Predator Control

Predators kill some pronghorn, especially fawns, and predation can be significant on marginal pronghorn rangelands or in areas where predator numbers are high in relation to pronghorn numbers (Smith et al. 1986). Most fawns killed are between 1-3 weeks of age, while separated from their dams. Trainer et al. (1983) reported that 87% of fawn mortality occurred during the first three weeks of life in their study area in Oregon.

Figure 25. Each species of predator has characteristic feeding patterns and often leaves evidence at a carcass in their attempts to bury or cover it. Here a bobcat has scratched out hair in an attempt to camouflage a carcass from carrion-eating birds. Cats often do this if ground litter is not available to cover a carcass. Feeding and covering patterns should not be considered conclusive evidence of a predator kill. Kills can only be determined by the typical wound patterns inflicted by a species of predator plus hemorrhages showing the prey was alive when the wounds were inflicted. Photo by Rod Canutt.

Pronghorn, although having made an impressive comeback, often are restricted in their movements due to fenced farms, highways, and right-of-ways as well as urban development. Thus, some herds are localized and relatively small. Under such artificial circumstances, predators may keep pronghorn populations from increasing, or even eliminate them (Udy 1953). Predator control to benefit a big game population often involves a reduction of predators over a large area, however, and even if desired, such control seldom is economically feasible. However, Smith et al. (1986) indicated that selective, time-specific application of aerial gunning in areas of high coyote density could be an economically beneficial means of increasing fawn survival on Anderson Mesa in north central Arizona.

As pointed out by Hornocker (1970), if suitable habitat is unavailable, no amount of predator control will bring about a flourishing population of a prey species. Also, controlling one species of predator may be compensated for by increased predation by other species, as happened on the National Bison Range when coyotes were reduced and predation by bobcats and golden eagles increased (Corneli et al. 1984). The overriding influences on pronghorn mortality are changes in carrying capacity and the quantity and quality of habitat available. As an example, Pyrah (1987) found that coyote density in the Yellow Triangle area of Montana was positively correlated with pronghorn numbers, presenting the possibility that coyote and pronghorn populations reacted concurrently to habitat factors.

Recognizing the many investigations relative to pronghorn neonate-predator relationships, a comprehensive report Yoakum et al. is being published in the 2004 Proceedings of the Pronghorn Workshop. The report assessed >35 publications from 1945 to 2006. A summary of these findings regarding pronghorn fawn relations to predators and predator control include:

1. *Native predators currently exist in all habitats occupied by pronghorn. Prey and predators have coevolved.*

2. *Pronghorn are prolific fawn producers—averaging 180 to 190 ff::100dd. Mortality of fawns are generally high—50 to 80 percent of annual production. Predation averaged 53 percent of overall fawn mortality for the 12 studies using radio telemetry.*

3. *Predation is highest during the first 30 days following parturition – hiding period for fawns before they grow large and swift enough to evade predators. Chronicle low fawn recruitment is not necessarily justification for a large-scale predator control program. Low fawn recruitment may be a symptom of low quality habitat or other predisposing factors.*

4. *For most habitats, coyotes are the main predator of pronghorn neonates. Bobcats and golden eagles take lower percentages.*

5. *Rates of neonatal mortality are generally higher in marginal pronghorn habitats or when a population is at or above ecological carrying capacity. Mortality rates are likewise high for areas suffering from high density dependency functions.*

6. *Even when predation has been identified as a major limiting factor for pronghorn and fawn recruitment below management objectives, other important mortality factors affecting carrying capacity should be considered before initiating predator control. Low fawn recruitment may be a symptom of low quality habitat or other predisposing factors: e.g., low abundance of alternate prey, large numbers of predators, poor health of prey, inclement*

weather, or unhealthy vegetation condition. Predation rates generally vary temporally and geographically, and recommendations for predator control should be supported by long-term studies (generally >5 years) that assess which environmental factors are truly responsible for limiting population size.

