



15 June, 2014

Scott Talbott  
Director, Wyoming Game and Fish Department  
5400 Bishop Blvd  
Cheyenne, WY 83001

Dear Mr. Talbott:

On behalf of The Science Committee of the Wyoming State Chapter of The Wildlife Society (WYTWS), we appreciate being approached to develop a definition as it relates to ungulate migration routes, incorporating updated geospatial technology and migration research conducted and published in Wyoming.

Attached you will find a stepwise definition process related to migration routes and other essential definitions in order to clarify the use of these terms, including: delineated ungulate migration route, delineated ungulate migration corridor, population, sample population, documented ungulate migration routes, and recognized ungulate migration routes. These terms and definitions will allow Departmental personnel to identify and designate migration routes based on available data when dealing with agency partners. We are fortunate to have some of the leaders in the field of migration studies and delineation right here in Wyoming and as members of the Wyoming Chapter of The Wildlife Society; inclusion of their expertise assisted with developing relevant and concise definitions based on your request.

Again, we sincerely thank you for the opportunity to work directly with the Wyoming Game and Fish Department, and the WYTWS would be happy to provide to provide you any other expertise or assistance as this project moves forward.

Sincerely;

Martin Grenier  
WYTWS President

Dan J. Thompson  
WYTWS Science Committee Chair

The terminology associated with migration (including routes, paths, and corridors) is widely used across ecological disciplines, and definitions or meanings vary. Several ungulate migration terms are defined here to help broaden the current seasonal range definitions used by the Wyoming Game and Fish Department (WGFD). Such definitions are key to incorporating migration data into the management and planning process.

1. **Delineated** ungulate migration routes and corridors are those documented using GPS collar technology capable of pinpointing the location of study animals accurately and at least once per day.
  - **Delineated ungulate migration route** is the path used by an animal to make seasonal movements (e.g., spring and fall) between winter and summer ranges. Migration routes, especially near summer ranges, may vary somewhat by individual or across generations, depending on the sex and age of the animals or environmental conditions. But the core pattern, including the land traversed, is consistent, habitual, and involves fidelity to a particular area or areas (Figure 1).
  - **Delineated ungulate migration corridor** is a composite of **delineated ungulate migration routes** estimated from monitored animals (i.e., GPS collared) comprising at least 10% of a **sample population**. A migration corridor represents areas that are used by a disproportionate number of migrating animals in the population as they move back and forth along established routes year after year (Figure 2). Movement between winter and summer range, and the corridors over which it occurs, are vital for long-term survival and productivity of a **population** (herd) or population segment.
  - **Population** is a biological unit at the level of ecological integration where it is meaningful to speak of population demographics (i.e., birth rate, death rate sex ratio) and an age structure in describing the properties of the unit (Caughley 1977). For the purposes of this discussion, it is a group of animals of which a subset (**sample population**) is marked as part of a study or studies, in which detailed (at least daily) movement data are obtained irrespective of the original purpose of the study. Population as used here is a term which may include an entire herd, a wintering population segment, or a summering population segment, depending upon the number of winter ranges within a herd unit and the number of population segments using each.
  - **Sample population** is a group of marked animals whose detailed movements are recorded, creating data sufficient to delineate a migration corridor. The sample population denotes a subset of animals that is large enough to be biologically meaningful. A sample population could change as new studies are conducted and sample sizes are increased.

Example:

- **Population** = 2,000 animals using a winter range;
- **Sample population** = monitored (e.g., GPS collared) animals. For this example, use 100 monitored animals;
- **Migration corridor** = composite of **migration routes** of  $\geq 10$  ( $\geq 10\%$ ) of the monitored animals. Migration corridor calculation is outlined in detail by Sawyer et al (2009).

References:

Allen, L. and M. Kauffman. 2012. WLCI Researchers Employ New Approaches to Help Managers Conserve Deer Migrations. Wyoming Landscape Conservation Initiative. Fact Sheet 2.

Berger, J., S. Zack, K. Ellison, and E. Cheng. 2010. Migrants across air, land and water: Framing science to achieve conservation for National Park Lands. Wildlife Conservation Society Report, March 2010. Bozeman, MT. U.S.A.

Berger, J., S. L. Cain, and K. M. Berger. 2006. Connecting the dots: an invariant migration corridor links the Holocene to the present. *Biology Letters* 2:528-531.

Caughley, G. 1977. *Analysis of vertebrate populations*. Wiley and Sons Ltd. New York, New York, USA.

Sawyer, H., M. J. Kauffman, R. M. Nielson, and J. S. Horne. 2009. Identifying and prioritizing ungulate migration routes for landscape-level conservation. *Ecological Applications* 19:2016-2025.

Sawyer, H., M. J. Kauffman, A. D. Middleton, T. A. Morrison, R. M. Nielson, and T. B. Wyckoff. 2013. A framework for understanding semi-permeable barrier effects on migratory ungulates. *Journal of Applied Ecology* 50:68-78

2. **Documented ungulate migration routes** are those that have been documented with observations of neck banded animals, winter track counts, and/or VHF equipped animals. Although data are insufficient to delineate entire migration routes or corridors in this case, they are detailed enough to document that general routes between winter and summer range exist. This information should be supplemented wherever possible with other information (ref. Recognized Migration) from the appropriate spring and fall migration periods. Additional studies that document migration routes are needed to help delineate associated migration corridors. They are of high priority for more accurate delineation (i.e., with GPS collar technology), and this should be done prior to any actions that would jeopardize their integrity.
  
