20 Feb 2002

INTRODUCTION TO RADIO TELEMETRY

Cara Lin Bridgman
caralinb@ms68.hinet.net
04-2632-5484

Radio telemetry is rather like something out of a James Bond movie, it uses plenty of fancy and expensive equipment and allows you to spy on your subject without actually having to see it. The problem is that there is a lot of error involved, ranging from equipment breakdown to moving animals, and it is VERY expensive. All attempts should be made to use some other method to answer your research questions. The information below should give you some idea of what is involved with radio telemetry, and will hopefully help as you plan your study.

USES

A. Home Range

Usually, telemetry is used to determine the area over which an animal spends most of its time. Researchers are most often interested in the range for a year, a season, a month, or during a particular time like the breeding season. They are also interested in how ranges of different individuals or different sexes overlap. With home range analysis, the more data points you have the greater the home range. You will want to try to keep the number of data points even from subject to subject and from season to season. Sample sizes and statistics are discussed in Aebischer et al. (1993) who conclude that you need at least 30 locations for each animal for each time period, and you need at least 6 animals for any one category (age, sex, habitat type). There is also the statistical problem of independence, for where an animal is now will affect where it is in 10 minutes. To "ensure" independence, it is best to have about 4 hours between locations.

B. Diehls

Often researchers want to know the daily activity patterns of an animal. To do this locations can be determined for every hour or every 2 hours throughout a 12 or 24 hour period. This will allow you to learn how much they move (straight line distance) and when. Birds, which usually sleep from dusk to dawn, only need to be studied in daylight hours. Some animals, like mongooses and cats, go 24 hours a day with short naps.

C. Habitat Use

Often radio location data can be overlaid on a map of habitat to determine which sorts of habitats are used more often. Be aware that you and your study animal probably see habitat categories differently. Things like canopy cover may be more important than canopy species.

EQUIPMENT

As with all electronic equipment, most telemetry equipment is not designed for use in the field no matter what the manufacturer says: you can't drop it and you can't get it wet. The big exception is the transmitter, which is encased in plastic or fiberglass and can get wet, although it's still best not to drop it.

To do radio telemetry you need at least one receiver, a coaxial cable, an antenna, transmitters, an accurate compass, and a very good map. The receiver, cable, and antenna are used by the researcher to locate the transmitters which are installed on the study subject. Most of this equipment comes with some instruction.

Here is a brief introduction:

The receiver has three things that are worth concentrating on: frequency dial, volume, and gain. It is also helpful to have a signal strength meter so you can see the signal as well as hear it. The frequency dial is used to tune the receiver so it can receive a particular transmitter. Receivers are programed to receive signals in a certain range: 150.000 - 151.999 MHz or 163.000 - 164.999 MHz. Each transmitter will emit signals at a particular frequency: 151.531 MHz, or 163.811 MHz. You should try to find out ahead of time what sorts of frequencies are commonly used by radios, cellular phones, and people with walkie-talkies, for activity at these frequencies will greatly interfere with your reception and your ability to find your transmitter. Volume only controls the loudness of the signal; it has nothing to do with reception. The important tool for controlling reception is the Gain. Gain focuses the signal, and you adjust this to keep the signal from being too loud or too soft. BEWARE of turning the gain too high, for you can blow out the receiver and then you'll have the great expense of repairing it. You should try to never turn the gain up more than 50%.

The most commonly used antenna is the Yagi Antenna. This antenna looks the most like the typical TV antenna. It is the most popular, in spite of its huge, unwieldy size, because it is the most directional. A Yagi Antenna pinpoints the direction the signal is coming from better than most. Still, with a Yagi, the loudest signal will cover a range of about 60 degrees. It is best to record the direction at which this loud signal begins and ends and then to calculate the midpoint for use in your analysis. If the signal covers more or less than 60 degrees, you need to adjust the gain (decrease or increase, respectively).

ATTACHMENT

Kenward (1987) has an excellent summary of collars and other attachments, with diagrams and a description of problems and side effects. Transmitters and straps should weigh no more than 5% of the study animal's body weight. Of course, less is better. With birds or bats that fly frequently, transmitter weight should be less than 3%.

