ESTIMATING PRONGHORN ABUNDANCE USING AERIAL LINE TRANSECT SAMPLING

by

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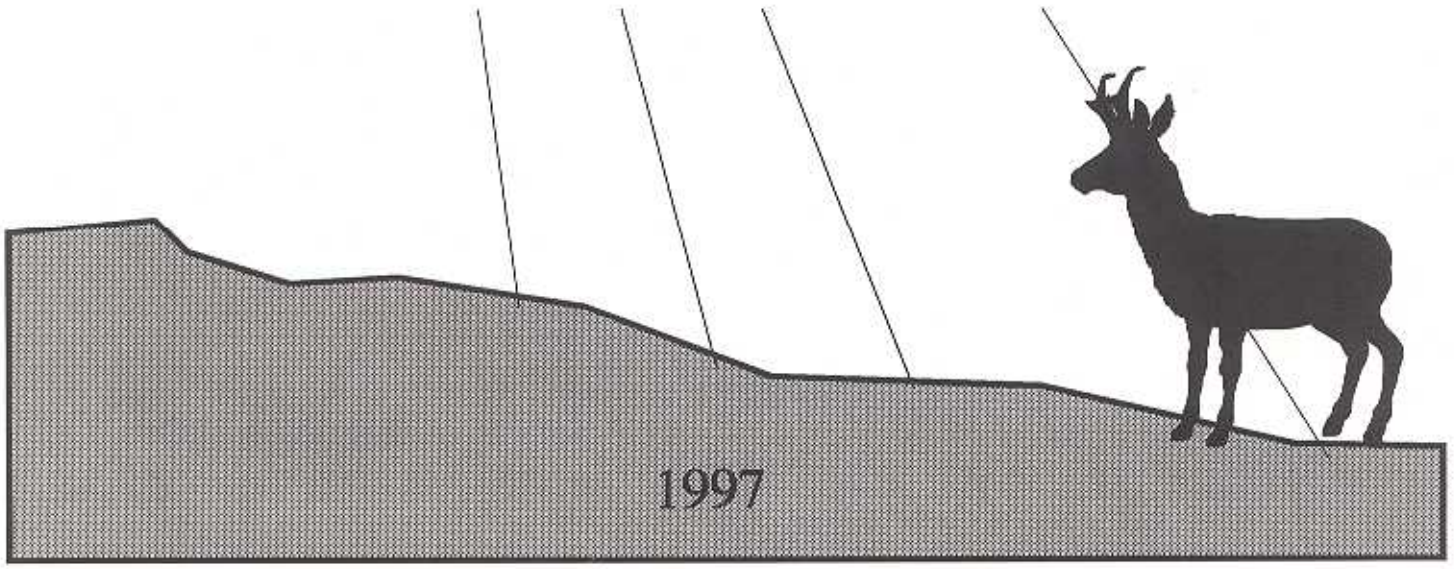

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DEDICATION

This manual is dedicated to the memory of Fred Reed. Fred helped refine the application of line transect sampling to aerial wildlife surveys. Fred was as dedicated to the wildlife resource as to his flying. He developed state-of-the-art technology for safely collecting high quality data from low level surveys. This system enabled aerial line transect surveys to be conducted efficiently and accurately. Fred maintained strict quality control and continued to improve equipment and procedures up until his untimely death on October 23, 1995. The Wyoming Chapter of The Wildlife Society awarded Fred and his wife, Linda, the Chapter's Professional of the Year Award for their contributions to wildlife management. The procedures described in this manual and the widespread use of aerial line transect surveys in pronghorn management in Wyoming are largely due to Fred's contributions.

