Pronghorn Roadway Crossings:
A Review of Available Information and Potential Options

Prepared For:
Federal Highway Administration
2617 E. Lincolnway, Suite D
Cheyenne, WY 82001-5662

Wyoming Department of Transportation
5300 Bishop Blvd.
Cheyenne, WY 82009

Wyoming Game and Fish Department
5400 Bishop Blvd.
Cheyenne, WY 82006

Prepared By:
Hall Sawyer
Western EcoSystems Technology, Inc.
2003 Central Avenue
Cheyenne, WY 82001

Bill Rudd
Wyoming Game and Fish Department
351 Astle
Green River, WY 82935

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Bill Alldredge, Colorado State University (retired)
Rick Danvir, Deseret Land & Livestock, Utah
John Eddins, Wyoming Department of Transportation
Gregg Fredrick, Wyoming Department of Transportation
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Dave Hacker, California Department of Transportation
Andy Holland, Colorado Division of Wildlife
Fred Lindzey, Wyoming Cooperative Fish and Wildlife Research Unit
Mark Mckinstry, Bureau of Reclamation, Utah
Rich Ockenfels, Arizona Game and Fish Department
Tom Pojar, Colorado Division of Wildlife (retired)
Kevin Powell, Wyoming Department of Transportation
Bill Rudd, Wyoming Game and Fish Department
Larry Sickerson, Montana Department of Transportation
Dale Strickland, Western Ecosystems Technology, Inc., Wyoming
Tim Tibbits, National Park Service, Oregon Pipe Cactus National Monument, Arizona
Rodney Vaughn, Federal Highway Administration
Mark Vieira, Colorado Division of Wildlife,
Tim Woolley, Wyoming Game and Fish Department
Dave Young, Western Ecosystems Technology, Inc., Wyoming

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OVERVIEW

Pronghorn historically ranged from southern Canada to northern Mexico and numbered 30-40 million (Yoakum and O’Gara 2000). While many historic ranges are occupied today, herds are much smaller and more isolated. Habitat loss and movement barriers have contributed to the fragmentation and general decline of pronghorn populations. Roadways pose a major concern for pronghorn populations, both as a barrier to movements (van Riper and Ockenfels 1998, Ticer et al. 1999, Yoakum 2004a) and as a mortality source from vehicle collisions. The ability of state wildlife agencies to manage and sustain pronghorn populations in future years will depend on their ability to maintain pronghorn movements across roadways and allow them access to the various seasonal ranges needed for survival.

Figure 1. Current and historical range of pronghorn (from Yoakum and O’Gara 2000).

While roadways themselves may not impede pronghorn movements, right-of-way (ROW) fences constructed adjacent to roadways are often a barrier to pronghorn. Unlike deer or elk, pronghorn rarely jump fences and their primary means to cross fences is to move underneath them. Pronghorn generally require a minimum 16” of space between the ground and the bottom wire of the fence to maneuver underneath (Yoakum 2004a) however, state wildlife agencies often recommend 18” for pronghorn-friendly fencing (B.
Rudd, Wyoming Game and Fish Department, pers. commun.). The inability of pronghorn to negotiate woven-wire fences and barbed-wire fences with low (< 16”) bottom wires is well-documented (Yoakum 2004a). And, unfortunately the vast majority of fences constructed on western rangelands have been designed with bottom wires approximately 10” off the ground, with no consideration given to pronghorn movements (Yoakum 2004a). Consequently, fencing is considered a major source of habitat fragmentation for pronghorn populations and poses serious management concerns because pronghorn rely on daily and seasonal movements, often across long distances, to meet their energetic and nutritional requirements (Van Riper and Ockenfels 1998, Yoakum 2004a). For example, pronghorn in western Wyoming are known to migrate up to 160 miles between seasonal ranges (Sawyer et al. 2005).