Remember, unless you recapture the animal at the end of the study, the transmitter probably is placed for life. There are very few studies of the long-term effects of the added weight and irritation. There is some experimentation with collars or backpacks that will fall off after a certain length of time, but there is often a problem with the transmitter falling off too early.

A. Necklaces & Collars

With this method, the transmitter is attached to the animal's neck. It is the usual method for mammals. Be sure that the collar is tight enough to prevent slipping but not too tight to interfere with the animal's activities. If you put a collar on a bird (used only with gallinaceous birds), be sure that the collar is loose enough to allow large food items to go down. Some pheasants are known to eat acorns or even snails. Another problem with this method on birds is that the transmitter may slip, causing irritation to the neck, and that the antenna will often get caught under the wing. This method is not used with birds that fly frequently.

B. Backpacks

This is commonly used with most birds. The transmitter is placed on the back between the shoulder blades and straps either wrap around the body or the wings to hold it in place. Straps around wings have a tendency to irritate the skin, and straps around the body have the potential to be constricting if the bird gains or loses a great deal of weight. Some pheasants vary their body weight by more than 25% throughout the year. The problem with placing straps too loosely is not just losing the transmitter, but the risk of entanglement, which can kill the bird.

TELEMETRY

A. Homing

This is the simplest way to radio track an animal. You simply follow the signal as it gets louder and louder and as you turn the gain lower and lower, until you locate the animal. You will use this method any time an animal is nesting, roosting, dies, or the transmitter falls off. Homing, though, is impractical in many terrains, and can interfere with animal behaviour. One of the reasons to use radio telemetry is so that the movements of the animal can be followed without investigator interference.

B. Triangulation

This is the usual method of radio telemetry. Just as a GPS unit tells you where you are by determining the angle from you to satellites with their known locations, you can locate your study animal by determining the angle between it

and known stations in your study site. This means that you must have an accurate map of the stations you use for triangulation. Then, the actual location can be determined by either drawing on a map the angles from the stations to determine where they intersect, or by putting station and angle data into a computer program like TELEM (Coleman and Jones 1988) or SAS (White and Garrott 1990).

With triangulation, three things are of utmost importance: station location, time between bearings, and bearing angle. You must have your stations accurately mapped. You must try to complete all your bearings in as little time as possible to avoid error based on study animal movement (see below). And, your bearing angles, from one station to the next, cannot be too flat or too sharp. If the angles are less than 30 degree (and between 150 and 180 degrees) you have a problem with the lines intersecting too gradually, providing too great a range over which the animal could really be.

TROUBLE SHOOTING & ERROR

A. Signal strength varies: sometimes loud, sometimes soft.

This means that the study subject is moving and things like trees and rocks get between it and you, blocking the signal. When this happens, it is difficult to determine the direction the signal is coming from. Also, because the animal is moving, this creates triangulation error. Depending on how long you take to get your triangulation and depending on how the animal moves relative to you, your triangulation will over or underestimate the animal's location. This is a very big source of error. About the only way to deal with this is to keep the time between bearings as short as possible and pray that the animal is not moving too fast.

B. Cannot receive signal.

In this case, the receiver may not be correctly tuned to receive the signal. Sometimes the signals vary a little bit: 150.531 to 150.532 to 150.530 MHz. Or your batteries may be dead, or the gain is down too low, or the transmitter battery is dead or there is some transmitter malfunction, or the study subject has moved out of receiving range. If you go through a time when the signal disappears (several days) and then reappears, you have a big problem with calculating home range: you cannot calculate home range if the animal moves out of the study area, for its range is bigger than your study site.

C. Bounce

This is a problem similar to the moving animal problem. The only way to deal with this is to have a thorough knowledge of your study area, to recognize locations where bounce is likely to be a problem, and to use another location for your triangulation station. Bounce is why you take at least 3 bearings (and often more than that) for each triangulation. The problem with bounce is that you can only know where the signal is coming from. With bounce, the signal goes from the study animal to a cliff (most likely) and then bounces off the cliff to you. You then think that your study animal is on the cliff when it is really somewhere else. A clue that bounce is a problem is when you follow the signal to the cliff or whatever, and the signal disappears or comes from an entirely different direction.