3. **Recognized ungulate migration routes** are those that WGFD has identified through other means that may serve as important migration routes but lack sufficient empirical evidence to delineate specific boundaries or confidently document the route. Examples include: historical records, WGFD Wildlife Observation System data, observations during severe weather events in the appropriate spring and fall time periods, and/or ancillary evidence supported through verification. In such cases, the Department believes that there are migrations in these general areas, but little is known about the specifics. The knowledge of WGFD personnel about migration in these areas should be used to bridge gaps in data for specific corridors. These paths should be prioritized for further study, and more detailed information should be sought prior to any large scale proposed project that could affect existing migrations in these locations.

Figure1. Migration routes with each individual animal route represented by a unique color

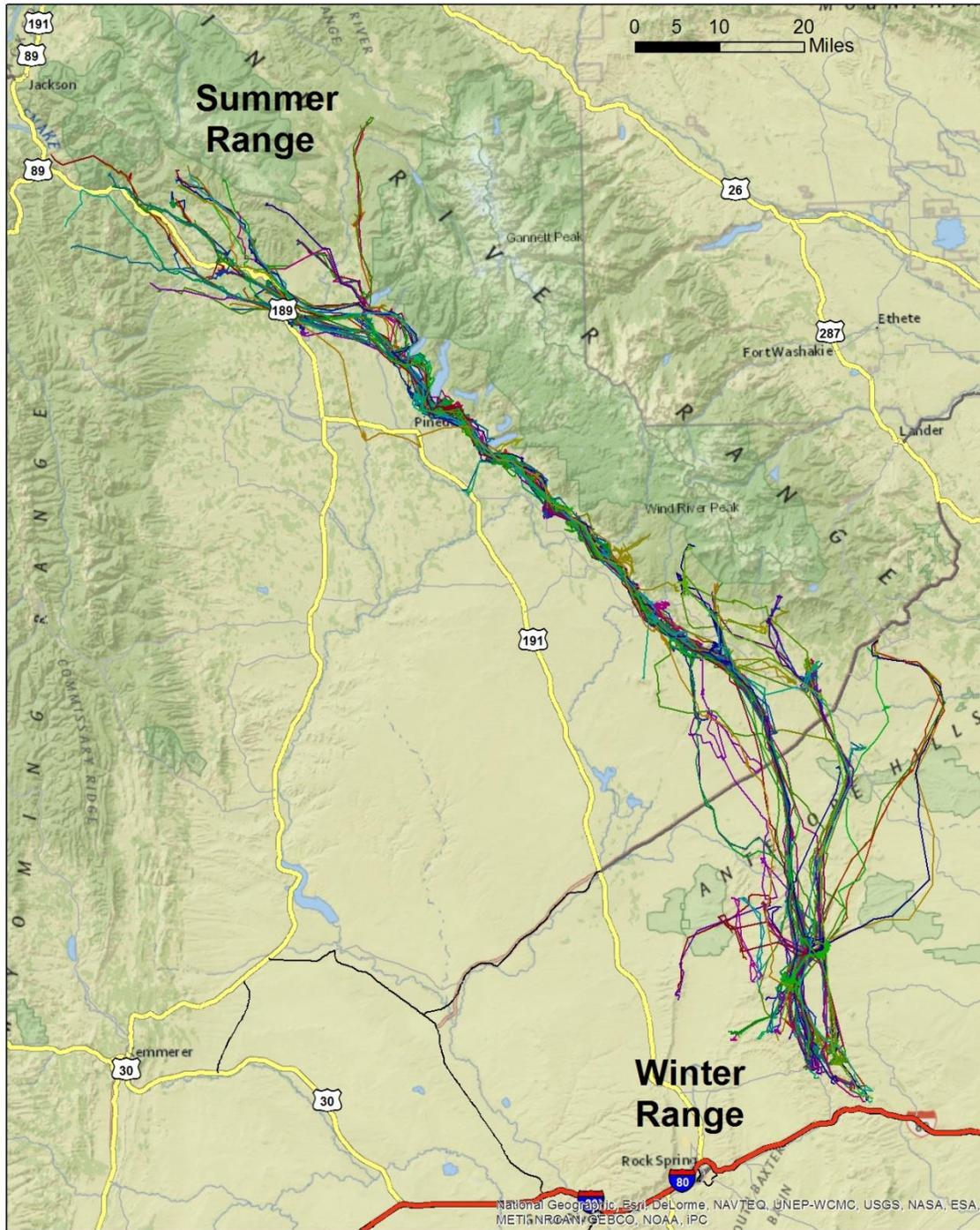


Figure 2. **Migration corridors** as determined by the aggregation of migration routes. In this illustration, only green and red areas qualify as corridors.

