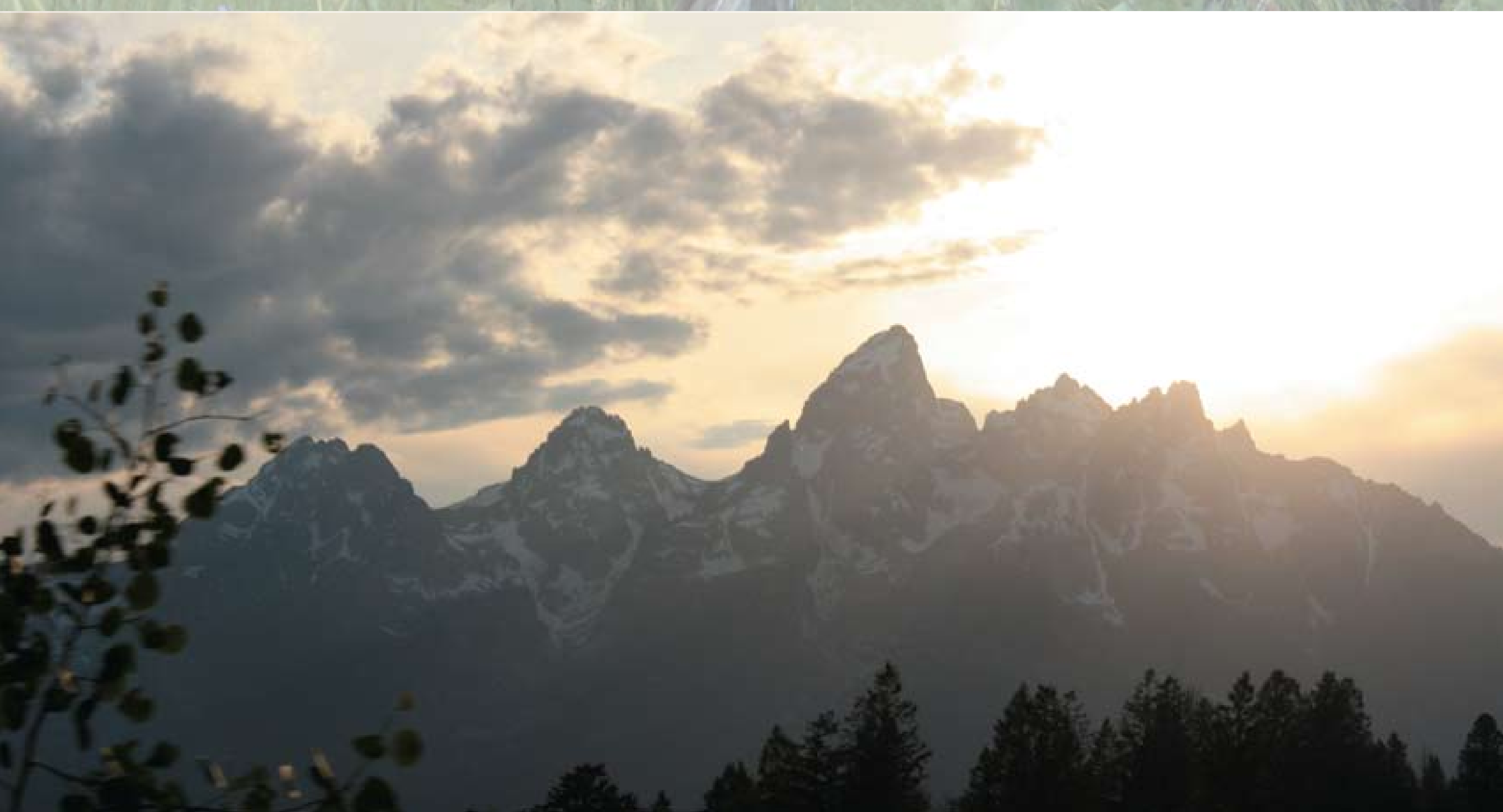
MULE DEER & DEVELOPMENT
MAKING SCIENCE RELEVANT TO PLANNING



INTEGRATING SCIENCE INTO POLICY:
A CASE STUDY OF MULE DEER IN JACKSON HOLE

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Thanks also to Tom Campbell and Biota Research and Consulting for providing access to historical data on mule deer research in Teton County.

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INTRODUCTION

Science and policy have traditionally had a tenuous relationship, circling around each other without ever aligning to the degree people hope. The problem takes many forms in different contexts, from planning boards grappling with development, to the federal government dealing with issues such as climate change.

In a place like Jackson, where natural resources, particularly wildlife, are highly valued, the perplexing interface between environmental science or ecology and policy plays out very directly in the planning process. Planners want to use good, sound scientific information to create conservation-oriented plans, but often cannot find clear information that is needed to make decisions that will hold up legally. On the other side, scientists are hesitant to make clear-cut, blanket statements because scientific research is inherently grounded in hypotheses and uncertainty. A scientist hesitates to make definitive statements as all situations cannot be perfectly modeled. Typically, a scientific report on a particular piece of land may include a description of the features of the property, a map, and perhaps some general recommendations on how to proceed, such as avoiding disturbance of winter habitat. However, participants in Sustaining Jackson Hole's Environment Working Group pointed out that though data and mapping are crucial pieces of decision-making, other factors, such as the value of a particular piece of property to overall regional ecosystem function need to also be assessed.

At a meeting of the Environment Group of Sustaining Jackson Hole on April 30, 2008, a member of the Teton County Planning and Development Department articulated the need for accurate scientific information to inform planning and development decisions in Jackson. The planners need concrete, enforceable regulations backed by good data. Scientists and planners both identified "lack of data" as one of the biggest obstacles to creating an environmentally sound development process.

This conundrum begged the question of how scientists and planners communicate, and where the inherent problems arise in communicating scientific findings to planners in a way that is understandable and useful.

Our intent in preparing this report is to illuminate the process of communicating ecological information to planners, assess where problems may occur, and provide recommendations as to how to improve the process. We tackled mule deer as a case study as it is a "Species of Special Concern" in the Teton County Comprehensive Plan. The first section lays out our current knowledge of mule deer science, including habitat use, roadkill, etc. in the county. The second section of the report details the overall issue with incorporating scientific information into policy, with a review of the current knowledge on the topic. Here, we narrow the case to Teton County, with an analysis of the results of a brief survey distributed to scientists & planners in the area. Finally, we will provide recommendations as to how to better incorporate science into the planning process using the mule deer case as well as the results of the directed survey.

There is clearly much more involved in land use planning than simply incorporating scientific information. Values, and how they are expressed and shared, are arguably the most definitive driver of how decisions are made. However, most people believe that scientific information will guide how to balance value demands, and our attempt to 1) provide latent (or under-represented) data to planners, and 2) be specific about how to improve the integrative process, will help move "science-based planning" from an abstract need to something that can be more adequately applied, as a means to move value debates forward. From our conversations and discussions, the topic we have tried to address is of key concern to our community. Preserving our wildlife heritage is of utmost importance, according to the results of community surveys regarding the Comprehensive Plan revision. Finding a better, more peaceful and less arduous means of merging science into policy has positive outcomes for not only wildlife and habitat, but community spirit and character.

Mule deer are an ideal species with which to tackle some of these issues, as they are highly visible in our community and populations are declining throughout the West, though not enough information is available to make the determination as to their population status in Teton County. Mule deer have been studied in Teton County, however, as outlined in the section on current research. Biota Research and Consulting conducted winter observational studies on mule deer from 1980-1991, which have been replicated recently by the Conservation Research Center of the Teton Science Schools. With some background knowledge of mule deer usage in Teton County, and community concern for wildlife - particularly mule deer as an often visible victim of vehicle collisions - they provide one of the best opportunities to enter into a more rigorous exploration of how to better integrate scientific information into the planning process.

We hope that this report will not only provide mule deer data and case specific insight, but will help mold the process in the future as to how ecological information might better aid the planning process, and provide some guidance to other communitites struggling with similar issues.

I. MULE DEER ECOLOGY

MULE DEER ECOLOGY IN THE ROCKY MOUNTAINS

Mule deer are a visible and charismatic part of Teton County's fauna. They are often seen on the buttes surrounding the town of Jackson, as well as moving through parts of town en route to summer or winter range. Our resident local herd is part of a wide-ranging population that persists throughout western North America.

Range

Mule deer (*Odocoileus hemionus)* occupy a startling diversity of habitat types through western North America. From the coastal islands of Alaska to Baja Mexico, and then inland from Zacatecas, Mexico up through the Great Plains to the Southern Yukon Territory, mule deer persist in an array of climates and habitats. Throughout their territory, however, different factors affect their populations - from prolonged winter in the north to sustained drought in the south, to human and biological concerns.

A general decline in mule deer populations began in the mid-1990s. Contributing factors to this decline include threats ranging from human-caused pressures from development and habitat degradation, to climate-induced factors such as drought and severe winter weather, to biological issues of disease and predation.

The Western Association of Fish and Wildlife Agencies (WAFWA) began the Mule Deer Working Group (MDWG) in 2004 to address three specific tasks:

- Develop solutions to common mule deer management plans;
- Identify and prioritize cooperative research and management activities in the western states and provinces; and
- Increase communications between agencies and the public that are interested in mule deer, and between those agencies, universities, and non-governmental organizations that are interested in mule deer management.[1]

Habitat

The working group found that the most compelling means of maintaining mule deer populations was to improve or maintain quality of habitat, through ecoregional planning. This approach is relevant to planners in Teton County as the group proposed to work with local governments, as well as agencies and other land management authorities, to ensure the survival of mule deer populations in the West. They also proposed developing standardized means of collecting data on mule deer populations. This approach would be integral to Teton County in putting together a research plan which would not only be beneficial to planning and conservation efforts here, but also to the wider, regional goal of coalescing information on mule deer populations.

The working group notes that "production and fawn survival are influenced by habitat conditions. When proximate causes of fawn productivity and survival are studied, the key factor typically is quality of forage available at critical times during the life cycle of the female mule deer."[2] Direct human impacts to mule deer include oil and gas development and mineral exploration, urban growth, and highway, railroad, and fenceline development, which affect migration patterns. Indirect impacts include recreation and

1 Mule Deer Working Group. 2004. North American Mule Deer Conservation Plan. Western Association of Fish and Wildlife Agencies. p. 2
2 Ibid, p. 4

camping, as well as fire suppression, exotic weed invasion, and grazing practices which alter forage quality.

Nutrition

Nutrition is also a key factor in mule deer viability. The nutritional status, or health, of an animal influences its chance of succumbing to predation, competing for resources with other mule deer and ungulates such as elk. Of key importance to Teton County are its chances of surviving a harsh winter. Changes in diet at stressful times may actually impede the ability of an animal to survive, as the microflora in its digestive tract may not quickly adapt to the change in diet. Of specific importance to planners and land managers is that supplemental feeding in the winter, then, may actually contribute to malnutrition among animals, and should be strongly discouraged.[3] The Teton County Land Development Regulations currently forbid feeding of ungulates during the winter, but these regulations should be strongly enforced.

Other Factors

Wyoming allows a mule deer hunting season which is carefully managed by the Wyoming Game & Fish department. Hunting quotas are determined through population counts.

Questions often arise as to the impact of predation on mule deer herds. The Mule Deer Working Group asserted that "this hypothesis has not been tested for mule deer."[4] Should it become an issue that predators, specifically mountain lions, may be having a significant impact on our already somewhat stressed mule deer populations, Wyoming Game and Fish would determine the best strategy to mitigate the predation impact.

Diseases and parasites that affect mule deer populations are also an issue of concern to maintaining populations. However, the Mule Deer Working Group assessed that emerging diseases were most likely the biggest threat to healthy populations.[5] These diseases include bluetongue virus, epizootic hemorrhagic disease, and the headline-gatherer chronic wasting disease, which has been detected in southeast Wyoming in mule deer herds. It has also most recently been detected in Alpine in a moose.[6] Again, Wyoming Game and Fish has the jurisdiction for dealing with these cases. Planners should be sure to keep aware of new threats to mule deer populations due to emerging diseases and take this into account when making planning decisions.

Elk and deer interactions are also of interest to Teton County, as elk spend their winters on the National Elk Refuge, in very close proximity to the Town of Jackson. Competition for grazing has been documented between these two species, and could grow more intense due to decreasing availability and quality of forage. Diseases may also travel between the two species. More research is needed on the complexities of mule deer competition with elk.[7]

In summary, ecological points to consider for mule deer in Teton County are winter habitat use, density of development, distribution, nodes, landscape permeability for people and wildlife, and road-based mortality. Balancing the needs of mule deer with development will take a thorough understanding of their nutrition, movement, and habitat requirements. Some of these topics have already been documented, as detailed in the next section, though there are information gaps.

