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A Case for Standardized Ungulate Surveys and Data Management in the Western United States

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Fluctuations in mule deer (*Odocoileus hemionus*) populations during the past century (Workman and Low 1976) have increased interest in ungulate population trends and cross-jurisdictional management (Heffelfinger and Messmer 2003). Linked to this interest is a need for more research and monitoring at regional and other inter-jurisdictional scales (Unsworth et al. 1999, Wakeling 2005). Considerable obstacles to addressing this need for landscape-scale research and monitoring include interstate and intrastate variation in data collection and monitoring that complicates inference about trends and underlying causes of ungulate population fluctuations (Carpenter 1997). We recognize that mule deer and elk (*Cervus elaphus*) management is constrained by ecological variability as well as local political and economic realities. Nevertheless, we believe that enhanced regional collaboration is critical for better understanding and management of ungulate populations (Carpenter et al. 2003).

In 2004 the Science and Research Committee of the International Association of Fish and Wildlife Agencies (IAFWA) formally acknowledged the need for improved interagency collaboration in data acquisition and management applications. In response IAFWA called for the development of strategies to improve ungulate monitoring programs. In 2005 IAFWA joined with the Wildlife Management Institute (WMI), United States Geological Survey Cooperative Research Units Program, Nevada Department of Wildlife, and the Western Association of Fish and Wildlife Agencies (WAFWA) Mule Deer Working Group to organize an Ungulate Survey and Data Management Workshop. This workshop was held on 19 May 2005, at the Boomtown Hotel and Casino, Reno, Nevada, USA, immediately following the annual meeting of the Western States and Provinces Mule Deer and Elk Workshop. More than 100 people attended, representing western state wildlife agencies, federal land management agencies, tribal wildlife management agencies, and private consultants.

The purpose of this workshop was to develop recommendations for more cooperative ungulate-data survey design, data collection and analysis, and data sharing. The event featured a series of formal presentations and break-out sessions. Participants focused on the case for regional collaboration, habitat monitoring in relation to herd objectives, sampling methods, data analysis and sharing, and the practical application of adaptive harvest management to deer (*Odocoileus* spp.) and elk. We describe the outcomes of the workshop and summarize the recommendations presented to state agency wildlife chiefs in 2005 at the WAFWA summer meeting held in Alberta, Canada.

The Case for Regional Collaboration

Data collection and analysis varies considerably across management jurisdictions, ranging from strategies employing extensive formal sampling constructs, to efforts dominated by convenience sampling with informal designs. Some data collection is weakly linked to agency management information needs. We recognize that this variously reflects constraints on available resources, demands of user groups,

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and organizational inertia. These constraints notwithstanding, we believe that important management questions, including those related to harvest allocation and the response of ungulate populations to management treatments, require statistically valid survey and data analysis regimes. We suggest that implementing sound data-collection strategies, greater standardization of protocols, and the development of data-sharing and storing mechanisms should be priorities for western wildlife agencies. We believe that cooperative leveraging of increasingly scarce resources will lead to more efficient and timely management while simultaneously improving the cost-effectiveness to individual agencies. We emphasize that the development of a regional archive of scientifically defensible data will strengthen the credibility of agency decision-making, broaden public support for harvest regulations, and reduce the opportunity for competing interests to exploit differences among agencies in harvest regimes to legally challenge deer and elk management efforts (Cormick 1989, Murphy and Noon 1991).

Overview of Existing Population Survey and Analytical Methods

Others have published inclusive summaries of mule deer and elk monitoring efforts (Rabe et al. 2002, Carpenter et al. 2003). We highlight salient features here to illustrate our discussion.

Southwest Region (Southeastern California, Arizona, New Mexico, West Texas)

All these states use aerial and ground surveys to assess mule deer and elk population characteristics, but there are notable differences among agencies in the timing and frequency of surveys, the formal structure of survey methods, the use of various harvest strategies to achieve management goals, the temporal revision of harvest recommendations on the basis of survey results, and the inferential power of techniques implemented for data analysis. We also note that there are substantial differences in the scale and purpose of management actions, ranging from the public-lands focus of Arizona, California, and New Mexico, to a detailed local-management focus on private lands in west Texas.

Northwest Region (Washington, Oregon, Idaho)

Similar to other regions, we found considerable variation in monitoring programs and methodologies among northwestern states. Some management decisions are made at a finer scale than that of the data collected. In Oregon and Washington, for example, some surveys are informal, and different methods are used in different locations. Population modeling (e.g., POP-II [Fossil Creek Software, Fort Collins, Colorado] and SAK) is widely used (Bartholow 1982, Bender and Spencer 1999, respectively). Data that fail to meet key statistical assumptions sometimes limit the utility of these modeling applications.