7. *Effects of predation are greatest when prey numbers are small and predators are many. Predation rates are generally higher for shrubsteppes and deserts than grasslands.*

8. *Numerous studies confirm that effective coyote control programs can increase initial fawn survival; however, it is rare that such practices result in increased pronghorn herd size. Generally, the condition and health of vegetation influences rates of predation.*

9. *A ratio of 15 to 20 ff::100dd in summer surveys is probably needed to sustain a population.*

10. *A predator control program to enhance pronghorn productivity may be justified if predation rates are high and the pronghorn population is well below carrying capacity.*

11. *A short-term predator control program may be justified to assist the growth of a newly translocated population, or to protect a captive herd.*

12. *To be effective, a coyote control program must remove >70 percent of the predators prior to the fawning season and be conducted for two consecutive years.*

The effects of predators and predator control on adult pronghorn mortality rates is less reported in the literature. This may be the result of fewer acts of predation on adult pronghorn compared to deer or elk that inhabit sites occupied by cougars and bears. O'Gara (2004d) provides examples of limited cases of predation on adults. Ockenfels (1994 and 1994b) reported increased cougar depredation when adult pronghorn moved to marginal habitats with abundant cougars.

Recommendations: In treating a problem situation in which pronghorn populations are reduced and predators are prevalent, the following guides should be used:

1. Determine what pronghorn herd parameters are desired. This may be in terms of total number, recruitment rate, age classes present, etc. Determine the year-round distribution of pronghorn and the habitat types involved. Consider other population influences including, but not limited to, predation.

2. If predation is determined to be a significant inhibitor of a particular population, the cost of actually controlling predators in the short-term must

be balanced against the long-term return. At present, the only method that appears to be economically feasible is aerial gunning of coyotes immediately prior to, and during the fawning season (Smith et al. 1986).

3. If it is determined that an increase in pronghorn numbers justifies the cost, predator control should be done on those herd units where documentation indicates predator reduction can meet management objectives.

4. In some captive situations, predator may also take the form of preventive maintenance. In these situations double fence enclosures to control coyotes and overhead netting to discourage predations by golden eagles may even be desirable in small areas.

Protection from Harassment: Little information is available concerning the impact of harassment on pronghorn. Although generally considered unethical, chasing animals with vehicles during hunting seasons is a common practice. Such stress probably also increases crippling loss as necropsies done by Chalmers and Barrett (1974) showed that pronghorn dying during drive trap operations exhibited muscle hemorrhages in the hind limbs, and concluded that stress may be highly detrimental to the pronghorn's well-being. McNay (1980) reported that does in late pregnancy and does with young fawns reacted negatively to any form of harassment, and pregnant does moved out of a fawning area when cattle moved in.

Road closures, seasonal use restrictions, and closed areas have all recently been employed as means to reduce pronghorn stress during the fawning season and at other critical times, especially in winter. Although numerous studies have documented the negative effects of human disturbance (see e.g., Baker 1955, Scott 1976, Helms 1978, Crowe and Strickland 1979, Markham et al. 1980, Constan et al. 1981, Segerstrom 1981, Medcraft and Clark 1984, Andrews et al. 1986, Clark and Medcraft 1986, Dickens and Andrews 1986, Haag 1986, Hess 1988, Howard et al. 1990, Bastian et al. 1991, Chervick 1991, Tullous and Fairbanks 2002, Smith and Guenzel 2002, U.S. Fish and Wildlife Service 1994, and Yoakum 2002), few scientific studies on the efficacy of closing pronghorn habitats to humans have been conducted.. Such data are sorely needed.

Supplemental Feeding: The quality of game animals and the quality of human enjoyment of them result from good wildlife management (Murie 1951). Pressed by a public who want more animals to hunt or otherwise enjoy, and faced with limited or below par habitat, wildlife managers may turn to artificial feeding or other measures that affect the "gameness" of a species and thereby foster inferior animals. According to Leopold (1933), the recreational value of a herd of game is inverse to the artificiality of its origin, and a proper game policy seeks a happy medium between the intensity of management necessary to maintain a game supply and that which would deteriorate its quality or recreational value. The desirability of a maintenance-free population should always be kept in mind when considering supplemental feeding.

Pronghorn populations are most stable on natural rangelands with unimpeded access to key seasonal habitats. Maintaining movement corridors to key habitats, some of which may be used no more than one year in 10, is becoming more and more difficult. Consequently, emergency feeding may be the only way to save large numbers of pronghorn during critical conditions. Supplemental feeding usually comes with considerable expense and logistical challenges, however.