3 Ibid, p. 8
4 Ibid, p. 12
5 Ibid, p. 13
6 Hatch, Cory. "Wasting disease found in Bedford." Jackson Hole News & Guide, October 18, 2008.
7 Mule Deer Working Group. 2004. North American Mule Deer Conservation Plan. Western Association of Fish and Wildlife Agencies. p. 15.

Biota Research & Consulting Study, 1979-1990

Questions regarding mule deer ecology have been under scrutiny for nearly thirty years. A study initiated by Biota Research and Consulting on mule deer began in the winter of 1979-1981 and lasted until the winter of 1989-1990, for a total of eleven years of field research. The study area for this project was the Gros Ventre Buttes, which are considered critical mule deer winter range but also essential spring, summer, and fall range. In the first progress report for this project, dated August of 1981, the authors asserted that "the high visibility of the wintering deer herd, its aesthetic, ethical, educational, biological, and social values, and its great vulnerability require that this deer herd receives a high priority for research, monitoring, and management."[1]

The purposes of this study were numerous, but overlap with many of the data that planners and scientists are requesting today on mule deer populations. They included an assessment of population demographics, geographic range, and migration routes, as well as an evaluation of the impacts of human use and development on the population.

The project observed and counted mule deer groups from several vantage points in the valley in order to obtain population numbers, information on habitat use, and activities (bedded, feeding, moving). Wyoming Game and Fish also contributed data on mortality. Beginning in the winter of 1981-1982, deer were marked with radio collars and neckbands to further augment their observation data.

The study found high usage of the Gros Ventre Buttes area, with constraints levied by deep snow years, food availability, and human and dog presence. Researchers identified three general wintering areas - two on East Gros Ventre Butte and one on West Gros Ventre Butte. Observations of deer use resulted in the identification of key wintering areas within these larger ranges over the duration of the study, or areas where deer consistently concentrate over a large part of the winter. Usage was highest at the middle elevations (6400 - 6800 feet) and somewhat less at the highest elevations (6800 feet +). Deer used the lowest elevations (<6400 feet) the least. This pattern was altered in the winter of 1988-89, when the authors thought that low elevation usage jumped considerably, possibly due to the preponderance of feedgrounds at these elevations.

In each year, the project estimated total herd size and broke out demographics including age and sex. Regarding population size, preliminary counts in the winter of 1977-78 estimated 365 animals. By the winter of 1981-1982, the estimated population size had dropped to 147. This drop was sizable at a 62% decline. This drop in population could be attributable to hunting pressure and changes in the Area 150 hunting season to include the period at which deer moved into their winter range. Regulations were changed again for the 1982 hunting season to only allow bow hunting in this area. Population numbers subsequently varied between 150 and 250 animals, until the winter of 1987-88 when the population soared back up to nearly catch the all-time high at 335, possibly due to a sequential mild winters, little hunting, and good fawn production. The following winter also had a high population count of 360 animals, with similar numbers in the final field season of 1989-1990 at 346 individuals.

The deer that winter on the Gros Ventre Buttes appear to spend their summers in Grand Teton National Park and areas of the Bridger-Teton National Forest. Length of winter and snow depth determine when the deer begin their migration. In the study years, deer began moving off of the Buttes in mid-April and wintering deer had moved to the summer range by early May. Movement to the buttes in the fall occurred in late November or early December, depending on the first

1 Clark & Campbell, 1981. Progress Report II on Winter Ecology and Migratory Movements of the Gros Ventre Buttes Mule Deer Herd, Jackson Hole, Wyoming. Biota Research & Consulting. P. 1.

significant snowfall event. Deer also moved between East Gros Ventre Butte and Snow King Mountain, just east of the Virginian and via South Hill. It was noted at this point that housing developments, both in progress and under consideration, would likely cut off these migration routes. The closure by development of migration routes may force deer to utilize other winter ranges with resident deer populations, potentially causing starvation due to competition for limited resources. Other areas from which deer were observed moving towards the Buttes included east from the Teton Mountains north of Wilson, south from Grand Teton National Park via the Snake River, and westward from Ditch Creek to the Buttes via Blacktail Butte.

Even at the beginning of this study, there was much community concern for the well-being of the mule deer herd. Identified threats to the herd at that point included dog predation, supplemental feeding, housing developments in winter range, and human disturbance via skiers and snowmobiles. Supplemental feeding brought deer closer to roadways and thus contributed to roadkill mortality, as well as dog predation. Supplemental feeding also damaged plant communities due to the congregation of large numbers of animals, and increased the chances of disease transmission. Furthermore, an intensive artificial feeding program was problematic for the researchers in trying to determine habitat use in the study. In fact, in the later years of the study, deer had virtually abandoned key wintering areas in favor of feedgrounds.

At the beginning of the study, only 5% or less of the Buttes were developed, and deer seemed to be accommodating this amount of human presence. There was no certainty as to what threshold of development may be the tipping point for deer using this area for winter range. It was recommended even then that developers incorporate covenants into their housing developments to minimize human impact (and pet impact) on wintering deer populations. As quoted in Progress Report II, Dr. Richard Mackie of Montana State University observed in 1980 that

We can't fully evaluate the loss of a unit of mule deer winter range solely in terms of the impact upon the herd or even the loss of a few hundred or mule deer that are directly affected. Loss of habitat in a local area or the disturbances caused by subdivisions and associated human activities in the area will likely be spread throughout the entire population, including deer using adjacent, undisturbed winter ranges.

Roadkilled deer were noticeable even at this time on valley roads, an issue still at the forefront of the community today. Data from the Wyoming Game and Fish Department indicated that 89% of 208 dead deer (186 animals) examined between 1976 and 1981 were due to vehicles. Deer - vehicle collisions occurred in four areas: heading north out of town on Highway 26/89/187 (40 deer), around the Virginian Motel on West Broadway (22 deer), from junction of Highway 22 and Highway 26/89/187 to Spring Gulch Road (12 deer), and from the junction to south of town about four miles (133 deer). These are areas often pinpointed for some sort of roadkill mitigation project today, particularly West Broadway. Roadkill varied in the subsequent years, with 4 found in 1982-83 and 23 in 1983-84. Roadkill numbers were not mentioned again until 1988-89, when Wyoming Game and Fish attributed 20 of 36 winter deaths to road kill. Again, this increase may be tied to the increase in feedgrounds at low elevations, bringing animals closer to roads. In the final report of 1989-1990, the authors concluded that "roadkills appear to be the main source of mortality for the Gros Ventre Buttes winter population."[2]

The research conducted by Biota from 1979-1990 provides a fantastic base from which to conduct a cumulative impacts study of mule deer in Jackson Hole. Key historical data on population size and habitat use provides a basis to assess current population status and threats. Many of the same threats identified in this earlier study - development, roadkill, and winter stress - still impact the deer herd today.

2 Campbell, T. 1991. Winter Ecology and Migratory Movements of the Gros Ventre Buttes Mule Deer Herd, Jackson Hole, Wyoming. Winter 1989-1990. Biota Research & Consulting. p. 31

Teton Science School Conservation Research Center

Current Research

Winter range availability is crucial to the survival of mule deer and elk (*Cervus elaphus*) in the Rocky Mountains. East and West Gros Ventre Buttes, High School Hill, Vogel's Hill and Boyles Hill are important winter range for mule deer in southern Jackson Hole. Located near the town of Jackson, Wyoming, this winter range is unique in that it is surrounded by and interspersed with roads and development. Because developable land is limited in Jackson Hole, and because mule deer winter range in the southern portion of the valley is mostly in private ownership, the future of undeveloped winter range remains uncertain. Specific knowledge of where mule deer winter on these buttes and hills will help inform management of important winter range areas.

The Conservation Research Center of Teton Science Schools has completed seven (2003 – 2009) seasons of data collection examining mule deer winter range use in southern Jackson Hole. Our study is a continuation of a mule deer winter ecology study done in 1981-1990 by Biota Research and Consulting, Inc. We mapped mule deer locations on the two Gros Ventre Buttes, Boyle's Hill, Vogel's Hill, High School Hill, and the hills east of the Hereford Ranch and Rafter J subdivision (directly east of highway 89). This study provides course-level monitoring data examining patterns in winter range use relative to residential development and weather conditions.

If we do not carefully maintain the quality of and access to these crucial habitats for deer and elk in Jackson Hole, then these animals will be in jeopardy. Our study identifies some of these important habitats. While our work documents trends in observed numbers of deer, it is not an assessment of population change. This project is purely observational (not experimental; *see future study recommendations*) and, as such, carries associated limitations. Our data should be used to identify areas in southern Jackson Hole that are consistently used by mule deer during the winter and, therefore, that may be important to long-term population viability.

Methods Overview

We observed mule deer from 27 fixed-observation stations located on or near major roads with good vantage points to observe mule deer activity during seven winter seasons (2003 – 2009). Data were collected twice per week, weather permitting, from December to mid-March. We scanned the visible hillsides for mule deer presence using binoculars and spotting scopes. Deer locations were mapped on USGS 1:24,000 topographic maps and then digitized into GIS software. We recorded deer locations as polygons to indicate groups of deer and account for imprecision in mapping deer locations. We recorded the date, time, observation station, weather conditions, hours since last snowfall and number of deer in a group. We examined trends in two primary response variables; maximum number of deer observed in a single day and average number of deer observed per day. The latter variable is standardized to account for variability in survey effort between years.

Summary Results

While the number of mule deer observed varied by year, the average number of deer observed per survey day was relatively consistent throughout the study (mean = 131 animals/day; range 93-165). Despite this lack of overall change in number of observed animals, the number of mule deer detected in some areas has declined. These areas include West Gros Ventre Butte and the west face of East Gros Ventre Butte and Vogel's Hill. The number of mule deer observed concomitantly increased on the east face of East Gros Ventre Butte. No change was detected on other priority areas including High School Hill, Boyle's Hill and the hills east of the Hereford Ranch and Rafter J subdivision. While statistically insignificant, these trends signal a need for more information on potential movement corridors, landscape connectivity, behavioral responses to human development and relationships between mule deer movement and traffic patterns. While our study provides course-level monitoring data, it does not generate population estimates or establish direct links to causal factors.

Future Study Recommendations

Proposed

- GPS-collar study of mule deer movements in southern Jackson Hole: Based on trends described above, we propose a 3-year, experimentally-designed study of mule deer movement patterns in the Jackson area. The study should include at least 30 sample animals marked with store-on-board GPS collars. GPS collars log animal locations at user-defined intervals and can be used to generate a detailed understanding of ungulate movements, responses to traffic volume, short distance migration corridors and habitat use patterns in Teton County. Results of our proposed project would facilitate proper sighting of habitat enhancement projects, aid in conservation planning and ensure best-placement of wildlife warning systems on roadways. This work would help ensure that conservation planning efforts and development regulations in Teton County, and other growing Wyoming communities, are informed by science and are placed in areas that have the greatest likelihood of conserving the resource.
- County –wide vegetation map: The health of local mule deer populations is determined largely by habitat quality and availability. As noted in the current draft Comprehensive Plan revision,[1] a comprehensive map of habitat composition in Teton County is crucial to understanding how remaining resources should be managed. The map should combine already-existing data from private lands, public lands, remotely-sensed imagery and ground-truthing efforts.

Other efforts

- Critical threshold modeling: With data from GPS collars, we would like to develop empirically-supported models that examine mule deer responses to varying development densities. This work would help planners, scientists and the public understand the ecological consequences of different development scenarios.

1 Teton County Draft Comprehensive Plan, 2009.

ROADKILL

**All figures and data in this section are courtesy of the Jackson Hole Wildlife Foundation.*

The Jackson Hole Wildlife Foundation launched a multi-faceted roadkill reduction campaign in 1994. The goals of this program are twofold: to reduce wildlife-vehicle collisions and promote safe wildlife movement.

Data available from the Wildlife Foundation indicates that an average of 200 elk, deer, and moose are killed on roadways in Teton County annually. The Jackson Hole Roadway and Crossing Study prepared for the Wildlife Foundation in 2003 by Biota Research and Consulting projects that this figure could rise to 500 animals killed on average annually by 2020. Collisions are currently estimated to cost over $1.2 million annually.