D. Equipment Problems.

Singing signals: signal varies in strength and pitch, getting louder and lower and then higher and softer. This could mean that you have an unstable transmitter or a problem with the receiver. Try to locate the animal using another receiver. If the problem still occurs, you will have to replace the transmitter.

Null spots in the receiver: occasionally a receiver has a problem in that it cannot receiver any transmitters emitting at, say, 15X.X9X MHz (i.e. any transmitter with a frequency near .09 MHz). Try with another receiver to make sure it is not a transmitter problem. Check with all transmitters that have a frequency in that range. If the receiver cannot pick up any of them, you'll have to send it back to the company for repairs.

LITERATURE CITED & USEFUL REFERENCES

Aebischer, N.J., P.A. Robertson, and R.E. Kenward. 1993. Compositional analysis of habitat use from animal radiotracking data. Ecology 74:1313-1325.

Coleman, J.S. and A.B. Jones III. 1987. User's Guide to TELEM88: Computer Analysis System for Radio Telemetry. Dept. Fish and Wild. Sci., Virginia Polytechnic Inst. and State University, Blacksburg, VA. 46pp.

Dywer, T.S. 1972. An adjustable radio package for ducks. Bird Banding 43:282-284.

Hupp, J.W., and T.J. Ratti. 1983. A test of radio telemetry triangulation accuracy in heterogeneous environments. Pages 31-41 IN D.G. Pincock, ed., Proc. 4th Int. Conf. Wildl. Bio. Telem. Applied Microelectronics Institute and Technical University of Nova Scotia, Halifax, Canada.

Kenward, R. 1987. Wildlife Radio Tagging: Equipment, Field Techniques and Data Analysis. Academic Press, London, Great Britain. 222pp.

Lee, J.E., G.C. White, R.A. Garrott, R.M. Bartman, and A.W. Alldredge. 1985. Accessing accuracy of a radio telemetry system for estimating animal locations. Journal of Wildlife Management 49:658-663.

White, G.C., and R.A. Garrott. 1990. Analysis of Wildlife RadioTracking Data. Academic Press, Inc., San Diego, CA. 383pp.

APPENDIX

Radio Telemetry Companies:

Advanced Telemetry Systems, Inc.
470 First Ave. N. Box 398
Isanti, MN 55040
tel: 612-444-9267
fax: 612-444-9384
email: 70743.512@compuserve.com
contact: Chris Koehanney

AVM Instrument Company, Ltd.
2356 Research Drive
Livermore, CA 94550
tel: 510-449-2286
fax: 510-449-3980
email: avmtelem@ix.netcom.com
contact: Barbara Kermeen

Hi-Tech Services
9 Devon Place
Camillus, NY 13031
tel: 315-426-7451
email: karen.kenty@suadmin.syr.edu
john_kenty@dec.mailnet.state.ny.us
contact: Karen Kenty

Telonics
Telemetry-Electronics Consultants
932 E. Impala Ave.
Mesa, AZ 85204-6699
tel: 602-892-4444
fax: 602-892-9139
email: 75052.1563@compuserve.com
contact: Michelle Guinn

Home Range Analysis Programs:

The following programs are available for free distribution, although the producers have consulting fees if you need help using them.

CALHOME: A Home Range Analysis Program. MS DOS Ver. 1.0, 25 July 1994.
John G. Kie
Forestry Sciences Laboratory
2081 E. Sierra Avenue
Fresno, CA 93710.
tel: 209-487-5589.
This program is almost idiot proof, but cannot calculate triangulation data. The (X,Y) coordinates for all your data have to be calculated elsewhere. Calhome produces reasonably pretty pictures of home range (with an option of four different methods) with little fuss.

TELEM88: Computer Analysis System for Radio Telemetry. 1987.
John S. Coleman
Department of Wildlife Ecology
Russell Labs
University of Wisconsin
Madison, WI 53706
tel: 608-262-1984
608-238-9642
This is a user-unfriendly program that can use triangulation data to calculate animal locations and home range. Plotting out the data is difficult. If you use this program, allow plenty of time and follow the instructions manual religiously.