Fence modification or removal can certainly be effective for maintaining grade-level pronghorn movements across relatively narrow (= 3 lanes) undivided roadways with low-moderated traffic volume (i.e., < 2000 Average Annual Daily Traffic;[AADT]). However, for divided highways, interstates, and other high-volume (i.e., > 2000 AADT) roadways, stringent ROW fencing is often required to keep wildlife off the roadway and minimize wildlife-vehicle collisions (WVCs). In these scenarios, roadways are only permeable to wildlife that can readily jump or maneuver through fences. Other wildlife movements across these roadways are restricted to designated crossing structures, typically underpasses in the form of bridges or culverts. And, if the existing crossing structures are not suitable for a particular species of wildlife such as pronghorn, then that species cannot move across the roadway.

Currently, many of the rural single-lane roadways across Wyoming and the Intermountain West with pronghorn-friendly fencing are permeable to grade-level pronghorn movements. However, roadway designs are projected to change in the next 10-20 years to accommodate increased traffic volumes and improve traffic flow. Many of the design changes will include wider top-widths, multiple-lanes, and divided-lanes. As narrow, single-lane roadways with low to moderate traffic volumes change to wider, multi or divided-lane roadways with high traffic volumes, the ability for pronghorn to cross at grade-level will decrease or possibly be eliminated. These inevitable changes to roadway designs make it increasingly important that we identify a structural option to facilitate pronghorn movements across roadways. Pronghorn would benefit from a design structure that allowed them to safely cross roadways and maintain the connectivity between their ranges.

The purpose of this study is to review, summarize and analyze available information on pronghorn roadway crossings; determine what type of pronghorn crossing structure is most likely to be effective; and to identify important considerations for sites where structures may be built and monitored for success.

METHODS

A literature review was conducted to gather pertinent information related to pronghorn roadway crossings. Database searches were restricted to peer-reviewed journals,
International Conference on Ecology and Transportation (IOCET) proceedings, and information available through the Wyoming Game and Fish Department (WGFD).

Existing information of roadway crossing structures and pronghorn behavior were used to identify what type of structure (e.g., overpass, underpass) would be most suitable for facilitating pronghorn movements across roadways. Biological and other considerations were identified to assist with selection of potential study site(s) where a crossing structure could be built and monitored for effectiveness. Additionally, structural engineers from Wyoming Department of Transportation (WYDOT) were consulted to provide general cost estimates. Suggested monitoring protocols were outlined.

RESULTS

Underpasses

Plumb et al. (2003) documented 70 pronghorn move through a concrete box underpass along a two-lane highway (US 30) in western Wyoming. Five different movement events were recorded between December 2001 and April 2002, with group sizes ranging from 1 to 57. Interestingly, most successful movement events occurred in the presence of mule deer. This particular underpass measured 20’ wide and 60’ long, and consisted of solid concrete walls and ceiling with a dirt floor (Gordon and Anderson 2003). Because of the dirt floor, the ceiling height varied from 10’6” to 11’0”’. Plumb et al. (2003) also noted 19 other pronghorn that approached the structure, but did not pass. These unsuccessful movement events by pronghorn were not attributed to traffic; rather they appeared to be due to pronghorn reluctance to enter the structure.

We found limited anecdotal accounts of pronghorn using other forms of underpasses, including two bridges in Wyoming (M. McKinstry, U.S. Bureau of Reclamation, pers. commun.) and one bridge in California (D. Hacker, California Department of Transportation, pers. commun.). With the exception of Plumb et al. (2003) and several anecdotal observations, we could not find any published or documented information on pronghorn utilizing roadway crossing structures. The lack of pronghorn information was consistent with recent literature reviews conducted by Nietvelt (2002), Plumb et al. (2003), Yoakum (2004a), and numerous personal communications with state biologists.