We found that Idaho employs the most standardized deer and elk monitoring strategies among the northwestern states. Idaho principally uses sightability correction models to adjust raw counts of mule deer and elk for detection bias (Samuel et al. 1987), and random sampling and stratification to reduce sampling bias and improve efficiency of monitoring designs. Idaho also has attempted to use regional data to address the relative contributions of predation and habitat quality to mule deer survival in both research and monitoring applications (Hurley et al. 2005).

Intermountain Region (Colorado, Nevada, Utah, Wyoming)

Colorado is the only state in this region to routinely conduct intensive mule deer population monitoring of adult female and winter fawn survival and use stratified randomly sampled survey designs to estimate deer density. Colorado also has been the only state to intensively monitor elk calf survival during winter along with adult female and male survival. Colorado does not formally estimate elk density, but sample-based systems have been evaluated and tested. Population modeling is used by all the states in this region, recognizing limitations of using imprecise data in models. The program POP-II (Bartholow 1982) is commonly used for modeling but Colorado recently developed a spreadsheet model framework requiring fewer input parameters to reduce assumptions associated with using imprecise data.

States within this region use different types of survey strategies (ranging from helicopters to horseback), different timing and frequency of surveys, and varied methods for data analysis. Colorado has committed to greater inter-jurisdictional cooperation to achieve meaningful regional data sets with clear management implications (i.e., cooperative mule deer monitoring between the Colorado Division of Wildlife and the Southern Ute Division of Wildlife Resources Management in the HD Mountains of southwestern Colo.; Johnson 2005).

We noted that there was often no systematic overlap between elk and deer monitoring systems in these and, in general, other western states. While this lack of overlap sometimes reflects species differences in habitat use, used at optimal times to conduct surveys on each species, we suggest that improving multiple-species monitoring would help address multiple-use management challenges facing state and federal agencies (Yeo et al. 1993, Kie et al. 2004). Other needs we identified among the states in the intermountain region included additional ungulate survival information in pinyon–juniper (*Pinus* sp., *Juniperus* sp.) and low-elevation habitats, more rigorous sampling designs for use on classification flights, and better internal and external understanding by agency personnel of modeling, data collection, and analysis. These omnibus concerns applied broadly to northwestern and southwestern states as well.

Habitat Monitoring Relative to Herd Objectives

Habitat condition data provide unique insights to ungulate population objectives and management. Such data typically exist at the scale of an individual national forest or state wildlife area, but broad-scale (state or ecoregion) habitat-monitoring efforts are rare. An exception is the Utah Big Game Range Trend Study (UBGRTS). The UBGRTS is a long-term evaluation of critical winter-range habitat. It is

linked to the ungulate management objectives of the Utah Division of Wildlife Resources (e.g., Utah Division of Wildlife Resources 2003), and documents changes in the composition of vegetative communities over time in critical habitats. It supplies the Utah Division of Wildlife Resources with input for management decisions about relative changes in ungulate populations, where and when to implement rehabilitation to restore critical range, and data on the effectiveness of habitat improvement projects. This information is central to management efforts in Utah because habitat degradation frequently is cited as an important reason for Utah mule deer population declines (Workman and Low 1976).

We suggest that habitat trend data can provide an important source of feedback on ungulate herd management objectives. Such data also explicitly address one of the central assumptions of any game management program (i.e., management treatments are applied to adjust population size to habitat condition). We concede that the UBGRTS may be too expensive (4 full-time personnel, 7–8 seasonal personnel, US$300,000 annual budget) for many state agencies acting alone, and we recognize that habitat features other than winter range, per se, (e.g., water availability) may be critical (Wallmo 1981). These caveats notwithstanding, we encourage further systematic efforts (perhaps by coalitions of agencies) to link habitat monitoring with deer and elk management objectives and harvest regimes. In the Southwest, for example, this could include evaluations of herbaceous plants and browse, especially in areas where deer populations are subject to significant oscillations and where livestock may be competitors, such as is done by Arizona on the Kaibab Plateau.