When an emergency situation arises, pronghorn usually move toward key habitats unless stopped by fences or other human-made impediments. Generally, emergency feeding should begin within a couple of days of the onset of stress for best results. Pronghorn that are starved for 10 days or more usually will not survive no matter what measures are taken to save them (Pearson 1969). Thus, palatable rations that are immediately accepted are needed.

Ken Clay (pers. comm.) reported that the only pronghorn to survive a catastrophic die-off in Arizona during the winter of 1966-67 were fed clippings that had been mowed by highway department personnel. Animals fed alfalfa or other hay all succumbed. Torbit et al. (1984) developed and tested a winter pellet ration formula that was economical, nutritionally complete, digestively safe, and acceptable to pronghorn. These researchers also investigated the most practical ways to deliver these rations to wild populations. As a result, a pelleted commercial ration for emergency use is now available from RanchWay Feeds in Fort Collins, CO (Baker and Hobbs 1985). This ration was used successfully in two situations encountered in Colorado, and demonstrated that emergency supplemental feeding of wild pronghorn is possible.

While experiencing a severe summer drought on the Carrizo Plain National Monument in southern California, wildlife managers reported a shortage of succulent nutritious forage and drinking water for a herd of wild, fee-roaming pronghorn (Koch and Yoakum 2002). Consequently, emergency action was taken by providing alfalfa hay and fresh drinking water. Pronghorn readily located and consumed the forage and water. However, soon after the first autumn rains arrived and herbaceous forage sprouted, the pronghorn quickly reverted to foraging on native vegetation. Field investigations located no pronghorn mortalities during and after the drought emergency program.

Habitat Management

The foundation for habitat management is a base inventory of the quality and quantity of food, water, physiographic features, etc. Once the base inventory has been completed, periodic monitoring studies should determine whether habitat conditions are static, improving, or declining. How often monitoring studies should be conducted varies with the degree of change in the habitat; however, it appears that every 5 years is adequate for relatively stable habitats. Rangelands experiencing rapid environmental changes should be monitored more frequently. Both the quality and quantity of forage and waters should be monitored on a prearranged schedule. Techniques to monitor

habitat are provided by Yoakum (1980, 2004) and Cooperrider et al. (1986). The habitat requirements discussed in Section II of this field guide should be included in every management program.

Evaluating Habitat Suitability and Habitat Models: After the base inventory has been completed, evaluating the suitability of an area for pronghorn is possible. This is accomplished by comparing the habitat characteristics with pronghorn habitat requirements. Suitable habitat for pronghorn can be determined through a system of rating the amount and juxtaposition of habitat characteristics. Too little or too much of any biotic or abiotic factor may become the primary component limiting pronghorn production and survival. Knowledge of these relationships becomes the ecological foundation for making management decisions.

Wildlife biologists today often use habitat models to evaluate pronghorn habitat suitability (quality), however, many of these models are based on professional judgment and lack quantified data. Models are used to synthesize knowledge of habitat components and apply information systematically towards management goals. Managers may find habitat suitability evaluations of assistance in making resource decisions. This is especially true when developing a plan to translocate herds, or when completing an Environmental Impact Study to determine the relationships between livestock and pronghorn using the same habitat or the impact of human involvement on pronghorn habitat. The utility of a model should be tested over a sufficiently long period of time, and on a large enough scale to sample a variety of conditions.

Models are generally of two types, either conceptual or quantitative. Conceptual models represent thoughts and ideas in a qualitative way rather than in terms of numbers. Quantitative models are based on ideas and relationships contained in conceptual models, but augmented by numeric data. Using measurable sets of environmental factors and relationships can often be used to predict the outcome of a future event

Habitat models may also be either extensive or intensive. Extensive models may be used to differentiate occupied from unoccupied environments on a broad geographic scale. One such endeavor was accomplished in Arizona by rating suitable pronghorn habitat in a statewide survey (Ockenfels et al. 1996).