There are two primary reasons for the lack of information on pronghorn roadway crossings. First, pronghorn are limited in distribution and numbers, relative to other ungulates such as mule deer, white-tailed deer, and elk. For example, white-tailed deer occur in all 48 states and have an estimated population of 30 million (Demarais et al. 2000). Pronghorn, on the other hand, are restricted to prairie and desert habitats across 16 western states and nearly 60% of the estimated 800,000 animals occur in Wyoming (Yoakum 2004b). Because of their limited distribution and smaller numbers, pronghorn are often not a priority for studies of movement patterns, roadway crossings, and roadway mitigation.
Second, most of the ungulate-roadway work and mitigation has focused on reducing WVCs (Pojar et al. 1975, Case 1978, Waring et al. 1991, Reeve and Anderson 1993, Romin and Bissonette 1996, Lehnert and Bissonette 1997, Hubbard et al. 2000, Clevenger et al. 2001, Nielsen et al. 2003, Sullivan and Messmer 2003, Gordon et al. 2004, Sullivan et al. 2004), rather than maintaining habitat connectivity (Reed et al. 1975, Reed 1981, Singer and Doherty 1985, Clevenger and Waltho 2000, Ng et al. 2004). And, because of their limited distribution and their reluctance to maneuver through fences, pronghorn are not involved with significant numbers of WVCs, compared to mule deer, white-tailed deer, and elk; species that are widely distributed, relatively abundant, and readily jump fences. Unlike other ungulate species, the primary concern with roadways for pronghorn is not vehicle collisions; rather it is that many roadways restrict pronghorn movements and act as a barrier between seasonal and/or daily ranges.

Studies addressing habitat connectivity and wildlife roadway crossing structures generally suggest the combination of fencing and underpasses are the most effective means to reduce WVCs and maintain habitat connectivity (Foster and Humphrey 1995, Yanes et al. 1995, Clevenger et al. 2001, Ng et al. 2004). While previous studies have not involved pronghorn, it is worth examining some of the common characteristics of successful crossing structures used by other ungulate species. In general, the effectiveness of ungulate underpasses is influenced by three factors, including: passage dimensions or openness ratio (Reed et al. 1975, Putman 1997, Clevenger and Waltho 2000, Gordon and Anderson 2003, Ng et al. 2004), surrounding habitat and landscape characteristics (Clevenger and Waltho 2000, Brudin 2003, Ng et al. 2004), and human activity (Clevenger and Waltho 2000).

Studies have consistently demonstrated that the effectiveness of crossing structures for ungulates is influenced by the passage dimensions (Reed et al. 1979, Reed 1981, Foster and Humphrey 1995, Yanes et al. 1995, Clevenger and Waltho 2000, Gordon and Anderson 2003, Ng et al. 2004). Concrete box-culverts with soil floors can be effective crossing structures for mule deer and white-tailed deer if they have openness ratios >0.6 and adequate height, width, and length dimensions (Reed et al. 1979, Reed 1981, Ward 1982, Brudin 2003, Gordon and Anderson 2003). Reed et al. 1979 defined the openness ratio as \[ \text{Openness Ratio} = \frac{\text{Height (m)} \times \text{Width (m)}}{\text{Length (m)}} \]. Gordon and Anderson (2003) recommended mule deer underpasses should be at least 20’ (6 m) wide, 8’ (2.5 m) in height, and have an openness ratio of >0.8. Nine box-culvert underpasses used by white-tailed deer in Pennsylvania had average openness ratios of 0.92 (Brudin 2003). However, depending on the site or species involved, height and width may not have equal importance (Foster and Humphrey 1995, Clevenger and Waltho 2000, Brudin 2003). More important than the openness ratio may be providing animals with an unobstructed view of the horizon on the far side of the underpass (Foster and Humphrey 1995). Because of their predator avoidance strategy and affinity for open spaces, this is likely the case with pronghorn.

Although ungulates may use cement box-culverts to cross underneath roadways, the most common and effective underpass appears to be open-span bridges (Singer and Doherty 1985, Forest and Humphrey 1995, Clevenger and Waltho 2000, Ng et al. 2004). A range
of open-span bridge structures are used by a variety of ungulates (i.e., mule deer, white-tailed deer, elk, moose) to cross major highways in Wyoming (H. Sawyer, West, Inc., unpublished data; Photos 1-4). Open-span bridges are most common over streams or rivers, which may restrict their use to wildlife species associated with riparian corridors. However, the ability for open-span bridges to provide wildlife movements can be improved by expanding the length of the bridge to include a portion of the uplands (Jackson and Griffin 1998, Ruediger 2001). And specifically for pronghorn, an open-span bridge built in flat prairie or shrubland habitat may prove effective for allowing pronghorn movements underneath roadways.