Figure 1 shows wildlife-vehicle collision hotspots, or corridors with higher incidents of accidents or road-killed animals. Though this graph is not specific to mule deer, it gives an idea of where animals are crossing county roads and facing high mortality rates. One item to note regarding this map

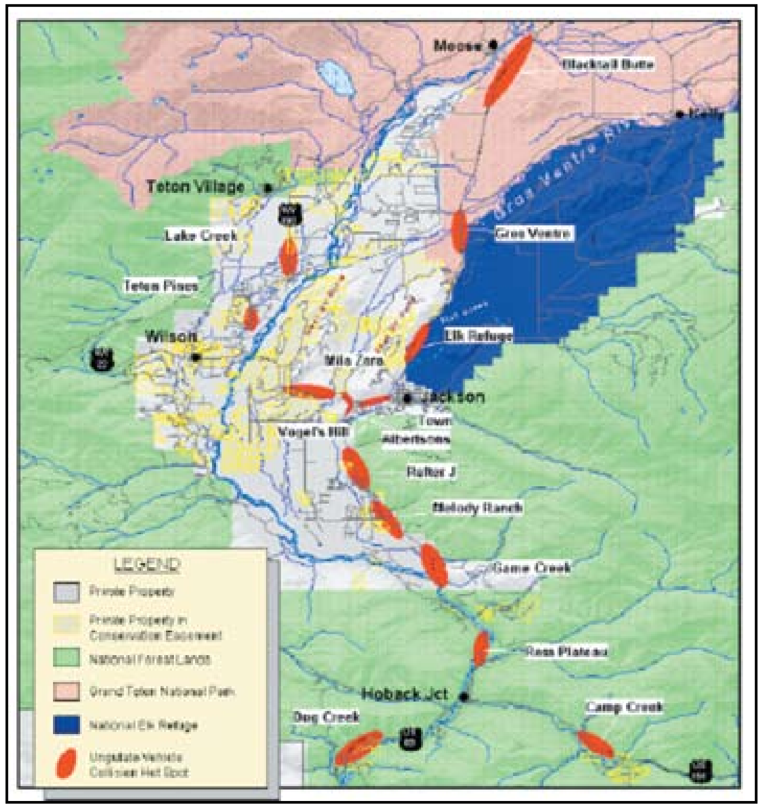


Figure 1: Map of vehicle-wildlfie collisions hotspots (in red).

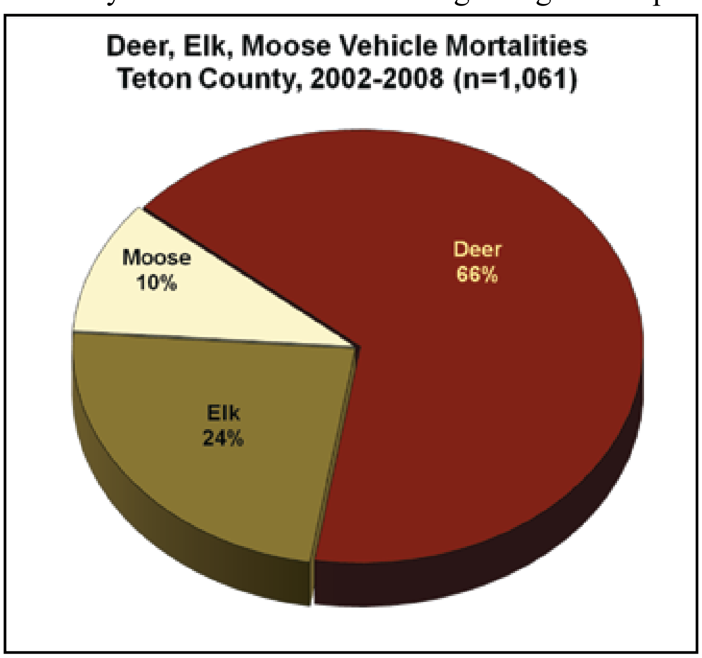


Figure 2: Breakdown of roadkilled ungulates into species

is that the size of the red area does not correlate to the number of animals killed. In fact, the smallest area (on W. Broadway) has the highest number of mule deer killed of any other area. Mule deer are the most commonly killed ungulate species on county roads. Figure 2 indicates that 66% of wildlife-vehicle collisions in Teton County result in mule deer mortality. ; With 1,061 road-killed animals between 2002 and 2008, 703 were mule deer.

Trends in the incidence of collisions are presented in Figure 3, which graphs the maximum and minimum averages of wildlife mortality. Half of all mule deer mortalities occurred in the four months of June/July and January/February, as noted in Figure 4, which are the months when the deer are generally on the move in the valley. When looking at the demographics of the mule deer killed, Figure 5 indicates that 50% of the mortalities were adult deer, and 61% were female. Female deer constitute 82% of the herd population in

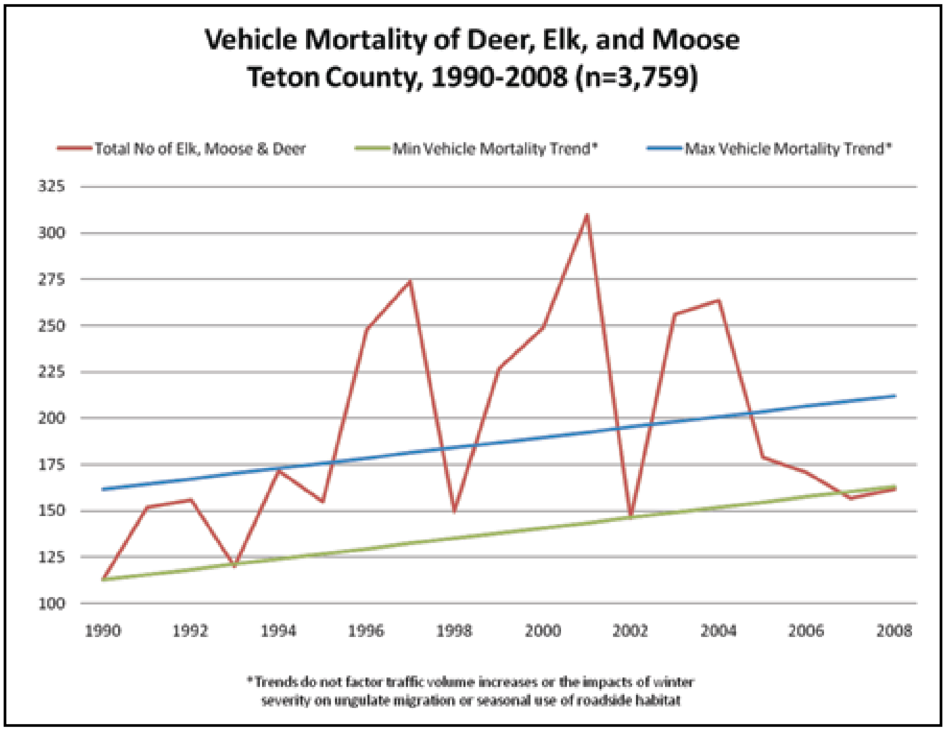


Figure 3: Vehicle Mortality of Deer, Elk, & Moose in Teton County, 1990 - 2008.

Sublette County and males constitute 18%. Assuming a similar demographic distribution for the herd in Teton County, these numbers would suggest that male deer are disproportionately being killed (22% of deaths) while female deer are significantly less likely than the males to be killed (61% killed versus 82% of population) compared to their population base. It is hard to evaluate these statistics, especially since there is such a large number of "unknowns." If we assume the same distribution of sex among the unknown dead deer as among the known dead deer, then it is likely 73.49% of all dead deer are female and 26.5% of all dead deer are males. This still leaves a higher death rate for male deer than for female deer based on their prevalence in the population. Whether this difference is significant is unclear because we do not know how accurate the sample is, as we do not know how many deer were killed that are not included in the data.

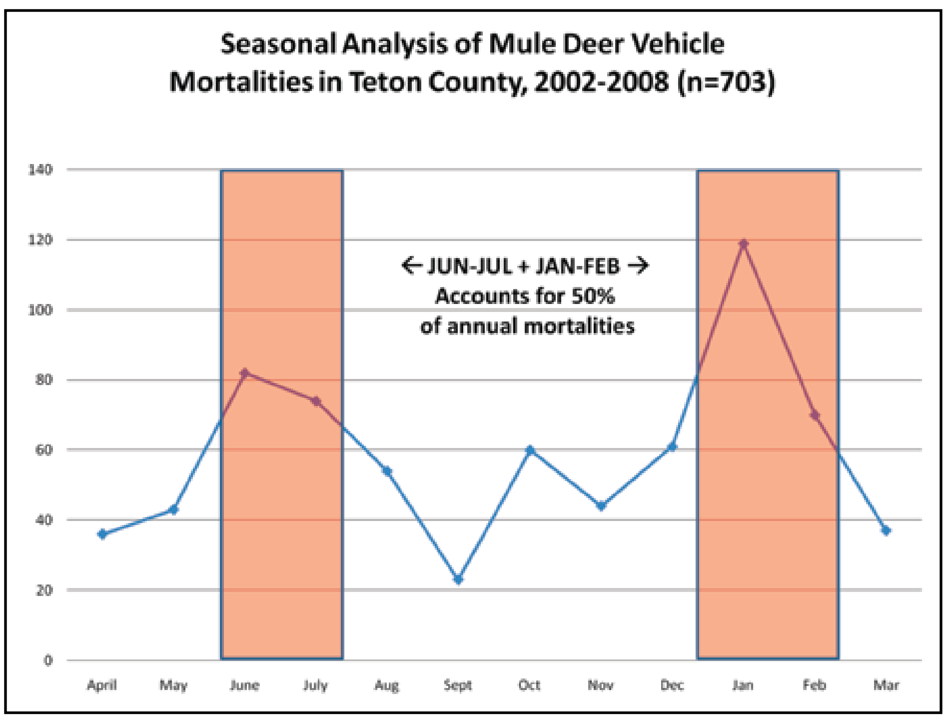
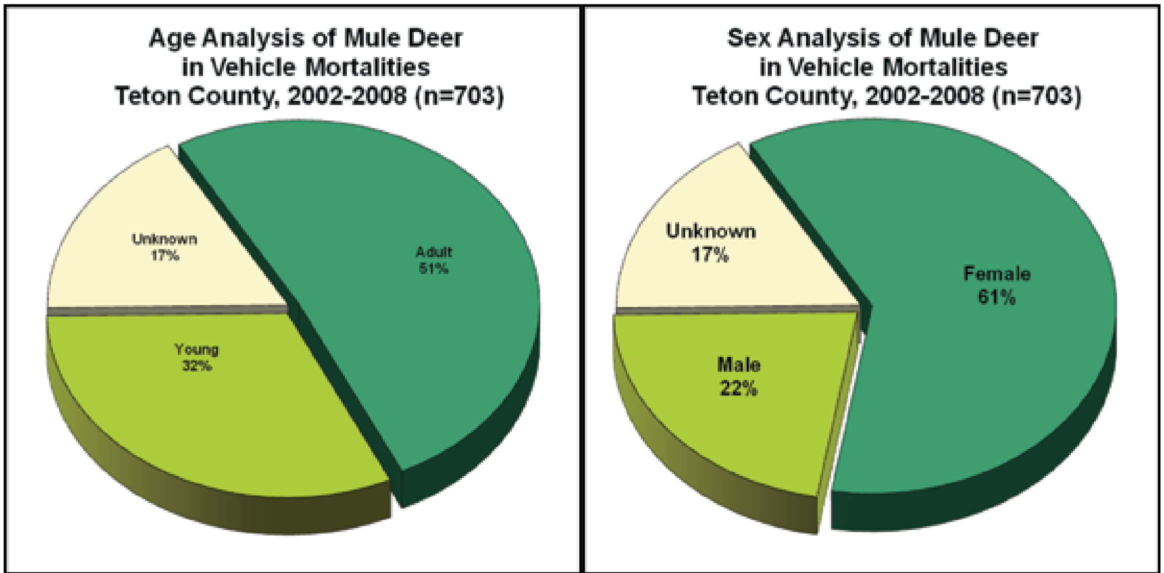


Figure 4: Seasonal Analysis of Mule Deer Roadkill

With respect to total mule deer populations, Wyoming Game & Fish estimated a population of 10,891 mule deer in the Sublette mule deer herd. Though the demographic information is relevant for comparing percentages, the range of this herd expands beyond the individual populations found in Teton County. Figures 6 and 7 compare the age and sex of roadkilled animals in Teton County to the demographics of the entire herd.