ACKNOWLEDGMENTS

Numerous persons contributed to the development and implementation of the techniques described in this manual. To them I owe a great deal of gratitude and am privileged to have worked with them. Any errors in this manual, however, are mine. First and foremost, the late Fred Reed deserves special thanks for his hard work and dedication in developing a suitable system for recording accurate data and conducting these surveys safely. His wife, Linda Reed, was instrumental in programming the onboard computer to capture survey data. The pilots and staff of their former company, Western Air Research, Inc., deserve special recognition for their commitment and skills in conducting line transect surveys. Merlin Hare ably piloted many of these surveys. Gary Lust and the staff of Mountain Air Research, Inc., successor to Western Air Research, maintained continuity in providing line transect services. Claude Tyrrel and the staff of Sky Aviation developed a new strut marker attachment for aircraft with single braces, and helped adapt a new computer system for use in line transect surveys. Sky Aviation did an admirable job of getting properly equipped and trained to conduct line transect surveys. Bruce Hahn of Izee Labs modified their computer system for use in aircraft.

Bruce Johnson, Oregon Department of Fish and Wildlife and formerly of the Wyoming Game and Fish Department, and Fred Lindzey of the Wyoming Cooperative Fish and Wildlife Research Unit, played major rolls in the development, formal testing and implementation of the Wyoming Technique to estimate pronghorn abundance. David Anderson and Ken Burnham of the Colorado Cooperative Fish and Wildlife Research Unit, and Jeff Laake of the National Marine Mammal Lab developed much of the theory and modern analytical tools for analyzing distance sampling data. All contributed suggestions for Wyoming's aerial line transect technique. Jeff Laake provided his vast expertise and practical knowledge on several occasions and presented a workshop on DISTANCE to Wyoming Game and Fish Department biologists. Stephen Buckland of the Scottish Agricultural Statistics Service likewise contributed much to modern line transect analysis and offered suggestions on some aspects of Wyoming's procedures. Tom Pojar of the Colorado Division of Wildlife provided advice on many aspects of our technique.

I offer my thanks to many of the current and past employees of the Wyoming Game and Fish Department for their help in implementing line transect sampling in pronghorn management. Some deserve special mention. Bill Hepworth, John Emmerich and Tom Christiansen were extremely helpful in getting aerial line transect surveys integrated into routine management and in helping to further evaluate the technique. Jay Lawson and Harry Harju of the Wildlife Division have supported the program from the time it was first proposed. I thank Gregg Arthur, Bob Lanka, Sharon Anderson, Debbie Wheat, and the other personnel of the Laramie Region for assuming some of my duties while on assignment to write this manual. Several Department biologists in the Wildlife Division reviewed the manual and provided numerous suggestions to improve it.

Jeff Laake, David Anderson, and Tom Pojar provided excellent review and assistance on this manuscript.

Finally, I thank Mary Collins for her love, patience and support throughout this project.

PREFACE

Line transect sampling (Buckland et. al. 1993, Burnham et al. 1980, Gates 1979) was adapted to aerial surveys to estimate pronghorn (*Antilocapra americana*) populations in Wyoming (Guenzel 1986, Johnson et al. 1991, Guenzel 1994). Use of this technique in Wyoming expanded from the domain of research and development to routine management (Guenzel 1994). At the time of this transition, Bruce Johnson and Fred Lindzey (1990) predicted that line transect procedures and software for analysis would be refined as biologists gained experience applying the technique to different circumstances, new technologies emerged, and improved algorithms were developed to analyze survey data. All those things happened. Biologists applied the technique throughout the state under varying population densities, terrain and sampling intensities. The marking and data recording systems used on survey planes were improved to better control some sources of error. A radar altimeter allows each observation to be corrected for actual height above ground. LORAN-C navigation systems have been replaced or supplemented with Global Positioning Systems (GPSs). Improved computer systems for recording data in flight are now commercially available. The analysis program TRANSECT (Laake et al. 1979) has been replaced by a more powerful and comprehensive package, DISTANCE (Laake et al. 1996). As predicted, the technique evolved from that described in Johnson and Lindzey's (1990) *Guidelines for Estimating Pronghorn Numbers Using Line Transects.*