Intensive quantitative models for pronghorn have been developed to assess: winter rangelands (Allen and Armbruster 1982), translocation sites (McCarthy and Yoakum 1984, Arizona Game and Fish Department 1993), suitable yearlong habitat (U.S. Bureau of Land Management 1980, U.S. Soil Conservation Service 1989), effects of wildfires on vegetation (U.S. Bureau of Land Management 1980), and the compatibility of domestic sheep with pronghorn (Howard et al. 1990). Each model has contributed to evaluating pronghorn habitat through documented reports, thereby advancing pronghorn management from earlier “professional judgment” efforts to written scientific rating systems (Yoakum 2004c.).

Examples of working systems for the Great Basin region are provided by Salwasser (1980), Yoakum (1980), and Kindschy et al. (1982). For the sagebrush-grasslands of Wyoming, a different system was used, which stressed the evaluation of winter habitats (Allen and Armbruster 1982, Cook et al. 1984, Cook and Irwin 1985).

At least 10 models are presently used to assess pronghorn habitat: Hoover et al. (1959), Yoakum (1974), U.S. Bureau of Land Management (1980), Allen and Armbruster (1982), Kindschy et al. (1982), McCarthy and Yoakum (1984), U.S. Soil Conservation Service (1989), Howard et al. (1990), Arizona Game and Fish Department (1993), and Ockenfels et al. (1996). Ockenfels et al. (1996) reviewed 9 habitat suitability methods developed since 1959, noting the strengths and weaknesses of each model, and presenting a landscape-level model for Arizona. In general, all models are based primarily on terrain physiognomy and vegetative structure and condition. Other factors are typically of secondary importance.

Figure 26. Rangelands with dominant, dense, tall shrubs are not productive pronghorn habitats. These shrublands decrease opportunities for pronghorn to see and flee from enemies. Extensive shrub communities also compete for moisture and soil nutrients and often lack nutritious forbs and grasses. Photo by David E. Brown.

Maintaining Quality Habitats: When a natural site is in good condition relative to its ecological potential, maintenance of that condition should be a major objective. Implementing this ecological principle, however, will not always favor some objectives, such as producing maximum numbers of pronghorn. For example, some shrub-steppe communities in the Intermountain West naturally have 60% or more shrubs; this is not conducive to high pronghorn densities, because such sites have low carrying capacities for pronghorn. Managers should not expect such sites to produce high numbers of

pronghorn or try to manipulate the vegetation for that purpose, ignoring the site's ecological potential.

Habitats that provide optimal resources for pronghorn will produce optimum numbers of pronghorn. Therefore, recognizing habitats in good ecological condition and maintaining them, by objective, is important. This is especially true where the land is managed for multiple-use.

However, some land managers are not aware of optimum pronghorn habitat conditions and may suggest changing the vegetation composition favoring livestock production. Under such circumstances, it behooves the wildlife manager to know the habitat conditions required by pronghorn, and advocate the maintenance of those conditions for the welfare of pronghorn populations.

Figure 27. Today's dominant shrublands can be treated to improve forage for pronghorn. Managers can use control techniques to decrease shrubs, resulting in vegetative communities with a greater mixture of forbs, shrubs, and grasses, meeting the habitat requirements of pronghorn. Photo by David E. Brown.

Dunbar (2001) disclosed that playas (shallow intermittent lake beds) on the Hart Mountain National Antelope Refuge were key habitats for pronghorn. Although these playas represented 3% of pronghorn habitat, they were occupied by more than two-thirds (n=1933) of the pronghorn population because the sites contained drinking water and an abundance of succulent, nutritious, preferred forage. The importance of quality playas in providing water and forage during dry seasons helped managers recognize the importance of these key sites in quality conditions, and protecting them from severe competitive use by cattle and feral horses.

Enhancing Poor Quality Habitats: Improving rangelands for a specific objective of restoring or increasing forage, cover, or water, is termed "habitat improvement"

(Yoakum et al. 1980). When rangelands are in poor ecological condition, and the site is capable of better forage and/or cover, projects should be designed to improve habitat conditions. For example, a site having a vegetation composition of 5% grasses, 10% forbs, and 85% shrubs, can be improved for pronghorn. Prescribed treatment of shrubs followed by seeding with mixtures of grasses, forbs, and shrubs can change the site to a more favorable composition of 35% grasses, 25% forbs, and 40% shrubs. In some areas, a desirable habitat factor may be inadequately distributed, and this situation also can be improved through management practices. For example, streams and springs may be abundant in half of an area, but water may be lacking or limited in the other half. By developing waters in the latter portion, managers can provide a more equitable distribution and increase carrying capacity throughout the unit.