Not surprisingly, the habitat and landscape attributes associated with underpasses influence their effectiveness for wildlife movements (Putman 1997, Clevenger and Waltho 2000, Ng et al. 2004). Natural habitat surrounding the underpass increases the likelihood of it being used by the species of interest. Obviously habitat surroundings are species specific, and what may be suitable for carnivores or elk or deer, may not be suitable for pronghorn and vice versa. Habitat surrounding a pronghorn crossing structure should consist of native grass or shrub vegetation and gentle topography. Additionally, human activity, in the form of recreation or urbanization, can be a major factor in the effectiveness of underpasses for wildlife movements (Clevenger and Waltho 2000, Ruediger 2001). The potential influence of human activity may be especially important for species like pronghorn that rely on open spaces and high visibility to detect predators. Although it is common for crossing structures to serve multiple uses (e.g., roads, machinery, livestock, hydrology, trails, etc.), a structure designed for pronghorn would be most effective if multiple use and the associated human activity were restricted.

Photo 1. Open-span bridge underpass (Buffalo Fork) consistently used by mule deer, elk, and moose along US 26/287 in western Wyoming.
Photo 2. Open-span bridge underpass (Flat Creek) consistently used by mule deer and elk along US 89/191 in western Wyoming.

Photo 3. Open-span bridge underpass (Snake River) consistently used by mule deer and elk along US 89/191 in western Wyoming.
Overpasses

Wildlife overpass structures are used extensively in Europe (Richard et al. 1996) and have recently been constructed in Canada (Photo 5) and Florida. An overpass is being proposed along US 93 in Montana (Becker 2001), but to the best of our knowledge there have been no overpasses designed for ungulates and built in the Intermountain West. According to Jackson and Griffin (1998), the most effective overpasses range in width from 50 m on the approaches and 8-35 m in the center, to structures up to 200 m wide. Soil depths usually range from 0.5 – 2 m to allow for herbaceous vegetation, shrubs, and small trees. When compared to underpasses, overpasses may be less confining, quieter, maintain ambient temperatures, and serve as a passage for a variety small and large mammals (Jackson and Griffin 1998). However, because of the high costs and increased maintenance and safety concerns, overpasses are often not a realistic option in roadway designs, especially if multiple crossing structures are required. Engineers with the WYDOT identified several major concerns with overpasses similar to the one in Photo 5, including: highway safety, increased maintenance, median access, and ROW access.

It is unknown whether pronghorn would utilize an overpass structure as depicted in Photo 5. Pronghorn have been known to utilize bridges to cross streams and rivers (H. Sawyer, WEST, Inc., unpublished data) (Photos 6-7) however, we simply do not know whether pronghorn would be willing to travel over a divided highway via an overpass structure. Based on the cautious nature of pronghorn, we believe grade-level crossings structures have more potential than above-grade.
Photo 5. One of two overpasses along the Trans-Canada Highway in Alberta, Canada (from Robbins 2003:52).
Photo 6. Pronghorn tracks across bridge (Tosi Creek) in western Wyoming.

Photo 7. Pronghorn crossing bridge (Wagon Creek) in western Wyoming.
Estimated Costs

There are many factors (e.g., dimensions, materials, fill, borrow, geology, drainage, design) that influence the cost of constructing a roadway structure. Structure costs can be accurately estimated for site specific projects, however estimating costs for general comparisons is difficult and the following numbers should be viewed as rough estimates intended to illustrate the relative costs of underpass bridge structures, overpass bridge structures, and underpass culvert structures.