This new manual is intended to help fill the gap between Johnson and Lindzey's (1990) *Guidelines* and current procedures. It should be considered as a supplement to more comprehensive publications on the design and analysis of line transect surveys (e.g., Buckland et al. 1993, Laake et al. 1996). Here, I describe the use of some of the major refinements that are now incorporated into the aerial line transect procedures for estimating pronghorn population sizes in Wyoming. I emphasize basic considerations and procedures for conducting these surveys. Like its predecessor, this manual should be viewed as just another step toward further improvements of the technique. It is intended as an update on current procedures and is not the final word on how to use the technique. As of this writing, another version of DISTANCE (3.0) operating under Windows 95 is being prepared and further refinements are expected.

This manual is intended as a basic presentation of the design, conduct and analysis of aerial line transect surveys to estimate pronghorn populations as currently used by the Wyoming Game and Fish Department. It borrows extensively from the previous guidelines (Johnson and Lindzey 1990) and examples from other aerial survey techniques (e.g., Unsworth et. al. 1994, Gasaway et al. 1986). Some of the discussion is based on information presented at Biennial Pronghorn Antelope Workshops and the North American Wildlife and Natural Resources Conference (Guenzel 1994). Readers should refer to more comprehensive texts for further background (see Buckland et al. 1993).

Many improvements in estimating pronghorn population sizes are expected to occur in the application of this technique as improved survey designs are tested and the limitations are better defined. Through that process, biologists should be better able to assess the reliability of survey results, their interpretations, and uses in management. The technique should continue to evolve. There is currently interest in the development of high-resolution video systems for estimating wildlife populations. Perhaps new technologies may someday be integrated with existing aerial surveys including line transects. Some future applications of distance sampling may incorporate traditional sightability techniques (see Unsworth et al. 1994)..

Constructive criticisms on the manual and the aerial line transect procedures are welcome.

Rich Guenzel

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READ THIS FIRST!

- **This manual is a basic presentation of current procedures used by the Wyoming Game and Fish Department to conduct aerial line transect surveys of pronghorn populations. It is not a complete reference on line transect sampling, nor is it a cookbook on how to conduct aerial line transect surveys.** Users will have to adapt these procedures to their own circumstances based upon their familiarity with the populations to be sampled. Those not familiar with line transect sampling should consult referenced texts, statisticians and other experienced persons before designing their own surveys. The only dumb question is the one that isn't asked. Users should check for additional improvements implemented after the publication of this manual.

- **The purpose of this manual is to supplement and not replace existing texts on line transect sampling and analysis by explaining this application to aerial pronghorn surveys.** This manual should be used in conjunction with the books, *Distance Sampling: Estimating Abundance of Biological Populations* (Buckland et al. 1993), and *DISTANCE User's Guide, Version 2.2* (Laake et al. 1996).

- **As with all aerial surveys, safety is the primary concern.** Although all low level survey work is potentially dangerous, surveys should not be performed under unusually hazardous conditions. Under those circumstances, pilots have difficulty flying designed transects and observers are less attentive to surveying. You can come back later to complete a survey.

- **The user is responsible for conducting the survey properly, meeting assumptions, and critically examining results.** Aerial line transect procedures require a great deal of quality control. The line transect technique provides an estimate of density which is subject to variability. This uncertainty should be considered in its interpretation and application.

- **Detailed procedures for setting up aircraft for line transect surveys are beyond the scope of this manual.** The marking of aircraft for line transect surveys require special calculations. Those interested should contact the author.

- **Persons who will participate as observers or pilots in these surveys should be properly trained prior to the survey.** Practice runs prior to the survey are very helpful to allow participants to get comfortable with the protocols and ask questions about the procedures.

- **This manual deviates from accepted standards for scientific writing by mixing Metric and English units.** The use of mixed units facilitates analysis because of aircraft instrumentation and the set-up for the Wyoming Technique.

- **Users of these procedures should use the program DISTANCE for analysis.** We no longer support the use of TRANSECT-II for data analysis.