Water Developments: During a 5-year pronghorn study in the Red Desert (1966-1970), pronghorn were seen using every type of water source available (Sundstrom 1968). These water sources consisted of springs, creeks, rivers, lakes, reservoirs, stock water developments, galvanized troughs fed by windmills, and troughs filled by springs.

Water improvement projects to increase drinking water for livestock and pronghorn are varied (Yoakum 1980, Yoakum et al. 2004c, Vallentine 1989). Springs and seeps are used extensively because they are abundant in some habitats and pronghorn are accustomed to using them. Such sources can also often be improved with proper development techniques. Improper development techniques, however, can also impair or remove the water source. No two springs are alike; consequently, an experienced hydrologist should be consulted before any alterations are made.

Hundreds of small reservoirs have been constructed to trap and retain precipitation. Many of these have been built on public lands through cooperative funding by state and federal management agencies for the benefit of livestock, with some participation by private landowners. Such developments often are natural in appearance and serve a variety of wildlife, contributing to the well-being and range expansion of some pronghorn herds. In Malheur County, Oregon, 1,037 small reservoirs have been developed for livestock and wildlife needs on public lands (Heady and Bartolome 1977).

Another water development used by pronghorn, especially during late summer, is the dugout or trench reservoir. Dugouts commonly are placed in areas of comparatively flat, but well-drained terrain. A natural pothole or dry lake bed may be a good location for a dugout (Good and Crawford 1978). Heavy use by livestock and other wildlife species may negatively impact forage surrounding these areas, however.

Precipitation catchments (guzzlers) on ranges lacking natural waters have been successful in providing water for pronghorn (June 1965). Such water developments serve a variety of wildlife. A surrounding fence should be constructed to protect the facility from trampling damage and competition by livestock. Any water development, including catchments, must be properly maintained if pronghorn are to benefit. Catchments that go dry for whatever reason, or fail to provide water at critical times, may do more harm than

good. If pronghorn access to water sources on rangelands occupied by cattle is a problem, see Figure 25 page 99.

Water Quality: Little information is available concerning water quality as it affects pronghorn. However, total dissolved solids and pH are probably important concerns. In the Red Desert, Sundstrom (1968) found little or no use by pronghorn of water sources that contained total dissolved solids in excess of 5,000 parts per million (ppm). Some use occurred on a water source with dissolved solids of 4,620 ppm. The maximum total dissolved solids recommended are about 4,500 ppm (McKee and Wolf 1963).

Figure 28. Water improvement project to increase drinking water for livestock may also aid wildlife. Dugouts or dirt stock tanks are commonly used by pronghorn if placed in flat, well-drained terrain. Photo by George Andrejko.

Livestock may be impaired by drinking water that contains excessive dissolved solids, and it is a good assumption that this may also apply to pronghorn. Continuous use of such water may cause general loss of condition, weakness, scouring, reduced milk production, bone degeneration, and death. However, animals can temporarily drink highly saline waters that would be harmful if used continuously. Animals also can adjust gradually to the use of waters with a higher solids concentration than that which they normally drink, although sudden change from slightly to highly mineralized water causes acute distress and diarrhea of varying severity. The limits of tolerance depend upon the particular salts present, the species of animal, its diet, age, physiological condition, season of year, climate, etc. (McKee and Wolf 1963).

The recommended pH range for most uses, such as domestic water supplies, irrigation, fish and other aquatic life, and recreational uses, appears to be from 6.5-8.5 (McKee and Wolf 1963). In Wyoming's Red Desert, when water sources exceeded a pH of 9.2, pronghorn appeared to seek other water sources (Sundstrom 1968).

Where water sources are available to pronghorn, but appear to be avoided, a complete water chemistry test should be made and measures taken to correct the problem. Where the water quality cannot be improved, and no other water source is in the vicinity, water catchments should be installed.