Methodological and Statistical Considerations

Ideally, monitoring provides unbiased and precise estimates of relevant population parameters. We recognize that while this ideal is rarely achieved, various practical methods to estimate detection probabilities and obtain unbiased population estimates have been devised and implemented in software available to practitioners, such as mark–recapture (CAPTURE; Otis et al. 1978, White and Burnham 1999), mark–resight (NOREMARK; White 1996), sightability models (e.g., Samuel et al. 1987, Millspaugh and Marzluff 2001; AERIAL SURVEY, Unsworth et al. 1994, 1998), double observers (Walter and Hone 2003, Potvin et al. 2004), and distance sampling (White et al. 1989; DISTANCE, Buckland et al. 1993). We found that while positive change is occurring in some states, few western wildlife agencies implement these methods systematically and that data sometimes violate the statistical assumptions of the models utilized.

We recognize and emphasize that practical and economic factors constrain the ability of many (if not most) state agencies to make dramatic changes in their ongoing monitoring activities. In the past the economic burden might have been spread across state agencies through the application of regional Federal Aid Administrative funds. While the Federal Aid Improvement Act of 2000 eliminated this possibility (J. Organ, U.S. Fish and Wildlife Service, personal communication), an alternative step that might be taken would be for the IAFWA, WAFWA, and WMI to work with and encourage state agencies to obtain Federal Aid funding for improvements to ungulate data-gathering and analysis through the National Multistate Grant Program. These funds would allow states to partner in cooperative efforts. The WMI could serve as a trustee for these funds along with other funding that conservation organizations might contribute. The WAFWA Mule Deer Working Group or other state agency committees might administer and oversee cooperative projects.

Regardless of whether targeted funding can be identified, we suggest that state agencies would be prudent, when possible, to consider changes in monitoring practices that improve the utility of the data collected. To this end, we recommend that state agencies implement statistically powerful survey and monitoring methods that incorporate rigorous sampling regimes and that provide estimates of detection probabilities to correct population counts. Further, we suggest that state wildlife agencies develop training and continuing education opportunities to assure that field personnel are skilled in conducting surveys, evaluating results, and implementing appropriate management actions and that states encourage and facilitate the training of their employees at national and international workshops on these topics. We encourage collaborations within and among state wildlife agencies to leverage available funding and the logistical resources needed to accomplish these tasks. Of course, we acknowledge that even the most carefully designed studies and scientifically valid data may be questioned (Freddy et al. 2004). Nevertheless, we endorse the proposition that scientifically collected data and statistically valid inferences are essential for our credibility.

Adaptive Decision-Making

Much has been written on the subject and practice of adaptive harvest management (AHM; e.g., Bormann et al. 1999, Johnson 1999), particularly for waterfowl populations (Williams et al. 1996, IAFWA Adaptive Management Task Force 2004). We define ungulate AHM as a goal-oriented process, where the expected outcomes of management action are compared (through the use of statistically valid monitoring efforts) with the actual results. To be successful, however, these comparisons require clear objectives, effective monitoring, and must be done with purpose and rigor (Frazier 1985). Benefits that we expect from implementing of AHM include an explicit decision-making process based on an evolving and current database. Use of this systematic approach will reduce uncertainty, improve public and professional credibility, and permit the evaluation of regulation changes on ungulate populations.

We offer the schemata developed by the Montana Department of Fish, Wildlife, and Parks (2001) as an example of how an AHM framework might be implemented to guide ungulate harvest management. The framework is based on the premise that environmental variation affects

mule deer recruitment and mortality and has the explicit goals of managing for the long-term welfare of mule deer and providing for maximum recreational opportunities linked to the dynamic nature of deer populations. Most notable, the Montana AHM strategy is responsive to mule deer population parameters rather than deer harvest levels. The 4 elements of the framework are 1) clearly stated objectives, 2) a set of regulation packages (restrictive, standard, liberal harvest), 3) a monitoring program, and 4) computer models that project population status from monitoring data. In Montana 13 representative populations are intensively surveyed to obtain relatively precise estimates of population size and composition. These estimates are obtained with one full-coverage postseason flight and one full-coverage spring flight with 2 replicates. Mark–resight estimates of population size are measured with radio-telemetry samples on a subset of the 13 census areas on a staggered schedule. There also are 67 populations monitored at lower intensity (one postseason classification flight and one full-coverage spring count and classification flight) for which data are collected to align management to local variations in deer dynamics, hunting opportunities, and private land ownership (D. F. Pac, Montana Department of Fish, Wildlife, and Parks, personal communication).