Underpass Bridge Structure:
Bridge structures designed for vehicle use generally cost $100-150/ft$^2$. Photo 8 is a two-lane bridge structure along I-25 in northern Wyoming. This type of structure could readily be used as an underpass for pronghorn. Estimated cost for this structure would be 1-2 million dollars. Note that this structure was built across an ephemeral drainage and used natural topographic features at bridge ends to reduce fill requirements and other earthwork. Also note a series of woven-wire fences precludes possible pronghorn use.

Width = two 12’ travel lanes and 5’ shoulders = 34’
Length = 200’
Area = 6,800 ft$^2$
Cost = $680,000 – $1,020,000 * 2 (divided highway) = $1,360,000 – $2,040,000

Photo 8. Two-lane divided bridge structures along I-25 in northern Wyoming.
Overpass Bridge Structure:
Overpass structure costs can be roughly estimated the same as a bridge structure (Photo 8), plus the additional costs for landscaping, drainage, and long-term maintenance. Typical interstate designs would require an overpass = 300’ in length to cross the roadway and necessary clear zones (G. Fredrick, Wyoming Department of Transportation, pers. commun.). If we assume a minimum width of 100’ for pronghorn, then the overpass cost would be 3.5 – 5.0 million dollars, plus costs necessary for maintenance. Estimating landscaping and maintenance costs is difficult because we have no existing structures or experience to compare to.

| Width  | = 100’ |
| Length | = 300’ |
| Area   | = 30,000 ft$^2$ |
| Construction Cost | = $3,000,000 – $4,500,000 |
| Landscaping/Drainage | = $500,000 |
| Total Cost | = $3,500,000 – $5,000,000 |

Underpass Culvert Structure:
Culvert structures generally cost $40-50/ft$^2$ or approximately half the cost of bridge structures (G. Fredrick, Wyoming Department of Transportation, pers. commun). However, despite the observations of Plumb et al. (2003), we do not believe conventional concrete box culverts, such as the one depicted in Photo 9, offer reasonable opportunities for pronghorn to cross underneath divided or multi-lane roadways. Concrete box culverts are usually limited in height and rarely exceed 12 or 13’. Because pronghorn rely on open spaces, eyesight, and running to avoid predation, the relatively confined nature and low openness ratios associated with box culverts are not conducive to use by pronghorn. However, new concrete arch culverts can be designed with heights up to 24’ and spans of >80’ (CON/SPAN®). Large arch culverts may be a viable option in some cases. Costs of CON/SPAN structures were not available for this report.
Suggested Structure Design

Although Yoakum (2004a) suggested that behavioral characteristics preclude pronghorn from using overpass and underpass structures to cross busy roadways, we believe a properly designed and carefully located open-span bridge structure (Photo 11) could be used as an effective underpass for pronghorn. Photo 11 depicts a railroad crossing along I-80 in southern Wyoming and illustrates the type of structure we believe would allow pronghorn movements underneath divided highway systems. The underpass formed by the bridge is approximately 60’ between support columns and approximately 24’ in height. Based on the available evidence and our limited knowledge of pronghorn movements underneath roadways, we believe this type of structure has the most potential for facilitating pronghorn movements across roadways.
Plumb et al. (2003) documented pronghorn use of concrete box culvert to cross underneath a two-lane highway however, available evidence and knowledge of pronghorn behavior suggests open-span bridges would be more effective because of their large openness ratios and ability to provide animals with an unobstructed view of the habitat and horizon on the far side of the underpass, even with divided four-lane roadways. Concrete box culverts are much cheaper than bridge structures, but they are less likely to allow pronghorn movement underneath multi-lane roadways due to restricted view of horizon and surrounding habitat.