In addition to being designed to provide a continuous supply of water, water developments in pronghorn range should provide maximum safety for animals using them. Wilson and Hannan (1977) listed the rationale and criteria needed to assure wildlife friendly use of water developments designed to supply livestock with drinking water. To help prevent animals from being entrapped and drowned, they suggested a number of recommendations including the following considerations for pronghorn: Troughs or other water containers should not extend more than 20 inches (51 cm) above the ground so that both adult and fawn pronghorn have access to the water. Deeper troughs should be set into the ground to achieve the desired height. Barricades should be considered in some situations that would prevent the accidental entry of animals into unsafe areas and drowning. The distance from the rim of the trough to the barricade should not exceed 20 inches (51 cm). Where water depths exceed 20 in (51 cm), rocks or other material should assist animals that accidentally enter the water in obtaining a footing to find their way back to dry ground.

Food Habit Studies

For these Guides, we have defined the term "diet selection" (discussed on page 9) to denote what and how much of each plant species an ungulate consumes. The term "food habit studies" includes diet selection, plus other factors that influence diet selection (e.g. weather patterns, forage similarities and competition with other herbivores, nutritional values, etc.). Different techniques have evolved and the findings between the various methods are no always comparable (Sundstrom et al. 1973, Yoakum 1990, 2004d). To help provide consistency for comparing future food habit studies, the following recommendations by Yoakum (2004d) are:

Pronghorn food habits can be determined by direct or indirect observations using rumen contents, fecal analysis, or cafeteria trials. The various techniques are described in detail below:

Figure 29. One of the most intensive food habit studies of pronghorn was accomplished on the Pawnee Grasslands, Colorado. Diet selection was determined for pronghorn, bison, cattle and domestic sheep during all seasons of the year for pastures with different foraging intensities. Such investigations provide data on diet preference and overlap competition between ungulates. Photo by Chuck Schwartz.

Direct vs. Indirect Observations: Direct observations require observing feeding pronghorn at close range in the field and estimating the amount of each plant species consumed. Sometimes this procedure is referred to as "bite counts" or feeding-minute" studies, and has been used with varying success (Büechner 1950, Hoover 1971, Schwartz et al. 1976, Schwartz 1977). Tame, semi-tame, or constrained animals are generally used; often these animals are raised in captivity and accustomed to humans. The animals are taken to the field and allowed to forage while the biologist closely monitors the pronghorn and records what is eaten. The accuracy of direct observations of tame animals has been questioned, but Schwartz (1977) found food habit results similar for reared and wild pronghorn using the same plant community. Another good source for direct observation studies are animals in National Parks or other refuges where the animals have become accustomed to human presence and tolerate proximity for observation.

Indirect observations or "feeding site" examinations of foraging wild animals is one of the oldest methods used for pronghorn food studies. Rouse (1941) used the procedure of trailing pronghorn after a fresh snow and recording the species and/or numbers of plants consumed. Since then the method has been used by (Büechner 1950, Cole 1956, Severson 1966, Beale and Smith 1970, Campbell 1970). Basically, pronghorn are located in the field, the exact location where the animals were feeding is examined and any use of the plants is recorded. The system calls for little equipment other than a pair of binoculars (or a spotting scope) and a field notebook. This procedure can be extremely time consuming, however, and it is often difficult to determine use on certain vegetation, e.g., sagebrush.

Rumen Contents (or stomach analysis) is a method commonly used to determine food habits for pronghorn (Ferrel and Leach 1950, Mason 1952, Baker 1953b, Cole 1956, Hoover et al. 1959, Dirschl 1963, Russell 1964, Severson 1966, Bayless 1969, Tsukamoto 1969, Beale and Smith 1970, Campbell 1970, Mitchell and Smoliak 1971, Taylor 1972, Schwartz et al. 1976, Jacobs 1973).

Korschgen (1980) described the technique in detail, including preservation of materials and identification of food items. Dirschl (1962) elaborated on sieve mesh size based upon working with pronghorn samples.
Food habits can be quantified by: (1) number and species, (2) frequency of occurrence, (3) volume, or (4) weight (Cooperrider et al. 1986).

Rumen analysis can be misleading in several ways. Certain plant species, such as graminoids, digest more quickly than forbs and shrubs; therefore, if the samples have not been timely or thoroughly preserved, these plants can be difficult to identify. Rumen sample collections usually also require dead animals, which can be costly, unacceptable to the public, or prohibited in the case of endangered species. For these reasons fecal analysis has become increasingly popular during the last three decades.

