



A Manual For Wildlife Radio Tagging

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A Manual For Wildlife Radio Tagging.—Robert E. Kenward. 2001. Academic Press, London. x + 311 pp., 107 figures and photographs, 5 tables, and 40 mathematical equations. ISBN 0-12-404242-2. \$65.00 (cloth).

Radio-telemetry has moved from science fiction to an indispensable science fact in only 40 years. Today we routinely employ radio-tagging and tracking to learn about the biology and conservation needs of birds. Radio-tags that once cost thousands of dollars are now inexpensive enough for most graduate students to deploy in reasonable numbers. Increased availability of telemetry has generated an increased need to learn about tagging, tracking, and handling the data that pour in from radio-tagged animals. For those of you possessed by questions like Where is that bird going? What resources are important to it? What might kill it? How fast does its heart beat? and How do our actions affect it?, Robert Kenward's new book, *A Manual For Wildlife Radio Tagging*, is required reading.

The mobile nature of birds has put a premium on using telemetry to better understand them. As a result, ornithologists have shaped many aspects of wildlife radio-tagging. Few have contributed more than Robert Kenward. Kenward has used telemetry to redefine raptor biology, written an integrated suite of software (RANGES V) to manage, analyze, and graph telemetry data, developed new analytical procedures, and, with his wife, Bridget Kenward, designed, perfected, and marketed radio-tags and receivers (BIOTRACK Ltd.). His insights, tribulations, recommendations, and approaches are clearly and often humorously detailed in this valuable book.

Kenward's thoughts are organized into 10 chapters followed by references, a glossary of telemetry terms, and two valuable appendices. The first eight chapters

introduce the reader to the types of questions resolved by telemetry, detail the equipment needed to tag and track animals, discuss how to make, purchase, and attach tags, explain how to track animals, and suggest what to anticipate when collecting data. The last two chapters discuss more detailed analyses concerning the estimation of home range, animal density, survival, movements, and interactions with resources and other animals. The appendices present a brief listing of companies (with valuable contact information) that make telemetry equipment, tags, and mounting components, as well as software to collect, analyze, and map data.

A Manual For Wildlife Radio Tagging expands and revises Kenward's *Wildlife Radio Tagging: Equipment, Techniques, and Analysis* (Academic Press, London, 1987). Kenward claims these books remain the only comprehensive guides to all aspects of the field useful to wildlife biologists of all levels of expertise. True, these are the best comprehensive guides, but as Kenward later points out, he is really writing for the novice user. Experienced users will learn from the review (for example, I will now label all my valuable equipment "radioactive" to reduce tampering in the field!), but novices will save money, time, effort, and embarrassment if they start with a thorough read of this book.

The sage advice Kenward presents in this book is priceless. His main points are summarized at the end of each chapter. As an example of the issues you will learn about, consider these points I found especially useful: (1) think and plan ahead so you have your equipment when you need it, (2) use the animal, not the location, as your experimental unit, (3) talk with experienced practitioners, (4) remember that other agencies may claim the frequencies we typically use for telemetry, so lobby regulating bodies to keep some for our use, (5) ask those making your equipment about its power output, antenna format, and how the equipment will perform in your field setting, (6) the accuracy of ARGOS satellite transmitter location estimates is measured in tens of kilometers under typical field conditions, (7) automated tracking systems remain inaccurate and impractical for many avian applications, (8) location estimates are not accurate to several decimal points, so don't waste time including such precision in your data sets, (9) consider several attachment options before selecting one for your application and make sure to test it for attachment effects, (10) get familiar with performance of your equipment in your field setting before you put tags on animals, (11) adjust the gain, not the volume, when homing, (12) if in doubt about a tag's location, gain altitude, (13) cell failure rarely accounts for transmitter loss, (14) there are old pilots and bold pilots, but no old, bold ones—hire an old one, (15) when estimating tag location, plot your bearings immediately, (16) error is more acceptable than bias, (17) to estimate survival you need to have many animals survive for the duration of study, so calculate sample size accordingly, and (18) analyses of resource selection can be focused on what animals use rather than defining use relative to "availability."

A few aspects of the book were poorly done, in my opinion. Electrical wiring diagrams are provided for a variety of tags, which can be insightful, but those in the book were not described well enough for any but

the most experienced electrician. Although lots of equipment and software are described, there is really no critical discussion of it. Advice on the best receivers, tags, and software, and a description of their limitations, would have been valuable. A more thorough and open comparison of software should have been presented: as written, Kenward really just describes how to use his software. The graphics, mapping, and data management limitations of RANGES V relative to available Geographic Information System software (GIS) are not thoroughly discussed. I also found the discussion of how to make a radio-tag a bit overdone. Because few people today will actually build a radio-tag from scratch, Kenward would have served readers better by focusing on repair, enhancement, and modification of transmitters.

These detractions make the book much more historical than forward looking. I appreciate the review of where we have been, but the field is changing daily and a useful manual should anticipate the future. One example of how Kenward's book fails to do this is in the lack of attention devoted to managing and analyzing telemetry data with readily available GIS software. Given the current profusion of GIS software and its accessibility to nearly all biologists, Kenward does a real disservice by not illustrating its potential to the field. Likewise, Kenward continually raises concerns about the accuracy of Global Positioning System (GPS) receivers, but this is largely moot because military degradation of the signal is no longer practiced. Few aspects of animal ecology are better enhanced by GPS and GIS technologies than telemetry studies, but Kenward seems to hold back on applying his blessing.

The most serious limitation of the book is the treatment of material presented in the last two chapters. Aspects of data analysis are introduced here, but not rigorously appraised and compared. Literally volumes have been written about the topics Kenward introduces (e.g., home-range estimators, resource selection, movement; White and Garrott 1990, Turchin 1998, Mills-paugh and Marzluff 2001). Kenward cites the appropriate literature, but does not provide the detailed review necessary. Those collecting telemetry data will need to study these books in addition to Kenward's manual. In this respect Kenward's manual is really more of a primer or starting point than a stand-alone source of information.

Kenward starts his book with a challenge to use telemetry to answer biological rather than methodological questions. Reading this book will stimulate you to begin asking such questions. However, if you want to get the most out of your efforts to understand birds through radio-telemetry, you will need to begin with Kenward, consult detailed volumes such as those mentioned above, and keep abreast of a wide range of technical, analytical, and biological primary literature. Using new technologies to extend Kenward's approaches may help us all understand what birds are doing after they leave our hand or view.—JOHN M. MARZLUFF, Division of Ecosystem Science and Conservation, College of Forest Resources, University of Washington, Seattle, WA 98195, e-mail: corvid@u.washington.edu

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