It is important to note that several other efforts of the Wildlife Foundation work to reduce wildlife-vehicle collisions; in fact, they are the organization for information on county roadkill as well as different mitigation structures. Currently, the Wildlife Foundation maintains a roadkill hotline so that drivers can report injured or killed wildlife along county roads. Additionally, the Wildlife Foundation has just implemented a Roadkill Watch System

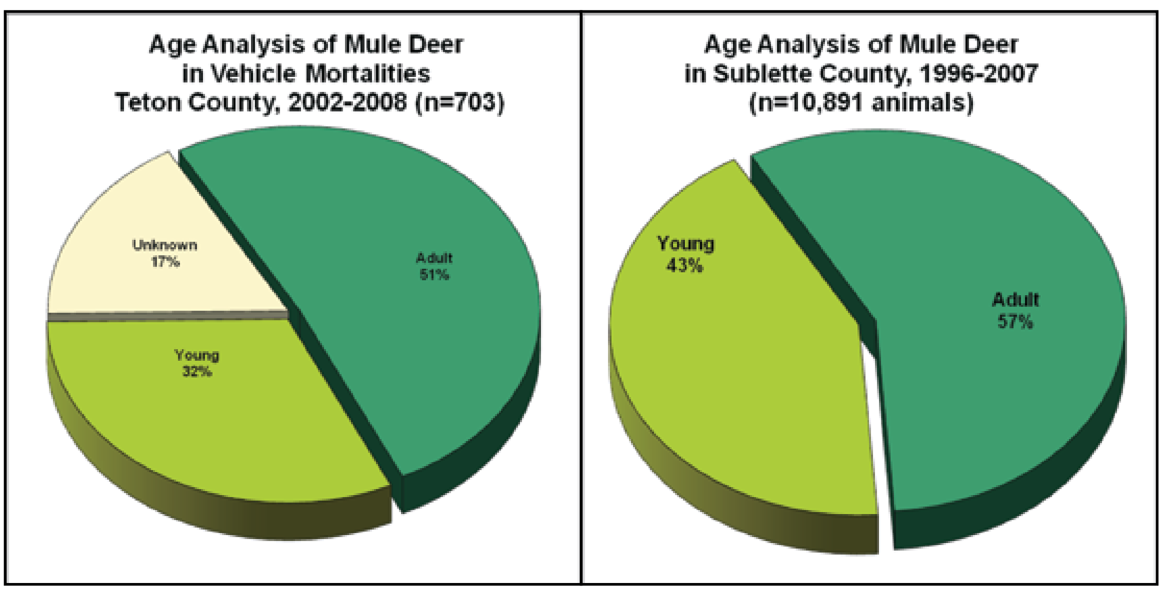


Figures 5: Analysis of road-killed mule deer demographics.

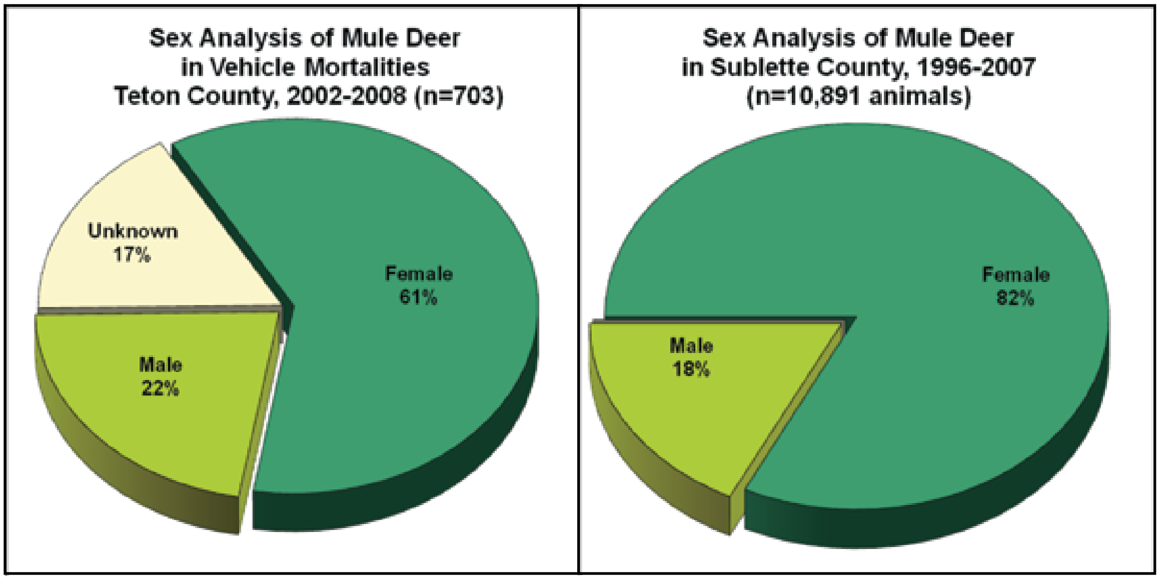
(RWS) where volunteers and professionals can visit their website and log in to report observations of dead wildlife along county roads. The benefits of this system are numerous. First, it is easier to report road-killed wildlife. Secondly, the data will be more current as observers can enter data immediately. Before this system, roadkill data was generally not available until the end of the month. This instant knowledge of where animals are being killed allows the Wildlife Foundation, in partnership with the Wyoming Department of Transportation, to better determine locations for their dynamic messaging trailers that warn motorists of the presence of wildlife in the area. Third, the information is displayed graphically on a map making it easy to determine wildlife hotspots. Finally, the data collected in this system will be entered in a consistent fashion, making analysis and reporting much easier and more accurate.

The Wildlife Foundation also maintains portable dynamic messaging systems along county roads which are moved throughout the valley as necessary to alert drivers to wildlife movements. The Foundation has purchased five of these trailers. Two of these trailers were donated to Grand Teton National Park, and the other three were donated to the Wyoming Department of Transportation for use around the Town of Jackson.

One current effort to target specific areas where roadkill is prevalent is Highway 89 heading south, between the Virginian restaurant and the intersection with Highway 22. A working group has met once thus far to discuss potential mitigation measures for this stretch of highway, where road-killed mule deer are particularly visible. With the construction of a new



Figures 6: Analysis of Teton County mule deer roadkill mortality as compared to Wyoming Game & Fish age demographics for the Sublette mule deer herd.



Figures 7: Analysis of Teton County mule deer roadkill mortality as compared to Wyoming Game & Fish sex demographics for the Sublette mule deer herd.

pathway on the west side of the highway, there is an opportunity here to implement mitigation measures when construction ensues on the pathway. To date, the Wildlife Foundation is preparing a report detailing the different mitigation measures available, such as underpasses, overpasses, lighting, reduced speed limit, etc. and providing recommendations to the town planners as to how to proceed. The first working group meeting consisted of a varied group of stakeholders, including the Pathways coordinator, chief of police, town engineer, representatives from non-profit groups, Wyoming Game & Fish, and private entities. Targeting a specific and tangible goal, such as one particular stretch of road, for reduction of mule deer mortality is one way to address the problem of reduction of roadkill, especially as it makes fundraising for costly mitigation measures more manageable.

Note that evaluation is a key aspect of these smaller projects. Should whatever mitigation technique that is implemented be shown to have a measurable impact on both reduction of mule deer mortality and improvement of human safety, the project should be well-documented and easily replicable in other problem areas for wildlife-vehicle collisions in the county.

II. Integrating Science & Policy

An Overview of Policy Science as Applied to Planning

The intersection of science, policy, and politics can be a stormy space. Debates about issues such as climate change, wolf reintroduction, evolution in the classroom, or stem cell research illustrate the complexity of incorporating science into policy. Yet in other cases – disease outbreaks, for example – the process seems much smoother and less contentious. What makes one issue so difficult to resolve, even while scientific information appears conclusive, while another issue is so much easier to deal with? To understand the different roles that science and scientists might play in policy and politics, it is important to clearly map the social context of the debate.

Borrowing from Roger Pielke's book *The Honest Broker*, policy debates that involve scientific information fall into two categories. Here, to frame the issues in a Western context, we will refer to these categories as "Invasive Weed Politics" and "Wolf Politics."

Imagine a gathering of people, representative of the diverse stakeholders in Western environmental issues – ranchers, hunters, environmentalists, scientists, community members, recreationists - gathered in a meadow on the slopes of a pristine mountain. The group is told that within the next year, the field will be colonized by multiple species of invasive weeds, and asked to come up with a decision about what to do. In this instance, the debate will likely be characterized by a discussion of information and options – policy alternatives – for preventing or minimizing the spread of the invasive weeds. Questions such as "what species are we dealing with?" and "what are effective methods of eradicating invasive weeds?" would be heard, scientists could provide fairly clear answers to these questions, and decision-making would focus on selecting the most efficient and thorough method of preventing the spread of the weeds into the meadow. In this instance, the diverse group of people share a common goal – ranchers dislike invasive plants because they are less nutritious for livestock; environmentalists dislike invasives because they represent non-native species; hunters might dislike invasives because they negatively impact native wildlife. Although each group has different reasons for not wanting invasive weeds taking over the field, there is a consensus on the desired outcome.

Now imagine that the same group of people, in the same pristine mountain meadow, are told that within a year, wolves are likely to recolonize the territory around the meadow. The group must decide what to do. Some people in the group will be thrilled by the idea of the return of a native species, particularly a carnivore, and will discuss all the science that shows that top predators regulate ecosystems in beneficial ways. Other people in the group will be outraged, and will offer information about the negative impacts of wolves on livestock weight gain or elk population dynamics. Underneath these conflicting collections of data is a debate about *values* that is being waged through a proxy debate about the validity of "scientific" information. In this case, the scientists in the group may offer information about the effects of trophic cascades on ecosystems, or cow-calf ratios in areas with wolves as opposed to areas without wolves, but these data are unlikely to help resolve the question of "what should we do about wolves?" Within the group gathered in the meadow, there is a lack of consensus about desired outcomes, and before any decision can be made, the group must either find some common ground, or else dissolve.

In these two situations, science and scientists play very different roles. In the case of Invasive Weed Politics, the scenario is relatively straightforward and adheres to an idealized model of linear science.

Most scientists perceive themselves to be part of this model, in which they convey non-partisan and objective scientific data to decision makers, who then use those data to create policies for societal benefit. At most, a scientist might be called upon to clarify information. In this case, the scientist plays the role of either a Pure Scientist – in which, once the data are compiled, the scientist plays no role in the decision-making process – or the Science Arbiter – in which the scientist might clarify points of uncertainty, if asked.[1]

In the case of Wolf Politics, however, where the definition of "societal benefit" itself is under debate, the equation is much less simple. In this scenario, scientists may play several roles. Depending on the values held by an individual scientist, the scientist might become an Issue Advocate, in which the scientist uses her knowledge of the data, in combination with her personal beliefs, to try to achieve a particular end. Alternatively, the scientist could play the role of Honest Broker of Policy Alternatives, in which she uses her knowledge of the data *and* an understanding of stakeholder concerns to outline and clarify different policy options.[2] Or, the scientist might attempt to stick with the idealized role of Pure Scientist or Science Arbiter, but these roles will not help to clarify options or resolve entrenched policy problems.

It is important for scientists and decision makers to understand these distinctions, because they play out in the local policy arena in the same ways that they do in the regional and national policy arenas.

First, determine whether the specific policy debate facing you is a case of Invasive Weeds Politics, or Wolf Politics. Then, decision makers need to clarify *what* they are asking of scientists. Will more information solve the problem? Or are decision makers really asking scientists to use their knowledge to outline a spectrum of possible policies and possible outcomes?

And scientists, who perceive themselves and their work as removed from the taint of politics and values, must make a conscious decision about the role they want to play. There is no such thing as a truly objective stance – the decision to maintain a scientific distance from the messiness of politics is not a null choice; it, too, has repercussions on the policy process and on the decision that is ultimately made.

Case Study: Mule Deer in Jackson Hole

The case of mule deer in Jackson Hole offers a chance to apply some of these theories in a real world context.

In Jackson, a clear consensus on desired outcomes exists. Residents have stated again and again that they value wildlife and that maintaining wildlife populations should be a priority in planning decisions. Teton County responded to this expressed consensus by making protection of wildlife a focal point of their current revision of the Teton County Comprehensive Plan.[3] Although advocates, planners, and citizens debate what "prioritization" looks like within a regulatory framework and on the ground, they generally agree that preserving wildlife and open space are important to the future character of Jackson.