Fecal Analysis is now the most common technique used to determine pronghorn food habits (Jacobs 1973, Schwartz et al. 1976, Sneva and Vavra 1978, Meeker 1979, Body 1979, Sexson 1979, Bailey and Cooperrider 1982, Howard et al. 1983, Goldsmith 1988, Cancino 1994 and Hansen et al. 2001). Although samples are easy to collect, the accuracy of the technique has been questioned (Holechek et al. 1982). The procedure is similar to rumen analyses except that fecal samples are collected rather than a rumen sample. Since fecal analyses requires a great deal of laboratory preparation and expertise, it is usually more efficient for wildlife biologists to pay for such laboratory work rather than doing it themselves. Field procedures for this method were evaluated and considered relatively cost-effective by Cooperrider et al. (1982).

Following are six major advantages of the fecal analysis method (Holechek et al. 1982): (1) it does not interfere with the normal behavior of animals, (2) it permits practically unlimited sampling, (3) it is particularly valuable for sampling animals ranging over mixed vegetative communities, (4) it is the most feasible procedure to use when studying secretive or endangered species, (5) it can be used to compare the diets of two or more ruminants at the same time, and (6) its requires little equipment.

Holechek et al. (1982) and Gill et al. (1983) concluded that inaccuracy could be the greatest limitation to the method. Regardless, the method remains the most popular today for accomplishing food habit studies and has even been accepted as admissible evidence in judicial proceedings (Cooperrider et al. 1986).

Cafeteria trials are a method used to determine the food preferences of confined pronghorn. An observer records what plants are selected by animals from a number of equally accessible plants made available in approximately equal quantities. These plant

species can then be analyzed for comparative nutritional values. The method was used by Smith et al. (1965) to study pronghorn preferences for different species of shrubs in Utah. Another study (Smith 1974) related artificial diets with different protein levels to pronghorn production and survival. Jacobs (1973) used cafeteria trials to test the validity of different food habit gathering techniques in Wyoming.

Fawn Mortality: Pronghorn are the only artiodactyls known that conceive two or three times as many embryos as are born (Mitchell 1965, O'Gara 1969). Embryonic mortality and a long gestation period probably are recent adaptations to produce fewer and more precocious fawns. Under favorable conditions, pronghorn populations can increase rapidly, even when fawn mortality is relatively high (Pyrah 1987). Vriend and Barret (1978) reviewed literature and concluded that low pronghorn fawn survival was a primary management concern throughout most of North America. Fawn losses ranging from 25 to 65% of the annual production occur regularly, often in the first 2-3 months of life. Low fawn recruitment has been considered the most important factor limiting pronghorn population numbers in the Southwest (Brown et al. 2000).

Figure 30. A recent study in Oregon of predation on neonates documented an average loss of around 50% for 10 years. Although mortality appeared high, the herd increased more than 80% during the decade long study. The availability of abundant quality and quantity forage appeared to influence population trends more than predation. Photo by Jim D. Yoakum.

In areas where predator control is deemed beneficial for fawn survival, predator removal is most effective just prior to fawning, but the control method must be done repeatedly to be cost-efficient (Smith et al. 1986). Hailey (1979), in an area of Texas, and Willis (1988), in an area of Oregon, reported significant increases in fawn survival where coyotes were intensively controlled. Connolly (1978) lists numerous cases of predator control increasing fawn survival. Menzel (1994) reported that two years of coyote control increased fawn survival, but that subsequent surveys revealed no increases in populations.

A report, in the 2004 Proceedings of the Pronghorn Workshop, provided findings for 35 predator/fawn mortality studies during the last 60 years (Yoakum et al. in prep). A conclusion from these studies was that predator control practices often resulted in increased fawn recruitment, but predator control rarely resulted in increased herd numbers.

The availability of quality forage for pronghorn is a primary factor in fawn survival according to Ellis (1970). He compared population dynamics and habitat characteristics for herds in the Great Basin with those on the Great Plains for the last two months of gestation and the first two months of lactation. Ellis concluded that fawn survival was twice as high on the Great Plains because of the availability of more nutritious forbs during late gestation and early lactation. Thus, the lower availability of preferred, succulent, nutritious desert forage, exacerbated by its consumption by livestock, resulted in Great Basin rangelands having a lower carrying capacity for pronghorn (Hervert et al. 2000).