There are several reasons why we consider the use of open-span bridges for pronghorn underpasses as a more promising structure than overpasses. First, there is evidence that pronghorn will move through underpasses, but no evidence that pronghorn would move across overpasses large enough to cross divided-lane roadways. Second, to the best of our knowledge open-span bridge structures have never been located in areas specific for pronghorn use, rather they generally occur over riparian areas or access roads or railroad tracks perpendicular to the roadway. Consequently, we believe the lack of documented pronghorn use is a function of structure location (e.g., rivers) and structure purpose (access road, rail road tracks, hydrology) rather than the unwillingness or inability of pronghorn to use the structures. Additional benefits of the open-span bridge structure compared to an overpass include lower costs, lower maintenance, and fewer highway safety concerns (i.e., right-of-way, median access, adequate clear zones, drainage,
lighting, etc.). The bottom line is we already know a variety of wildlife species use open-span bridges to move underneath roadways and if properly located, we believe pronghorn would also use them.

Hacker (2002) initially proposed construction of a pronghorn overpass along a California highway (US 46) however, after further review these plans were modified to include underpasses only. Specifically, California Department of Transportation biologists held the view that strategically placed open-span bridge structures would allow pronghorn movements underneath the highway. Further, anecdotal evidence suggests pronghorn already cross underneath existing bridges in the area (D. Hacker, California Department of Transportation, pers. commun).

Site Selection

There are many important considerations for the identifying the most suitable site(s) for wildlife crossing structures (Beier and Loe 1992, Barnum 2003a,b). Ideally, structures should be designed for multiple species (Clevenger and Waltho 2000, Ruediger 2001), located in areas free of human disturbance, and surrounded by natural vegetation (Beier and Loe 1992). We identified biological and other considerations to assist with potential site selection of a test case structure.

Biological Considerations:

1) **Pronghorn Abundance**: Ideally, there should be abundant numbers (i.e., hundreds) of pronghorn that utilize the project area so that structure effectiveness can be accurately evaluated for numerous crossing events and a wide range of group sizes. We recognize there are areas (e.g., Arizona, California) with small pronghorn populations where highway crossings are a major concern. Protection and highway mitigation for small populations is no less important than for larger populations; however, monitoring a structure where pronghorn numbers are high may result in a wider range of crossing information (i.e., seasonal use, daily use, group sizes, failed crossings, timing of movements, etc.).

2) **Knowledge of Pronghorn Movement and Distribution Patterns**: Understanding the seasonal movement and distribution patterns of pronghorn in the project area is key to identifying the most suitable location for a crossing structure and also assessing how effective the structure(s) is for maintaining pronghorn movements after construction. Additionally, this information allows biologists to determine if the crossing structure would be needed for daily use movements or spring/fall seasonal migrations, or both. Ideally, a potential site would have both daily and seasonal movements of pronghorn so that structure effectiveness could be evaluated under a variety of conditions and animal behaviors (i.e., daily movements vs. seasonal migration).
3) **Multiple Species Potential:** A project area with multiple-species occurrence may be important to help justify construction of pronghorn crossing structure. Crossing structures designed for deer, elk, or livestock are often not suitable for pronghorn because pronghorn are generally more wary and have more difficulty negotiating fences. However, we believe a crossing structure that is designed for and used by pronghorn would be suitable for deer, elk, and a variety of other wildlife species.

**Other Considerations:**

1) **Land Status:** Land status of the project area may be an important factor as it relates to DOT’s ability to acquire access, right-of-way agreements, and borrow sources. Public lands are preferable to private because of the ability to manage human/livestock activity, reclamation practices, and fence designs. Additionally, public lands ensure access for proper monitoring and evaluation.

2) **Human activity:** Crossing structure should be located away from potential sources of human disturbance (e.g., housing developments, access roads, machinery).

3) **Fencing:** Ideally, a crossing structure would be located in an area with no fencing. If fencing is required, then crossing structure should be located in area where fence design is pronghorn-friendly and restrictive fences (e.g., woven wire) do not inhibit pronghorn movements to and from the structure.

4) **NHS Status:** The roadway should be part of the National Highway System (NHS) so that federal funding is an available option.

5) **Topography:** Incorporating natural topographic features such as small hills, swells, or ridges into the construction plans may reduce costs by substantially minimizing backfill and other earthwork.

6) **Monitoring Commitment:** Adequate pre and post-development monitoring plans (and funding) should be in place so the effectiveness of the crossing structure can be properly evaluated.