Despite the prioritization of wildlife within the plan, however, planners, scientists, and advocates alike have repeatedly articulated the need for more information about key species, including mule deer.[4] Without this information, they state that gaining a comprehensive picture of the effects of development on the ecosystem will be difficult, and imposing regulations on private land-owners will be nearly impossible. In this case, with an agreed-upon definition of societal benefit, the scientists are being asked to play the role of Pure Scientists and Science Arbiters, offering clearly relevant information and clarifying questions that planners might have about the interpretation of data.

1 Pielke, Roger. *The Honest Broker. Cambridge,* 2007. P. 14.
2 Ibid.

3 Teton County Comprehensive Plan draft, April 2009
4 Environment Working Group of Sustaining Jackson Hole, 2008.

USING THE Q METHOD: AN OVERVIEW OF METHODOLOGY

Our project was premised on a widely perceived problem of a significant gap between scientific information and land use planning. We found that while many make this claim, understanding the source of this problem is difficult for many people to identify, and further, especially difficult on which to agree.

Rather than simply collecting claims and comments, we sought to understand perspective in the aggregate to better understand "The Problem" of integrating science and management. A better understanding of root problems can clarify opportunities to make necessary process changes. Since we are attempting to bridge expectations and understanding, we needed a better way to delve into this, thus we initiated our"Q-study"

The Q-method is a social science tool used to analyze the subjectivity of a participant in a particular situation. The Q-method allows researchers to statistically analyze viewpoints to find areas of overlap and diversion. It asks participants to rank statements about a particular issue — in this case, the integration of science into planning — in relation to other statements.The methodology is complex, but reflects people's tendency to think of issues relationally rather than in isolation.

We developed a suite of statements based on interactions with individuals involved in the science and planning communities in Teton County who were asked to comment on the integration of science into public policy. From this exhaustive list of statements, we pared down to thirty distinct and compact statements to use in the sort, or the "Q set."

One of the key aspects of a q analysis is that the number of participants, or sample size, can be quite small, as long as the participants are thoughtfully targeted. This set is referred to as the "P set." Here, we asked the many of the same individuals from the scientific and the planning communities from whom we generated the sort statements to be the "P set."

The participants in the survey were identified by three means, exclusive of each other:

1. conducted individual interviews with either Rebecca Watters, Lydia Dixon, or both.
2. participated in a group discussion or meeting about this issue
3. participated in a Sustaining Jackson Hole Environment working group meeting.

Each respondent ranked the thirty statements according to their degree of agreement with each statement. Each respondent was also asked to include any additional comments regarding the question at hand and the process.

Out of 15 surveys solicited, we received 9 responses (60%).

We entered the data into a free, DOS-based program (found online at http://www.lrz-muenchen.de/~schmolck/qmethod/) which statistically analyzed the responses using factor analysis to explain variances among respondents.

Because of the complexities and nuances associated with developing a meaningful Q sort, including the identification of the Q set and P set, we consulted intensively with a doctoral student, David Cherney, at the University of Colorado - Boulder. David has had extensive experience with Q methodology in other natural resource management cases, and graciously reviewed our statements, provided feedback, and helped to interpret the results.

Our second question requested that respondents rank a series of statements relative to each other on what solutions may best address the problem of integrating science into public policy. These statements were not Q-sorted, but simply averaged according to the rank that each respondent assigned to the statement. Those statements with the lowest scores were the most amenable solutions to the problem.

Further information on Q-methodology is included in Appendix A.

RESULTS OF THE Q-SORT & RANKING QUESTIONS

Each "sort," or survey response, was entered into the q-analysis program. The results were statistically analyzed according to a factor of four groups. The factor of four was chosen based on the number of sorts that were statistically valid and not outliers. In the results, we identified statements with which respondents generally disagreed, agreed, and were neutral, as well as the statements with the greatest spread, or divergence in opinion, among respondents.

Appendix A lists all of the statements and associated factor arrays.

Statements with which Respondents Most Disagreed

- Statement 7: Information that scientists provide to planners is presented in a format that is not useful.
- Statement 12: Scientists have no incentives to share information from their studies with the planning community.
- Statement 28: Private property rights trump scientific information when it comes to sensitive ecological issues.
- Statement 27: There is not a problem with transferring science into the planning process.
- Statement 25: Planners and decision makers are dismissive of scientific information.

Statements with which Respondents Most Agreed

- Statement 5: Planning requires a "hard" line and precise locations to delineate where development can occur without harming the ecosystem.
- Statement 4: Ecological studies operate on a different geographic scale than planning decisions.
- Statement 9: Planners are not scientific experts.

Statements which Respondents Were Neutral

- Statement 10: Planners cannot judge the relevance of information in a scientific study for planning decisions.
- Statement 8: Information that scientists provide to planners needs to be more exact and measurable.

Statements on which Respondents Diverged

- Statement 26: Science is subordinated to business interests when making planning decisions.
- Statement 19: Cumulative impacts of development are overlooked in making planning decisions.
- Statement 20: Regulations need to be legally enforceable.
- Statement 11: Planners cannot interpret and balance conflicting scientific claims.
- Statement 17: Overall ecological function is overlooked in planning decisions.
- Statement 30: Values and resolving values conflicts around decisions-making deserves precedent over integrating science into decision making.
- Statement 6: Scientific studies can only provide a confidence interval about where development may proceed without having a negative impact on the ecosystem.
- Statement 21: Scientific information is frequently too imprecise to provide a legal basis for making a decision.
- Statement 3: Planning decisions require immediate answers to specific scientific- or ecosystem-related questions.

Results of “Solution” Ranking Question

Respondents were asked, subsequent to sorting the thirty statements in the Q analysis, to rank nine statements. Due to a discrepancy in the distributed survey, two respondents only ranked eight statements. However all rankings were used to calculate the final averages and used to calculate the final averages. The results are presented in Table 1.

Average of Rankings	What solutions are best implemented in order to integrate science into land use planning?
3.56	Teton County needs to conduct an inventory of ecosystem assets.
3.67	We should make a series of detailed maps of vegetation, water resources, ecosystem function, and wildlife resources to help planners make decisions.
4	The planning office should have a position for a quantitative arbiter of science, or someone who has the background to interface with scientists and planners.
4.11	There should be more up-front meetings in which planners and scientists design studies together, to address potential needs on longer timelines.
4.44	A voluntary environment commission should review planning decisions (as currently proposed in the Comprehensive Plan).
5.11	Planners and scientists should determine a reliable, consistent method to translate scientific concerns or results into regulatory mechanisms.
5.71	The planning department should develop a system of metrics to evaluate or score developments according to how well they maintain ecological integrity.
5.89	We should compile a database of all existing environmental information to help planners make decisions.
7	A system should be implemented for passing information to the planning department as a whole, rather than just communicating with one person and being unsure as to whether it has been disseminated and incorporated into planning decisions.

Table 1: Results of the second question in survey to scientists and planners, asking respondents to rank the statements on the right in the order of “best” to “least” amenable solution. A low score indicates that it is one of the preferred, or “best” solutions.

Respondents most strongly disagreed with Statement 27, "There is not a problem with transferring science into the planning process." By extension, it was agreed that there IS a problem transferring scientific information into the planning process. From the coarsest level, then, this agreement validated the premise of this project — to recommend ways to better use scientific information in planning decisions. Furthermore, it reinforced the sentiment heard through various meetings that incorporating science into the planning process is a tricky venture.

The next statement with which respondents disagreed most strongly was 25, "Planners and decision makers are dismissive of scientific information." Disagreement with this statement indicates that though there is a problem incorporating scientific information into the planning process, it is not because planners do not WANT to incorporate this information. Though not stated explicitly, we can infer that planners and decision makers are faced with scientific information that they value but cannot interpret in a way that is useful for them in making decisions, or that needed scientific information simply does not exist.

Respondents also strongly disagreed with Statement 28, "Private property rights trump scientific information when it comes to sensitive ecological issues." In our meetings, private property rights were mentioned several times as a value held dear to Wyoming property owners. When it comes to a decision on a planning issue involving private property and wildlife habitat, the best planners can do is to enforce the law. Thus, laws need to be strong enough to be upheld in a challenge, and based on sound scientific information. The Land Development Regulations (LDRs) are the documents by which planners evaluate proposed land uses, and thus, need to have sound directives based on ecological science in order for planners to make the best decision for ecological values. Essentially, private property rights and ecological issues are not mutually exclusive, and planners will do their best to enforce the legal regulations governing development. The point, again, is that sound scientific information and interpretation is needed in order to guide planning decisions.

Respondents generally disagreed with statements 7 and 12, though not as strongly as the previous three. Disagreement with statement 12, "Scientists have no incentives to share information from the studies with the planning community," implies the opposite, or that scientists do have incentives to share their studies with the planning community. Perhaps these incentives need to be better articulated, however, in order for scientific information to better inform planning decisions and rule-making. Disagreement with statement 7, "Information that scientists provide to planners is presented in a format that is not useful," though not strong, indicates that scientific information is useful. Though disagreement with these two statements was not vehement, they do provide an interesting basis to reflect upon. If scientists have incentives to share their information with planners, the information provided is useful, and planners do not dismiss the information, then where is the problem of integrating science into the planning process?

Perhaps the statements with which respondents agreed will help tell the story. No statement had the degree of agreement that statements 27 and 25 had for disagreement. However, statement 5 had relatively strong agreement across the board. Statement 5 reads, "Planning requires a "hard" line and precise locations to delineate where development can occur without harming the ecosystem." Respondents also agreed consistently with statement 9, "planners are not scientific experts." Statement 4 also had consistent agreement, though closer to neutral then statements 5 and 9: "Ecological studies operate on a different geographic scale than planning decisions."

It becomes clearer that the problem of integrating science into the policy process is a fundamental difference in process. Scientific studies often incorporate a broad time scale, and wide geographic focus. A study on mule deer, for example, is considered brief when conducted over three years. The study area may encompass vast areas that overlap Teton County, but extend into federal lands and surrounding counties. Making a specific statement regarding a question of mule deer habitat preference in Teton County at one particular time is difficult to do, especially when the scientific information needs to contribute to a legally enforceable regulation or decision. A planner is faced with the difficulty of making a decision based on scientific information that either is non-existent, not perfectly applicable, or not concrete based on scientists' reluctance to make precise statements on imperfect information. The disciplines of science and planning, and their requirements for due process, are fundamentally different. In the next section, we provide some recommendations for tackling this seemingly insurmountable and often cited problem of process constraints.

The statements on which respondents were neutral, as well as those on which responses varied widely, may help guide next steps. In conflict resolution, finding the basis for agreement and moving forward from there is often the most rewarding approach to a stagnant problem. Identifying areas of strong disagreement and shelving them for the interim is also a way to help move the conservation forward.

Here, respondents were fairly neutral with statements 10, "Planners cannot judge the relevance of information in a scientific study for planning decisions" and 8, "Information that scientists provide to planners needs to be more exact and measurable". Both of these statements are related to the way in which information is provided. The presentation of information does not seem to be problematic, though a standardized format may help planners interpret particular pieces of information.

Respondents' perspectives varied widely on a range of topics. The greatest spread, or distance between arrays, occurred with Statement 26, "Science is subordinated to business interests when making planning decisions." With an array of -3 to 3, some respondents strongly agreed and others strongly disagreed with this statement. The sentiment expressed in this statement, that there exists a "pecking order" when it comes to planning decisions and that ecological concerns may sometimes fall second to business interests may not be able to be conclusively proven. Providing sound scientific information regarding particular areas of concern may help alleviate this contention, but it may be more productive to shelve this concern and again, address areas where there exist clear paths forward.

Statement 20, "Regulations need to be legally enforceable," would have been in the category of statements with which most respondents agreed, and strongly, had it not been for a small number of responses which rated this statement less then neutral. The factor arrays indicated that this statement fell into the "most agree" category in several responses, which is in line with our conversations with planners who asserted that any decisions that they make need to be enforceable in accordance with the Land Development Regulations and guided by the Comprehensive Plan.

Two other statements of disagreement revolved around a common theme of "cumulative impacts," or the overall effect of all development in Teton County instead of a development-by-development piecemeal approach. For example, planners look at individual applications for a development on their own merit. A cumulative effects approach would look at the individual development and the potential impacts it may have in other parts of the county or ecosystem. Would a development in a particular area have impacts on migrating waterfowl? Mule deer movement? Statements 19, "Cumulative impacts of development are overlooked in making planning decisions" and 17, "Overall ecological function is overlooked in planning decisions" address this issue. Respondents ranged in strong agreement to disagreement with these statements.

