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WHAT WILDLIFE MANAGERS SHOULD KNOW WHEN USING RADIO-TELEMETRY DATA

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History of Wildlife Radio-Telemetry

Radio-telemetry, the recording and transmitting of information from an instrument, refers to attaching a radio-transmitter to an individual animal to monitor survival, movements, and habitat selection. Since the late 1950s radio-transmitters have been deployed on wildlife to study their behavior and life history.

For the first few decades only very high frequency (VHF) radios were commonly available. Telemetry works in a manner similar to any radio system. There is a transmitter source sending out a signal at a given frequency (e.g., a radio "station") and a receiver (e.g., a vehicle's radio) is tuned to that frequency allowing us to hear the signal (e.g., music or talk show). Biologists attach radio-transmitters to animals, often a neck-lace style is used (Figure 1), and then a hand-held receiver and directional antenna are employed for relocation and monitoring (Figure 2).

Figure 1. Cow elk (Cervus canadensis) with a necklace-style radio-transmitter.

The VHF radio-transmitters emit a signal at a predetermined rate; e.g., one pulse per second, and when detected by a receiver the signal produces a "beep." If a directional antenna is used, the biologist can triangulate the signal (i.e., using the bearings of the signal from different locations around the

Figure 2. A biologist using a VHF directional antenna and receiver to detect signals from radio-marked greater sage-grouse (Centrocercus urophasianus).

animal to then estimate a location where the bearings intersect) or simply track down the radio-transmitter to get the animal's locations.
Later, motion sensors were incorporated in radio-transmitters to detect mortalities. If the radio-transmitter did not move for a period of time, e.g., 8 hours, the signal rate would double. Thus, biologists were able to record the location of the marked animal (i.e., habitat selection), and determine if the animal was alive or dead (i.e., survival). However, the issue of "telemetry bias," has always been a concern and adds significant caution when interpreting telemetry-based data.

Telemetry bias is the bias associated with a radio-marked individual's location relative to the rest of the unmarked population. In other words, just because a radio-marked animal did not use a certain area does not mean that the area is not used by and important to the rest of the population. Telemetry bias is always a concern when researchers use telemetry information gathered from just a portion of individuals (i.e., a sample) in an entire population.

An understandable, but common, error is for a biologist to look at a map of telemetry locations and delineate areas used by radio-marked birds as important habitat and unused areas as less important. This is an example of how telemetry bias could erroneously influence management decisions. Before making a management decision, managers must first try to understand what the majority (i.e., unmarked individuals) of the population is doing and this requires using models to interpret the data. Much of what we now know about wildlife species has come from the use of VHF radio-telemetry. However, since the 1990s, with the advent and increased availability of global positioning system (GPS) technology, biologists have developed GPS radio-transmitters that can be attached to individual animals and record multiple locations daily with much less labor cost per location than using VHF technology. This also allows for monitoring animals at night or when they are in inaccessible areas. In other words, the biologist does not need to be near the animal to record its location.

The weight of the radio and its impact on the animal has always been a concern to biologists, especially for those studying birds (Fair et al. 2010). However, as GPS technology advanced the instrumentation became smaller and lighter. By the mid-2000s GPS radios became light enough to be attached to large birds and by the late 2000s researchers started radio-marking medium-sized birds, such as the greater sage-grouse (*Centrocercus urophasianus*; sage-grouse).

GPS Technology, Telemetry Bias, and Sage-Grouse

In the past few years, the number of GPS radio-transmitters deployed on sage-grouse throughout their range, and specifically in Utah, has increased dramatically (Figure 3). Biologists using GPS radios are interested in gathering more locations over time from these marked individuals to improve management of the populations and habitat in their jurisdictions. However, although we are now collecting even more data from specific individuals using GPS radio-transmitters, the significant concern – "the effect of telemetry bias" – remains when using data collected from GPS radio-marked animals to manage wildlife.

Because all projects have limited resources, biologists mark a very small portion of the overall population when conducting wildlife radio-telemetry studies. In our experience, we generally radio-mark less than 2% or so of the population at any given time. This means that most (i.e., at least 98%) individuals in a population are not directly represented by the collected data. We cannot be sure of the location and habitat selection of the unmarked individuals. Thus, telemetry bias raises important questions about how well the entire population is represented by data when just a small portion of the population is radio-marked.

Figure 3. Greater sage-grouse female with a rump-mounted solar-powered GPS radio on her back. (Photo credit: Kade Lazenby)

As an example of the issue of telemetry bias, please consider our experience with radio-marked female sage-grouse on Parker Mountain, Utah (Figure 4). In this experiment, we were interested in learning how sage-grouse, specifically hens with broods, might respond to specific habitat treatments (e.g., Tebuthiuron, Dixie harrow, and Lawson Aerator). We captured and radio-marked female sage-grouse near our experimental plots and expected to evaluate which treatment type was best based on how radio-marked grouse used the habitat in the plots (Figure 4).