**Monitoring Protocols**

Inadequate pre and post-construction monitoring is the main reason for the lack of information on wildlife crossing structures and other highway mitigation measures (Clevenger and Waltho 2003, Hardy et al. 2003). Numerous authors have emphasized the need for pre and post-construction monitoring plans (Beier and Loe 1992, Clevenger and Waltho 2003, Hardy et al. 2003) and because so little is known about pronghorn movements, implementing an adequate monitoring plan to evaluate a pronghorn crossing structure would be particularly important. Hardy et al. (2003) outlined a 7-step monitoring approach:
1) Identify evaluation question(s) and definition of effectiveness
   The evaluation question(s) will likely be site-specific, but should address what the goal of the structure is (e.g., allow pronghorn movement) and how ‘effectiveness’ will be defined (e.g., % of pronghorn using structure).

2) Identify methods to measure effectiveness
   The methods may be site-specific and influenced by the evaluation question(s) in Step 1. However, the most likely methods for monitoring pronghorn use will be one or more of the following: radio or gps-tracking, track counts, and video/camera monitoring.

3) Design monitoring program
   The design of the monitoring program will involve determining sampling strategies (e.g., When and where should animals be marked? When and where should animals or tracks be monitored?). Additionally, the design should incorporate a pre-construction phase so that comparisons can be made following construction.

4) Pilot methods, adjust to meet goals, project budget
   More than likely the monitoring methods will need to be adjusted according to their performance and the project budget. The first year of the monitoring should be viewed as a ‘pilot’ year and appropriate changes should be made over the course of the study.

5) Collect data for evaluation
   Data collection should be consistent and regularly recorded. Clevenger and Waltho (2003) recommend a minimum of 4 years of post-construction data collection.

6) Analyze data to determine effectiveness
   Carefully analyze and interpret results as they relate to the ‘effectiveness’ of the structure.

7) Report results
   Distribute results to appropriate outlets so they can be accessed and reviewed by agencies and other stakeholders.
SUMMARY AND RECOMMENDATIONS

- We believe underpasses associated with large open-span bridge structures offer the most opportunity for pronghorn to cross both two-lane and divided multi-lane roadways (Photo 11). No other structure allows for grade-level movements and unobstructed views of the horizon. Although no information exists on specific dimensions, we recommend minimum heights and widths of 18' and 60', respectively, if and when a structure is designed exclusively for pronghorn use. Additionally, column supports depicted in Photo 11 provide more visibility than solid slab supports.


- The ability of existing open-span bridges to provide pronghorn movements could likely be improved by: 1) modifying or removing restrictive fencing, 2) limit human-related disturbance, and 3) for those structures that cross hydrologic features or riparian habitat, expanding the length of the bridge to include a portion of the uplands. Expanding the length of existing bridge structures during planned roadway reconstruction or rehabilitation may cost substantially less than building a structure exclusively for pronghorn use.

- There is potential to learn more about structure dimensions and effectiveness from existing open-span bridges. An effort should be made to identify existing open-
span bridges that may be suitable for pronghorn use (Photo 11), given minor modification (i.e., fence removal). Identified open-span bridges should be examined for pronghorn use. Additional information (i.e., structure dimensions) would be valuable for improving future construction plans. In Wyoming alone, 308 bridge structures have spans = 60 feet (Figure 2).

- Additionally, we recommend identifying existing bridge structures that cross riparian habitats but have potential to serve as pronghorn underpasses if they were expanded to include upland habitats. This information would allow WGFD biologists and WYDOT engineers to consider bridge expansion during the early planning phases of reconstruction and rehabilitation projects.

- Although documented use of concrete box or arch culvert underpasses is limited, we believe further investigation and consideration is warranted, especially for project areas with two-lane or separated highways with fenced median.

Figure 2. Location of all WYDOT bridge structures (n=1,884) and those greater than 60-feet in length (n=308) across pronghorn seasonal ranges in Wyoming.
LITERATURE CITED


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