Other statements of disagreement among respondents addressed the issue of scientific information and its incorporation into the planning process, interesting because of general agreement with Statement 2 "Planning requires a "hard" line and precise locations to delineate where development can occur without harming the ecosystem" and Statement 4, "Ecological studies operate on a different geographic scale than planning decisions." These two statements indicated that respondents agreed with the limitations and constraints of scientific information. However, respondents varied in their rating of statement 6, "Scientific studies can only provide a confidence interval about where development may proceed without having a negative impact on the ecosystem," statement 21, "Scientific information is frequently too imprecise to provide a legal basis for making a decision," statement 3, "planning decisions require immediate answers to specific scientific — or ecosystem-related questions," and statement 11, "planners cannot interpret and balance conflicting scientific claims."

The conflicting responses to the statements based on scientific studies indicate that scientists and planners have different perceptions of how scientific information is to be used. Though the respondents agreed that planning and ecology have different scopes in time and space, they disagreed as to how scientific information can be used in the planning process and what the purpose of this information is - should it be used to design legal regulations? To direct where development actually occurs? To provide planners with clear-cut, yes-or-no directives? The problem, it seems, is identifying the specific role that science plays in making decisions.

This conundrum is also reflected in the mixed opinions on statement 30, "Values and resolving values conflicts around decision-making deserves precedent over integrating science into decision making."

Planners are faced with a multitude of judgments to make when deciding on a particular issue. Conservation of wildlife and wildlife habitat, though explicitly stated as the community's top priority in surveys regarding the Comprehensive Plan (citation needed), need to be balanced with other values, including housing, business interests, recreation, etc. There is disagreement as to how other values fall out on a priority list. Scientific information can be used to guide the decision, but it needs to be clear that other community priorities will remain critical to how decisions are made.

Question 2: Analysis of Solutions Ranking

Through interviews and communication with scientists and planners, we identified eight solutions initially as the range of possibilities to combat the problem of integrating science into the planning process. These solutions and their ranked ratings can be referenced in Table 1. A ninth solution was added after input from survey respondents. Interestingly, the top two solutions focused on data collection and synthesis: "Teton County needs to conduct an inventory of ecosystem assets," and "We should make a series of detailed maps of vegetation, water resources, ecosystem function, and wildlife resources to help planners make decisions." These top two solutions are directly related to the conflict we saw in respondents' feelings on the role of science in planning. Here, the role of science as a tool instead of arbiter is articulated. The more information, or tools, that the planners have on hand, presumably the better the decisions they can make.

However, it is interesting to note that despite the available scientific information, as in the mule deer case, the planners had distinct questions which the best available science was not able to answer (See Appendix C, Research Questions). It is somewhat surprising, then, that the idea of co-designing studies, or at the minimum, collaborating on study questions prior to the inception of an ecological research project, did not rate higher on the solution scale.

Also interesting to note is that the current proposal to aid in the integration of scientific information in the planning process — to have a voluntary commission reviewing decisions — fell in the middle of best solutions.

The solutions identified as the "best" for implementation do fit with the statements that participants generally agreed upon, especially statement 2, "Planning requires a "hard" line and precise locations to delineate where development can occur without harming the ecosystem" and statement 9, "planners are not scientific experts." The top solutions here would provide more information to planners, but not necessarily in a way that was helpful. Or, to frame it slightly differently, the preferred solutions would provide tools, but without addressing the question of how the tools should be used. It seems as if solutions one and two were pursued, solution 3, "The planning office should have a position for a quantitative arbiter of science, or someone who has the background to interface with scientists and planners," would be inevitable. A recent report by the Environmental Law Institute supports this position, stating that despite advances in technology and information to aid in planning decisions, "development of a cadre of cross-trained conservation scientists and planners - individuals who are capable of bridging the divide between the two worlds - is a particular need."[1] This assertion further reinforces the potential value of this position in addressing the issue at hand. It is clear that there needs to be a change in the process by which science is integrated into planning decisions, and taking small, tangible steps towards changing this process may be the most effective way to evaluate the efficacy of incorporated changes and move forward in relieving some of the stagnation we face now.

1 Stein, Bruce A. 2007. Lasting Landscapes: Reflections on the Role of Conservation Science in Land Use Planning. Environmental Law Institute. Available online at www.elistore.org. p. 57.

Based on our literature reviews, interviews, and observations, we would like to submit several recommendations for planners and scientists to progress in the future. When appropriate, we have include mule deer specific references.

Process Recommendations

- Design a process for communication with a select group of scientists and planners prior to the conduction of new scientific research projects in the region.
- Mule Deer: Planners identified several key research questions that would be of help to them in making decisions (See Appendix C) during a meeting in December of 2008. The entity spearheading the research, in this case, the Conservation Research Center of the Teton Science School, should try to incorporate a study design that may help to answer some of these questions posed by the planners.
- General: Use this process to aid in designing research projects for other Species of Special Concern in the Teton County Land Development Regulations, including Snake River Cutthroat trout, bald eagle, elk, peregrine falcon, moose, raptors, bighorn sheep, trumpeter swan, pronghorn antelope, Great blue heron, bison, and river otter.
- Design a "contact list" to which planners can refer when seated with a planning decision that may affect a particular species. This "contact list" will include the scientists and non-governmental organizations in the region and what species they research. See Appendix E for an example of this list.
- Design a "contact list" to which scientists can refer when they have special research findings to report from a particular project that may be relevant to planning decisions. See Appendix E for an example of this list.
- Hire a liaison between the scientific community and the planners who has a thorough background in both science and planning to help interpret scientific information for the benefit of planners.
- Engage an Environmental Committee that would help translate scientific concerns or research results into regulatory mechanisms. (Essentially, this solution is already proposed in the Draft Comprehensive Plan revision, and was proposed by the Sustaining Jackson Hole Working group.)

Data recommendations

- Seek funding for a "cumulative impacts" assessment, which would include compiling detailed maps of vegetation, water resources, ecosystem function, and wildlife resources in the County, as well as a database of all existing ecological information. These resources would provide a thorough source of information to which planners can refer and scientists can contribute to make the best planning decisions. This recommendation was also proposed by the Sustaining Jackson Hole Environment Working Group.
- Mule Deer: We have tried to compile and assess the best available information on mule deer in this report. However, it is clear that there are many relevant questions still are unanswered. A similar exercise for other species may also reveal significant gaps in understanding, but would also, as in the mule deer case, provide information on where to focus research given development and population pressures.
- Mule Deer: Use standardized ecological research methods and data collection for mule deer research (see WAFWA Mule Deer Working Group).

- Mule Deer: Seek funding for a cumulative impacts assessment on the local mule deer herd unit , which is a subset of Sublette Mule deer herd. Include ecological components such as herd population growth rate and analysis of its sustainability, demographics, winter habitat, etc. The goal is to have a quantitative understanding of how site specific development may impact overall herd health.

- Mule Deer: Work with Wyoming Game and Fish and all relevant partners to determine a target population size for mule deer in the Gros Ventres Buttes sub-herd unit of the Sublette herd. Tie this target population level to the amount of existing winter range. This exercise will help determine how much exisiting winter range should not be developed, or how it is developed, etc.

- Mule Deer: Develop site specific regulations for development in or near mule deer winter range (such as regulations for development in bald eagle range articulated in the Teton County Land Development Regulations).

- Mule Deer: More detailed information from Biota Research and Consulting, the Conservation Research Center of the Teton Science Schools, and Wyoming Game and Fish, may be available. Actively seek this data and exhaust all existing opportunities to acquire existing mule deer data.

Social recommendations

- When facing a particularly complex or contentious issue, consider employing a method of analyzing viewpoints in order to maximize stakeholder participation and understanding, and to identify common interests. For the purposes of this study, we employed a very basic Q methodology approach, which is extremely useful to determine stakeholder perspectives and possible means of moving forward in a stagnated situation. More information is provided on Q-methodology in Appendix A.

- Systematically implement the least contentious solutions ranked in Table 1 above. Start with basic identification and implementation of data acquisition and progress towards more complex process-enhancing activities.

- Mule Deer: Target a specific project area to focus on to minimize roadkill mortalities of mule deer, and establish evaluation mechanisms to scientifically assess efficacy of mitigation measures.

CONCLUSIONS

Though our research was focused more on the interaction between scientists and planners, and not the community as a whole, we would be remiss to not mention that Teton County is currently revising the Comprehensive Plan. The first planning exercise for the county occurred in 1978, and was updated in 1994. The planning goals in both cases were to "preserve the unique natural and social character of the valley."[1] Lurie et al reviewed the planning process used for both of these exercises, and concluded that Teton County would benefit from using a model of sustainability planning in order to achieve greater public support and reach the goals asserted in the plans. Sustainability planning focuses on creating policy decisions that are both environmentally and economically beneficial, with high levels of public participation.[2] Though it is beyond the scope of our work here, it bears mentioning that some of the same observations articulated in this 10-year old paper regarding previous planning processes are echoed in the public surveys conducted regarding the 2009 comprehensive planning process. The authors noted that "there was a large gap between people's expectations about the planning process and its outcomes and what they perceived as the actual process and outcomes. This gap produced feelings of dismay, mistrust, alienation, and blame was laid on local government for "betraying" them."[3]

This sentiment is evident still in the contention surrounding the current Comprehensive Planning exercise. The statement of ideal for Theme 1, "Promote Stewardship of Wildlife and Natural Resources," says, "Maintain viable populations of all native species; and preserve the natural, scenic, and agricultural resources that define Teton County's character." It remains to be seen as to whether this statement is adopted in the final Comprehensive Plan revision, but it lays out a clear, concise mandate for the direction in which planners need to orient.

1 Lurie, S., and Clark. The Policy Frontier: Sustainability Planning in Teton County, Wyoming. Yale School of Forestry & Environmental Studies. Bulletin No. 105.
2 Ibid, p. 206
3 Ibid, p. 209

This mandate, when coupled with the findings of the Sustaining Jackson Hole Environment Working Group, indicate that change needs to happen in order to achieve the community vision of "viable populations of all native species." The Sustaining Jackson Hole Environment Working Group drafted a document in late 2008 titled, "Applying Science to Land Use Planning in the Jackson Hole Region: Fundamental Principles and Considerations." The participants in this working group articulated the problem we hoped to help address quite succinctly, noting that there are fundamental differences between the policy process and the scientific process — on the basis of time scales, geography, and data collection.

We hope that our work, which builds on the efforts of previous studies and collaborations, provides more insight into the problem of integrating science into the planning process. Our Q-analysis reinforces what has been articulated anecdotally, and provides some guidelines as to how to move forward. Our recommendations overlap with others identified in studies both here in Teton County and elsewhere. Finally, our compilation of some data and resources pertaining to a particular species — mule deer — may help provide the basis for a larger cooperative study investigating the impacts of the planning process on this species of special concern.

Finally, this effort could be framed as a "meta-level" exercise, meaning that the project required input and work from parties with already-full schedules and duties in their respective jobs. Also, thinking about process concerns between organizations requires additional time and effort on the part of many. This makes process-oriented concerns difficult for people to engage in at times. We are pleased to provide recommendations that are explicit about process, in addition to delivering ecological information. Through this approach, we are providing not only needed process-level information, but immediately useful data.

APPENDIX A: Q METHODOLOGY & SURVEY QUESTION

Q-methodology has not been used in natural resource management issues until relatively recently. An article in the journal *Hydrology and Earth System Sciences* identified four reasons for using this methodology to assess natural resource problems:

1. setting the research agenda
2. identifying differences in values and interests that need to be discussed
3. creating awareness among a broad range of stakeholders
4. developing scenarios.[1]

Q-methodology was used in the above case to determine a shared vision for flood management for the Rhine Basin, which is located in Germany and The Netherlands. The methods used to collect stakeholder perspectives in this particular example were much more intensive then those we used. A solid process for stakeholder perception identification is one of our recommendations, since use of the Q-method may be instrumental in moving forward with stagnated problems.

In our q exercise, each "sort," or survey response, was entered into the q-analysis program, which can be found at http://www.lrz-muenchen.de/~schmolck/qmethod/. The results were statistically analyzed according to a factor of four groups. The factor of four was chosen based on the number of sorts that were statistically valid and not outliers. All nine responses were statistically relevant using a factor of four.