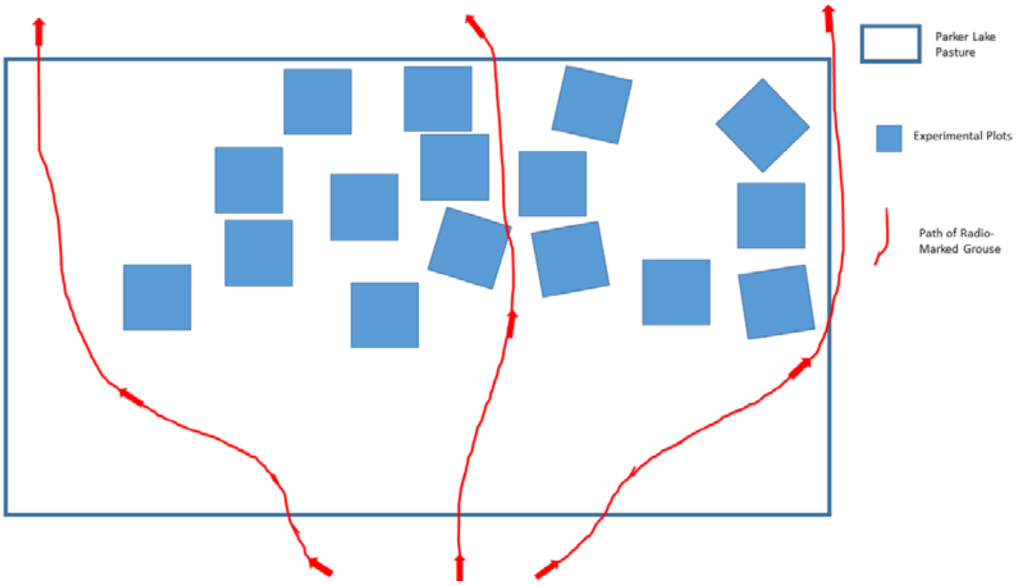

Figure 4. Diagram representing the movements of radio-marked sage-grouse during a research study on Parker Mountain, Utah (Dahlgren et al. 2006).

Experimental plots (100 ac) were designed and treatment types and control implemented in each plot. All radio-marked grouse either went around the experimental plots or skipped through them quickly (Figure 4). Based on the radio-marked birds, it seemed that grouse were avoiding the treatment areas altogether. However, by conducting pellet counts and bird dog flush counts we found many unmarked grouse using the treatment plots (Dahlgren et al. 2006). If we had only based our evaluation on the few radio-marked grouse we would have incorporated telemetry bias into our analysis and come to erroneous conclusions.
As you can see from the diagram in Figure 4, if we based our assessment of treatment type on radio-marked birds alone we would have concluded that sage-grouse avoided our sagebrush treatments altogether. However, this was not the case. In fact, a significant number of unmarked sage-grouse regularly used the experimental plots (see Dahlgren et al. 2006). The relatively low percentage of radio-marked individuals in any given research project creates a strong possibility for this same kind of telemetry bias simply due to random chance, potentially leading to erroneous conclusions.

Using Marked Individuals to Represent the Population

To fix the problem of telemetry bias, biologists have developed mathematical models to analyze telemetry data and make it representative of the overall population. For example, habitat selection models assume that radio-marked animals represent selection of habitat characteristics (e.g., vegetation type, canopy cover, and distance to features, etc.) made by the rest of the population and then apply those choices across a pre-defined landscape (e.g., parcel, management unit, or habitat patch). In essence, these models take the habitat characteristics known to be used by radio-marked individuals and then compares them to characteristics available at the broader landscape. The resulting differentiations (used vs. available) allow the model to predict, with probability values (i.e., values between 0 and 1), which habitat characteristics will be selected by the overall population. These models generally fall under the category of Resource Selection Functions or RSFs. The results of these models are often displayed in a heat map (Figure 5).

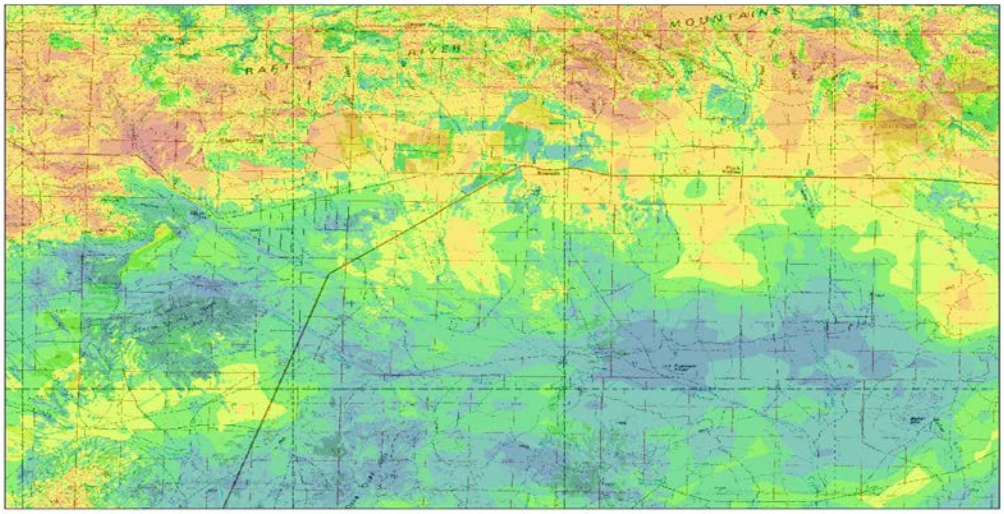

Figure 5. This is an example of a heat map representing habitat values (the warmer the color the higher probability of selection) for this landscape and produced by modeling data from radio-marked individuals.

Available Services

We understand that not everyone has the expertise and/or software available to model telemetry data and produce habitat selection maps, such as Figure 5. Therefore, we have initiated a process with state and federal agencies in Utah to provide this service to interested parties, especially local managers. If you desire to understand what the sage-grouse telemetry data in your management area represents, please contact your agency's lead for sage-grouse conservation. They will be able to provide the link and relevant information to Utah State University to meet your request. For more information about greater sage-grouse and their management visit www.utahcbcp.org.

Literature Cited

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