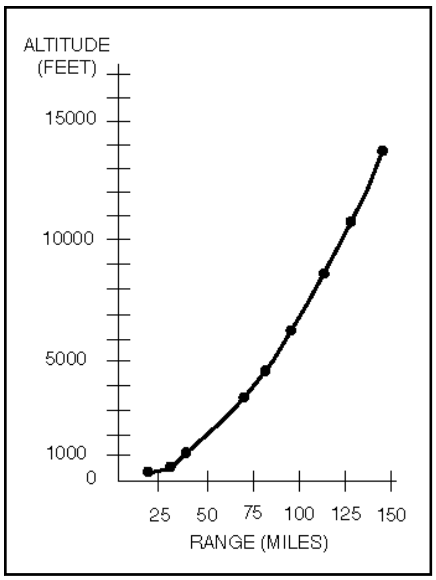


Figure 2. Relation between Aircraft Altitude and Radio Horizon

C. The transmitter should now be located directly ahead of the plane, but at some unknown distance. The switch box is utilized to keep the plane on course. If either antenna is picking up a signal, the course is slightly adjusted to keep the transmitter in the null.

D. Flying the null of the antenna pattern can be disconcerting at first. In order to increase the confidence of the user, a second bearing can be taken by banking the aircraft to the left in a slow turn. Once again the pilot dips the left wing down 30°. This tips the right wing up 30°, placing the gain of the right antenna on the antenna.

E. A second bearing is taken and quickly compared to the first. The intersection of the two represents the theoretical location of the animal.

F. The pilot then resumes course toward the transmitter. As the aircraft approaches the transmitter, the null disappears and the signal must be kept equalized between the two antennas. The actual point of signal acquisition when the transmitter is directly in front of the aircraft is dependent on several factors, including AGL. Figure 4 depicts the change in signal strength as function of AGL as the aircraft approaches, passes directly over, and goes by the transmitter. An altitude of 1000 to 1500 feet AGL is recommended for precise locations.

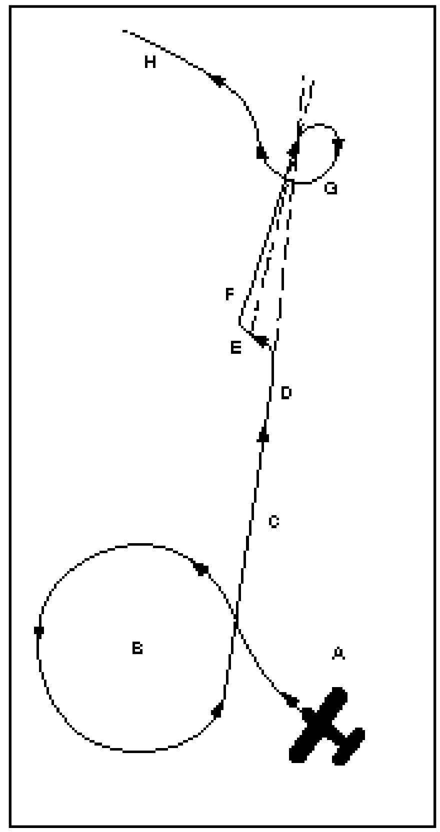


Figure 3. Aircraft Search Pattern

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NOTE: *As the aircraft passes over the transmitter, the gain of the antenna (as a dipole) is placed directly on the transmitter. As the signal saturates the receiver, the audio output of the receiver may change from a "beep" to a plodding or "thud" sound.*

G. After passing directly over the transmitter, the aircraft is banked to the right to begin a 360° turn. The PILOT's wing tip is now up 30°. Since the antenna is initially attached to the strut at a downward angle of 30° from the horizontal, the combined effect is a right antenna that is now 60° down from the horizontal. The maximum gain of the right antenna is pointed directly at the center of the area being circled. The animal should be in the center of the circle and the receiver should be supersaturated with signal.

H. Upon completion of the monitoring process, the frequency of the transmitter can be deleted from the program of the scanner/receiver and the search for other transmitters resumed.

Although the technique described above may appear to be time consuming and complicated at first, its effectiveness has been proven time and again throughout the world. The search pattern is most effective when there is constant cooperation and communication between pilot and biologist. After a short time, the procedure becomes almost automatic. In several studies this procedure, coupled with frequency stable receiver and transmitter subsystems, has reduced flight time by up to seventy percent. The result is substantial reductions in budgetary expenditures associated with tracking wildlife from fixed-wing aircraft.

Dave Beaty and Stan Tomkiewicz

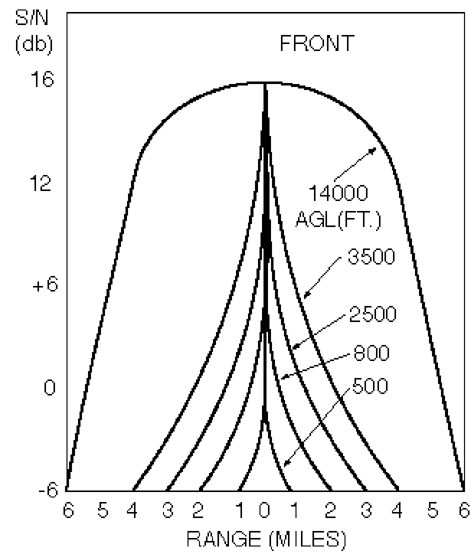

Figure 4. Signal Strength Expressed as Signal to Noise Ratio in db Versus Range to the Transmitter Directly in Front of and Behind the Aircraft.

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