The Q software performs a centroid analysis test and a variance test, and a final analysis. Statements were sorted according to degrees of consensus to disagreement, and each statement received three "factor arrays," where the statement was ranked on a scale of -4 (least agree) to 4 (most agree). Results of the analysis are in Table 2, with factor arrays in the second column. A factor array of "-1, -1, -1," for example, indicates that after the statistical analysis, this statement fell one step away from neutral (0) all three times it was arrayed. Statements with varied factor arrays indicated areas in which respondents did not conclusively agree or disagree, and the distance between these arrays indicated the degree of disagreement. For example, the factor array for statement 19 was "3, -1, -2," so the spread was 6 degrees (3, 2, 1, 0, -1, -2).

The statements that respondents were asked to rank are listed on the following page, with specific raw results of the sort following.

More information on Q-methodology can be found on these websites:

http://qmethod.com/about.php
Provides an overview of the history and uses of Q methodology.

http://www.fort.usgs.gov/QMethodology/
The Policy Analysis and Science Assistance Branch(PASA) of the U.S. Geological Survey (USGS) Fort Collins Science Center (FORT) hosted a workshop on Q Methodology January 12, 2007, in Fort Collins, Colorado. This workshop provided an overview of the Q-methodology, presented multiple applications of Q Methodology in natural resource settings, and included a round-table discussion of opportunities and obstacles of applying this method to natural resource problems—both from researcher and practitioner perspectives.

http://www.aanro.net/VRESEARCH.html
Provides a short overview of a land use planning & natural resource project using Q method in Australia.

1 Raadgever, G.T., E. Mostert, & N.C. van de Giesen. 2008. Identification of stakeholder perspectives on future flood management in the Rhine basin using Q methodology. Hydrology and Earth System Sciences. 12: 1097-1109.

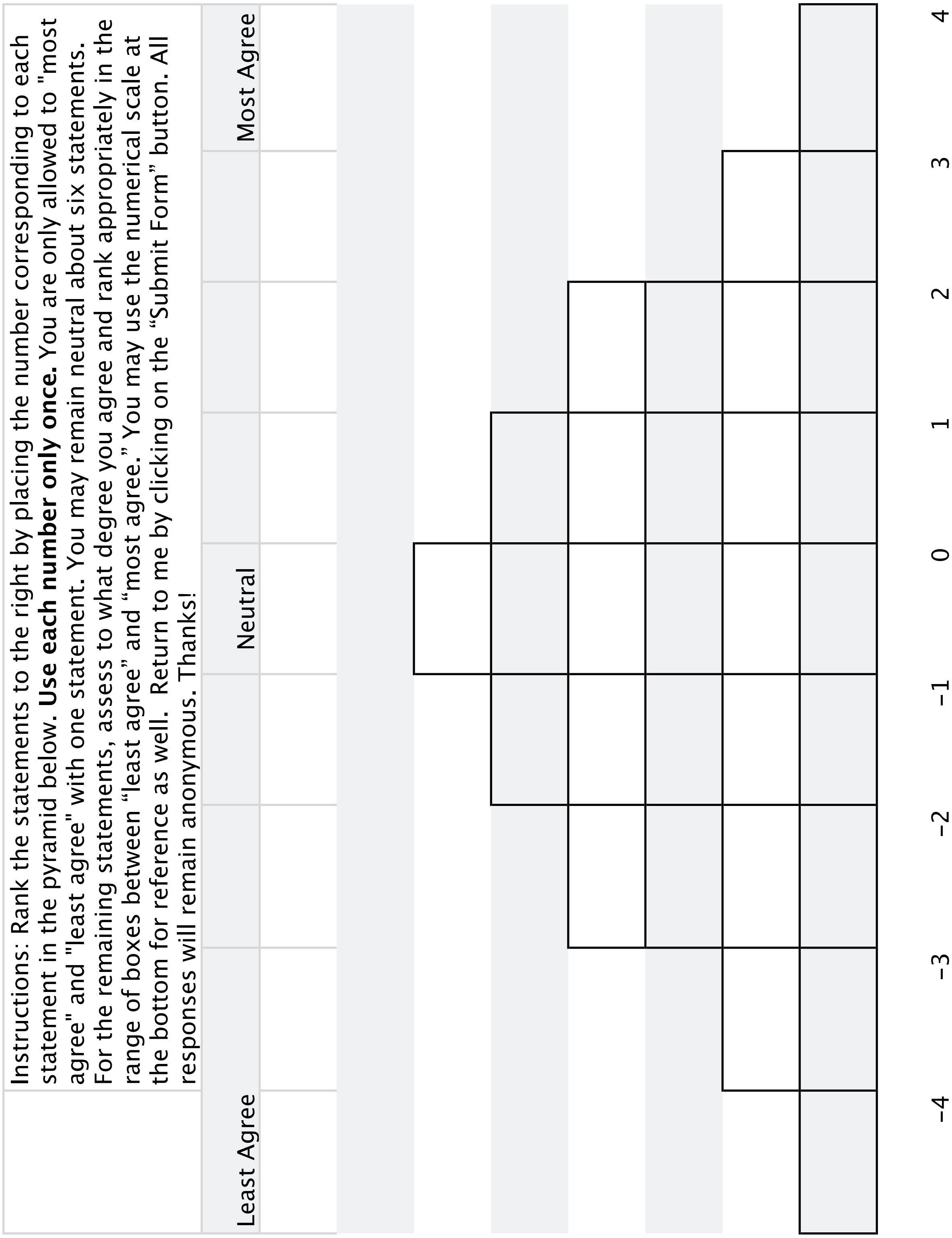
Statements answering the question "What problems exist in the integration of science into land use planning?

1. There is an inherent disconnect between scientific and planning timelines.
2. Rigorous scientific research needs multiple years to carry out.
3. Planning decisions require immediate answers to specific scientific- or ecosystem-related questions.
4. Ecological studies operate on a different geographic scale than planning decisions.
5. Planning requires a "hard" line and precise locations to delineate where development can occur without harming the ecosystem.
6. Scientific studies can only provide a confidence interval about where development may proceed without having a negative impact on the ecosystem.
7. Information that scientists provide to planners is presented in a format that is not useful.
8. Information that scientists provide to planners needs to be more exact and measurable.
9. Planners are not scientific experts.
10. Planners cannot judge the relevance of information in a scientific study for planning decisions.
11. Planners cannot interpret and balance conflicting scientific claims.
12. Scientists have no incentives to share information from their studies with the planning community.
13. Scientists do not understand the procedure for transmitting information to planners.
14. Scientists are mostly interested in sharing information with other scientists and the academic community.
15. The decision-making process involved in how science is used in town planning is not clear.
16. There is no guarantee that scientific information provided by researchers is disseminated to decision makers.
17. Overall ecological function is overlooked in planning decisions.
18. Planning decisions are piecemeal, looking at one project in isolation instead of the impacts of the project on the community as a whole.
19. Cumulative impacts of development are overlooked in making planning decisions.
20. Regulations need to be legally enforceable.
21. Scientific information is frequently too imprecise to provide a legal basis for making a decision.
22. Scientific information is unreliable if it is provided by advocacy groups.
23. Scientific information is unreliable if it is provided by industry or other special interests.
24. Scientists need to better convey information in layperson terms when they talk to people who are not scientists.
25. Planners and decision makers are dismissive of scientific information.
26. Science is subordinated to business interests when making planning decisions.
27. There is not a problem with transferring science into the planning process.
28. Private property rights trump scientific information when it comes to sensitive ecological issues.
29. Incorporating science into planning decisions is not the biggest problem when planning for a sustainable community.
30. Values and resolving values conflicts around decisions-making deserves precedent over integrating science into decision making.

Factor Q-Sort Values for Statements Sorted by Consensus vs. Disagreement			
Statement No.	**Factor Arrays**		
	1	**2**	**3**
7	-1	-1	-1
12	-2	-1	-1
5	2	2	2
4	1	2	1
22	-2	0	0
9	2	3	1
23	-2	-2	0
28	-1	-3	-3
24	0	1	2
8	-1	0	-1
18	0	0	-2
2	0	1	2
27	-4	-2	-4
10	1	-1	0
25	-3	-4	-1
13	0	0	3
29	0	2	0
1	1	2	-1
16	-1	-1	2
15	1	1	4
14	-2	1	1
3	1	0	-3
21	-3	1	0
6	3	0	-2
30	-2	3	0
17	2	-2	-2
11	2	-2	1
20	4	4	-1
19	3	-1	-2
26	-1	-3	3

Table 2: Factor Arrays resulting from Q-analysis.

Question 1: A Q-sort requires a pyramid-shaped ranking system that allows equal numbers of “agree” and “disagree” statements. Below is the pyramid we distributed to respondents, along with the instructions. Statements ranked and the results are on the previous two pages.



APPENDIX B: RANKING OF SOLUTIONS QUESTION

Question 2: Respondents were asked to rank solutions to the problem of integrating science into policy from best to worst of those proposed.

What solutions are best implemented in order to integrate science into land use planning?	Ranking
There should be more up-front meetings in which planners and scientists design studies together, to address potential needs on longer timelines.	
A system should be implemented for passing information to the planning department as a whole, rather than just communicating with one person and being unsure as to whether it has been disseminated and incorporated into planning decisions.	
The planning office should have a position for a quantitative arbiter of science, or someone who has the background to interface with scientists and planners.	
Teton County needs to conduct an inventory of ecosystem assets.	
Planners and scientists should determine a reliable, consistent method to translate scientific concerns or results into regulatory mechanisms.	
A voluntary environment commission should review planning decisions.	
We should make a series of detailed maps of vegetation, water resources, ecosystem function, and wildlife resources to help planners make decisions.	
We should compile a database of all existing environmental information to help planners make decisions.	
The planning department should develop a system of metrics to evaluate or score developments according to how well they maintain ecological integrity.	

Rank each statement on the order of 1 to 8, with 1 being the best solution and 8 being the worst.

APPENDIX C: RESEARCH QUESTIONS

Based on discussions with planners, we were able to draft an initial cut on planning-relevent scientific information that planners need regarding mule deer to make scientifically sound decisions.

Wish List from Planners for Data Related to Mule Deer

- Density of housing & effects on mule deer movement
- Spatial arrangement of housing & effects on mule deer movement
- Winter range delineation
- Impacts to use of winter range (i.e., traffic, skiers, etc.)
- Wildlife crossing areas
- Mule deer use areas in County
- Effects of development on mule deer movements
- Use of visual screens in development to promote mule deer movement
- Use of habitat in town v. rural areas
- Use of structure & associated impacts on mule deer (i.e., year-round living areas v. vacation homes)
- Areas for mitigation of displaced habitat

Wish List for Proposed Scientific Research

- GPS-collar study of mule deer movements in southern Jackson Hole
- County –wide vegetation map
- Critical threshold modeling: develop models that examine mule deer responses to varying development densities.

APPENDIX D: EXCERPTS FROM LAND DEVELOPMENT REGULATIONS REGARDING MULE DEER

a. **General.** The mule deer is another large ungulate species native to Teton County. Teton County supports a relatively small population of mule deer in comparison to elk, but these animals are particularly obvious during the winter and are enjoyed by many valley residents and visitors.

b. **Mule deer migrate between summer and fall habitat to crucial winter range.**
Mule deer are known as browsers, and rely on a variety of shrub and scrub trees for forage. Because of their diet, and the climate in Teton County and the Greater Yellowstone Ecosystem, mule deer are migratory animals, moving from summer and fall habitat to low elevation winter range. Mule deer winter ranges are classified as either crucial or non-crucial.

c. **Summer range.** Mule deer summer range is widely distributed throughout Teton County in both lowland and upland areas, but primarily occurs on public lands in the mountains which surround the valley.

d. **Migration to winter range.** Heavy snow accumulation on summer ranges reduces food availability and forces mule deer to migrate to low elevation winter range. Non- crucial winter ranges are used first by mule deer until environmental conditions cause deer to move to crucial winter range.

e. **Migration routes essential to survival.** Although mule deer rely less on traditionally used migration routes than elk, they do use the same general route while moving to and from winter ranges and between crucial and non-crucial winter ranges. These "movement corridors," which allow unencumbered access to both crucial and non- crucial winter range, are essential to the survival of Teton County mule deer and are classified as crucial migration routes.

f. **Crucial winter range essential to survival.**
Crucial mule deer winter range is limited and occurs at low elevations where shrub scrub-grassland habitat types are located. Crucial mule deer winter range generally consists of xeric and mesic sagebrush-grasslands and mixed shrub types that mule deer use during the crucial winter months eight (8) out of every ten (10) years during winter months. Crucial winter range is essential to the survival of these animals. Mule deer find food and/or cover on these sites during the most inclement and difficult winter weather conditions because of their physiographic and vegetative characteristics.

g. **Location of crucial winter range.** Primary crucial winter range for mule deer in Teton County is generally confined to five areas: (1) the Gros Ventre Buttes (East and West); (2) the west slopes along WY Highway 26, 89, 189 above and to the east of South Park; (3) the Hoback Canyon; (4) the Snake River Canyon; and (5) Miller Butte and the slopes east and west of the National Elk Refuge. In addition, some mule deer are known to irregularly winter within the Snake River riparian zone, depending on the severity of the winter and/or the availability of artificial foods intentionally or unintentionally provided by humans.

h. **Essential to protect crucial winter range.** It is essential that crucial mule deer winter ranges be maintained and protected, because without it, mule deer could not survive the harsh, energy-demanding winters of Teton County.