Recommendations

We believe there are substantial needs and opportunities to improve interagency and intra-agency coordination and collaboration in data-collection and analysis and to implement better communication and data-sharing strategies. We also believe that there is a need to improve the rigor of data-collection and analysis strategies used in the monitoring and management of western deer and elk populations (Carpenter 1997, deVos et al. 2003). We stress that states should strive to use common standards for obtaining population data; by standardization we do not imply that all states use the same survey system but, rather, that all states should at least employ fundamental statistical aspects of random sampling and bias corrections when developing new or applying previously published survey techniques. We suggest that more states should strive to obtain valid survival-rate estimates for adult and juvenile ungulates. This basic degree of standardization would enable collaborative data analyses and sharing that would provide a common and more legitimate basis for evaluating the effects of various replicated management prescriptions among states and across jurisdictions. We believe that it would be valuable to develop and implement adaptive management strategies based on structured sampling designs and methods and to seek ways to formally improve interstate, intrastate, and inter-jurisdictional communication. We suggest developing peer-reviewed, standardized data-collection methods and a searchable relational database. Involvement of the hunting and other conservation user groups in the development of these standards could increase their probability of acceptance (Bacow 1990, Riley et al. 2002, 2003). Because habitat monitoring rarely is featured in monitoring efforts, we encourage agencies to consider collecting data that link regional habitat condition with herd management objectives.

More immediately, we support the establishment of a steering committee of wildlife professionals, under WAFWA auspices, to develop practical standards and guidelines for protocol development, data collection and storage, and data-sharing. Already, the WAFWA Wildlife Chiefs have endorsed this recommendation. We believe that the development of AHM strategies should be explicitly linked to the North American Mule Deer Conservation Plan (deVos et al. 2003) and to the implementation plans identified in State Comprehensive Wildlife Conservation Strategies (Teaming With Wildlife 2005). In particular, we support adoption of habitat management guidelines structured around mule deer distributional maps indicating where and suggesting when management problems might most effectively be addressed. We concur with the conclusion of the WAFWA Mule Deer Working Group that until large-scale habitat programs can be implemented mule deer populations will continue to decline (Wakeling 2005). Echoing others (Wakeling 2005), we support efforts to prioritize areas to initiate habitat-restoration treatments that will have the highest return on investment.

We encourage the steering committee to focus on the development of a handbook of recommended field-sampling and statistical-analysis methods for elk and deer population and habitat monitoring. This kind of effort is already underway in other contexts for other species (Elzinga et al. 2001) with positive results. We suggest that the steering committee review existing state monitoring and management strategies, with the aim of identifying opportunities to increase consistency and data-sharing, and exploring inconsistencies among management plans that impede greater regional and inter-jurisdictional cooperation.

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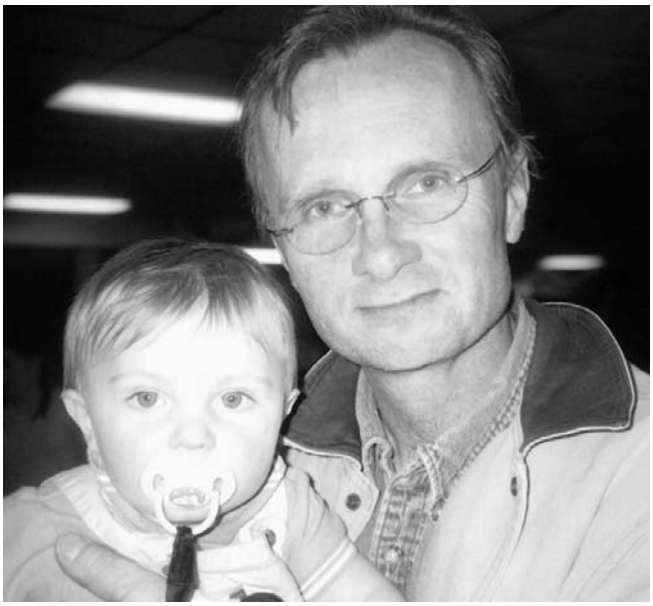

The authors represent a broad cross-section of managers interested in mule deer. They are western fish and wildlife agency big game specialists and wildlife division chiefs (Ariz., Colo., Mont., Nev., Ut., and Wash.), as well as scientists and specialists employed by conservation organizations (Wildlife Management Institute), the United States Geological Survey Cooperative Research Units, and academia (Colorado State University). At the time this manuscript was prepared, the senior author, ***Russ Mason*** (photo, with friend), was the Science and Research Liaison to the International Association of Fish and Wildlife Agencies. He is now the Chief of the Game Bureau for the Nevada Department of Wildlife, **"**the best little wildlife agency in the west.**"**