Regional Researcher Contact Information for Planners

Use this reference sheet to identify regional groups who may have information concerning a particular wildlife species or focus.

Non-Profits

Craighead Beringia South
Species Foci: Sage Grouse, Cougars, Ravens, Red-tailed Hawks, Other
Website: www.beringiasouth.org
Phone: 307-734-0581

Craighead Environmental Research Institute
Species Foci: Varied; Mapping; Conservation Planning
Website: www.craigheadresearch.org
Phone: 406-585-8705

Ducks Unlimited
Species Foci: Wetlands, Waterfowl
Website: www.ducks.org
Phone: 307-733-1780

Endeavor Wildlife Research
Species Foci: Lynx
Website:www.endeavorwildliferesearch.org
Phone: 307-733-2333

Jackson Hole Conservation Alliance
Foci: Land Use & Planning, Wildlife
Website: www.jhalliance.org
Phone: 307-733-9417

Jackson Hole Land Trust
Foci: Conservation Easements, Open Space, Wildlife
Website: www.jhlandtrust.org
Phone: 307-733-4707

Jackson Hole Wildlife Foundation
Species Foci: Ungulates (Roadkill & Fencing), Bears
Website: www.jhwildlife.org
Phone: 307-739-0968
Other: Jackson Hole Wildlife Foundation Roadkill Hotline: 307-734-9454, to report wildlife killed or injured along roads in Teton County

Northern Rockies Conservation Cooperative
Foci: Carnivores, Conservation Decision-making, Upgrading policy process
Website: www.nrccooperative.org
Phone: 307-733-6856

Teton Science School's Conservation Research Center
Foci: Interface Between Human Land Uses & Ecosystems; Avians, Ungulates, Climate Change, Predators
Website: www.tetonscience.org
Phone: 307-734-3740

The Trumpeter Swan Fund and Wyoming Wetlands Society
Foci: Trumpeter Swans, Wetlands
website: www.trumpeterswanfund.org

Public Agencies

Bridger-Teton National Forest
Website: http://www.fs.fed.us/r4/btnf/
Phone: 307-739-5500

Grand Teton National Park
Website: http://www.nps.gov/grte/
Phone: 307-739-3400

National Elk Refuge
Website: http://www.fws.gov/nationalelkrefuge/
Phone: 307-733-9212

U.S. Geological Survey, Northern Rocky Mountain Science Center (NROCK)
Research Ecologist: Geneva Chong
Website: www.nrmsc.usgs.gov
Phone: 307-733-9212 x 226

Wyoming Cooperative Fish and Wildlife Research Unit
Website: www.uwyo.edu/wycoopunit/
Phone: 307-766-5415

Wyoming Game & Fish Department
Website: http://gf.state.wy.us
Phone: 307-733-2321

Private Firms

Biota Research & Consulting
Website: http://www.biotaresearch.com
Phone: 307-733-4216

Intermountain Aquatics
Website: http://www.intermountainaquatics.com
Phone: 208-354-3690

West, Inc.
Website: www.west-inc.com/
Phone: 307-634-1756

Contacts for Scientists in the Planning Departments

Use these references to convey data and information to the planning offices.

Teton County
Planning Director: Jeff Daugherty, 307-733-3959, jdaugherty@tetonwyo.org
Planning Commission Chair: Larry Hamilton, 307-733-4451, tetonplan@tetonwyo.org
Senior Planner, Amy Kuszak: 307-733-3959, akuszak@tetonwyo.org

Town of Jackson
Planning Director: Tyler Sinclair, 307-733-0440, tsinclair@ci.jackson.wy.us
Principal Planner: Jeff Noffsinger, 307-733-0440, jnoffsinger@ci.jackson.wy.us

Online Technology Resources

NatureServe
NatureServe Vista 2.0 is available for free public download. Vista is a very powerful and flexible tool for conducting conservation planning and integrating conservation with other assessment and planning activities such as land use, transportation, energy, and natural resources management. It can be found at http://www.natureserve.org/prodServices/vista/overview.jsp.

APPENDIX F: GLOSSARY OF RELEVANT TERMS

Scientific Terms of Use to Planners

Biodiversity: Biodiversity is the variation of life forms within a given ecosystem, biome, or for the entire Earth. Biodiversity is often used as a measure of the health of biological systems. (Wikipedia)

Carrying Capacity: The carrying capacity of a biological species in an environment is the population size of the species that the environment can sustain in the long term, given the food, habitat, water and other necessities available in the environment. (Wikipedia)

Competition: Occurs between two species when those species use the same resource to the detriment of one or both species. (Mule Deer Working Group, p. 15)

Cumulative Effects Assessment: An assessment of the incremental effects of an action on the environment when the effects are combined with those from other past, existing and future actions (Canadian Environmental Assessment Agency).

Demographics: Statistical characteristics of a wildlife population, such as age structure, population size, etc.

Ecosystem: The physical and biological components of a particular environment, as well as the interactions between these components. An ecosystem can be as particular as a rotting log to an entire geographic region, such as Yellowstone.

Habitat: Those resources and conditions present in an area that produce occupancy, including survival and reproduction, by a given organism. (Mule Deer Working Group, p. 6)

Habitat Quality: The accessibility and an animal's ability to use physical and biological components in the habitat. (Mule Deer Working Group, p. 6)

Herd Unit: The geographic boundaries of a particular species as delineated by Wyoming Game and Fish for management purposes.

Migration: The periodic passage of groups of animals (especially birds or fishes) from one region to another for feeding or breeding. (Princeton WordNet).

Landscape Permeability: The quality of a heterogeneous land area, a landscape, to provide for passage of animals (Singleton & The Rewilding Institute, www.rewildling.org).

Population Growth Rate: The fractional rate at which the number of individuals in a population increases. (Wikipedia).

Range: Also referred to as distribution, the geographical area within which a species can be found. Summer range is the habitat used by the species through the summer months; winter range provides the habitat requirements for a particular species to survive through the winter..

Restoration: Intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability (Society for Ecological Restoration).

Travel Corridors: Pathways connecting patches of habitat. Often the means by which animals move from summer to winter range and vice versa.

Planning Terms of Use to Scientists

Cluster Development: A pattern of development in which homes, and less frequently, industrial and commercial facilities, are grouped together on parcels of land in order to leave parts of the land undeveloped. Cluster development is often used in areas that require large lot sizes, and typically involves density transfer. Zoning ordinances permit cluster development by allowing smaller lot sizes when part of the land is left as open space (Glossary of Massachusetts Planning Terms).

Conservation Easement. Conservation easement means land upon which an easement or restriction running with the land has been granted in perpetuity, whereby the owner of the underlying fee relinquishes all or some development rights (Teton County LDRs).

Development. Development means any of the following activities for which permission may be required pursuant to these Land Development Regulations: (a) the division of a parcel of land into two (2) or more parcels; (b) the construction, reconstruction, conversion, structural alteration, relocation, or enlargement of any buildings, structures, or accessory structures; (c) any use or change in use of any buildings, land, or water; (d) any extension of any use of land; (e) any clearing, grading or other movement of land; (f) any mining, dredging, filling, grading, paving, excavation, or drilling operations; or (g) the storage, deposition, or excavation of materials, public or private sewage disposal systems, or water supply facilities (Teton County LDRs).

Easement: A legal right granted by a property owner which allows another to use the owner's land for a specific purpose, such as access or placement and maintenance of utilities (Glossary of Massachusetts Planning Terms).

Eminent Domain: The legal right of government to take private property for public use, provided the owner is offered just compensation for the taking of property (Glossary of Massachusetts Planning Terms).

Landscape Surface Area. Landscape surface area means a land surface not covered by buildings, structures, impervious surfaces, porches, decks, solid or sand-set terraces and patios, walkways, and gravel, paved or grasscrete driveways and parking areas. Facilities and/or impervious surfaces specifically permitted in Section 4150, Standard Plant Unit, ponds, public and neighborhood pathways, and flood control levees are excluded from landscape surface area calculations. Landscape surface area excludes rivers and regularly disturbed areas such as camping sites, corrals, outdoor storage, and stockpiles. The landscape surface area shall be maintained to support plant life (Teton County LDRs).

Lodging Overlay. The purpose of the LO District is to provide lands within the Town which are appropriate for lodging uses, and to ensure that a balance is maintained between the amount of lodging uses and other visitor- and resident-oriented services (Ord. 586 § 1, 1997, referenced in Article 3 of the Teton County LDRs).

Natural Resources Overlay District. The objective of the NRO District is to protect (1) the migration routes and crucial winter ranges of elk, (2) the migration routes and crucial winter ranges of mule deer, (3) the crucial winter habitat of moose, (4) the nesting areas and winter habitat of trumpeter swans, (5) the spawning areas of cutthroat trout, and (6) the nesting areas and crucial winter habitat of bald eagles. Development is to be designed to protect the areas wildlife need to survive; therefore, development is to be kept outside of the NRO, as much as possible (Teton County LDRs, Article 3).

Nodal development: Development pattern consisting of urban centers or villages situated along transit corridors (Online glossary of land-use terms @ http://tclocal.org/land-use-glossary.html).

Permeability: The extent to which urban forms permit (or restrict) movement of people or vehicles in different directions. Permeability is generally considered a positive attribute of an urban design, as it permits ease of movement and avoids severing neighborhoods (Wikipedia).

Planned Resort District. The PR District is to be a mixed use district configured around a resort complex. Resorts are to be well-balanced; they are to provide tourist accommodations as well as seasonal and year-round housing. The design of resorts are to be compatible with adjoining areas and are to be connected to the community at-large by roads, transit, and pathways. A portion of the resort work force, particularly seasonal employees of hotels and restaurants are to be able to find housing within the resort district. Commercial development is to provide both tourist and local convenience shopping opportunities as appropriate (Ord. 580 § 7, 1997, referenced in the Teton County LDRs, Article 3).

Road, Arterial. Arterial road means a road, which is intended to provide for travel between or within communities or to and from collector roads. Access is controlled so that only significant land uses may take direct access to these streets. For the purposes of these Land Development Regulations, arterial roads are identified as arterials on the Official County Highway Map (Teton County LDRs).

Road, Collector. Collector road means a road, which is intended to connect local roads to arterial roads.

Road, Local. Local road means a road, which is intended to provide access to abutting lands.

Scenic Resources Overlay District. The purpose of the Scenic Resources Overlay (SRO) District is to preserve and maintain the County's most frequently viewed scenic resources that are important to both its character and economy. This is done through the establishment of several Scenic Areas within the SRO District, within which the location, design, and landscaping of development is regulated, so that development preserves, maintains, and/or complements the County's important scenic resources (Teton County LDRs, Article 3).

Setback: the distance which a building or other structure is set back from a street or road, a river or other stream, a shore or flood plain, or any other place which needs protection (Wikipedia).

Skyline. Skyline means the visual line at which the earth or vegetation and the sky appear to meet. It is typically viewed as the top, crest, or peak of a ridge, hillside, or butte (Teton County LDRs).

Subdivision. Subdivision means any division of a structure, plat, tract, parcel or lot of land, into two (2) or more parts by any means (Teton County LDRs).

Taking: Process whereby a government uses eminent domain to obtain private land for a public purpose (Glossary of Massachusetts Planning Terms).

Town Square Overlay District. The purpose of the Town Square Overlay District is to provide development standards that preserve and enhance the unique character, qualities, and pedestrian-oriented environment of the Jackson Town Square and its immediate vicinity (Teton County LDRs, Article 3).