More than 200 food habit studies have been conducted during the past 50 years. However, different techniques were involved and the findings between the various methods often are not comparable (Sundstrom et al. 1973, Yoakum 1990). To provide consistency for comparisons in future studies, the following guides are suggested (Yoakum 2004d).

Determining Food Habits: Various methods can be used to determine pronghorn diets, including direct or indirect observations, collecting rumen samples, fecal analysis, cafeteria trials, and rumen fistulas. Of these, fecal analysis has been used almost exclusively as the method of choice during the past 20 years. When using fecal analysis, individual sample size should be at least 0.5 lbs (227g), air dried, in order to have sufficient material for forage identification, nutrient analysis, rechecks of earlier results, or samples for additional studies determined later in a project. Simple food habit studies, in which the only purpose is to identify the species of plants consumed can consist of as few as 25 pellets from five pellet groups (T. McKinney, pers. comm..)

If fecal samples are collected, the individual animal producing the pellets should be identified if possible. Random collections of fecal samples in the field without observing the animal responsible can result in misidentification and misjudgment of season (pellets dry quickly in arid ecosystems). Collection sites should be representative of major areas where animals forage, and include location data on crucial habitats such as wintering grounds, fawning areas, seasonal movement corridors, etc.

Depending on study design, pellet collections should be made monthly throughout the year. A good food habit study should include 3-5 years of data. Findings are of greatest value when taken over a period of years because, as precipitation patterns change, animal foraging habits respond to differences in forage availability.

It may also be desirable to collect samples from other ungulates using the same sites by season. This allows the computation of dietary overlap and species preferences for various forage classes.

Plant Collections and Forage Composition: Plant collections are needed for identifying forage in food habit studies and nutrition analysis. Plant collections should be from the same sites where pellet samples were obtained. Plant samples should include all forage classes (grasses, forbs, shrubs) by season. Although placing some plants in a particular forage class may be artificial, each sample should be assigned a category and an explanation as to what species each category contains. Lichens, mosses, cacti, and half-shrubs often have been placed in the forbs category. Plant samples need to be preserved and stored as herbarium collections. Forage preference by category can be determined by taking line transects (Gysel and Lyon 1980) or using the step-point method (Evans and Love 1957) of sampling vegetation composition in the sample areas. The step-point method is quick and allows for many transect readings in a relatively short period of time.

Ecological Factors: Recording ecological data at the time that pellet and plant collections are made is important. This information is needed when analyzing or relating findings. Examples of such information are: precipitation quantities by kinds (rain, snow) for all seasons of the year (relate to years of normal and above or below normal precipitation); the behaviors of pronghorn and other ungulates at the time of collections, especially foraging characteristics and note the phenology of the vegetation, especially those species producing seed. It is also especially important to record the implementation dates of any grazing systems involved; record other ungulate use or non-use of the site to evaluate dietary overlap; and note ungulate intensities and the effects on the vegetation. Those forage species which have been lightly, moderately, or heavily used should be noted.

Laboratory Analysis: Laboratory facilities and trained personnel are often lacking when food habit studies are attempted. Thus, sending fecal and plant samples to a specialty laboratory for analysis may be cost effective. Also, specialized laboratories often are more efficient in fecal analyses than a well- meaning technician or graduate student with a part-time commitment.

Some food habit studies (Meeker 1979, McInnes 1984) may not have portrayed a true picture because no correction factors were used to compensate for differences in digestibility of various forage plants. The problem of differential digestibility of various plants has plagued laboratory personnel conducting rumen and fecal analysis for years. However, recent studies have developed correction factors that are especially important for forbs and shrubs, the two most common forage classes in pronghorn diets (Yoakum 2004d).

Data Compilation and Evaluation: All diet collections should be compiled by plant species, and then totaled into species and forage classes by period of use. If analysis is by percent volume, list all plants, even those found in trace quantities (less

than 1%), as this information may be needed for evaluating use of trace nutrient elements or noxious plants.

When field collections include quantitative data for diet selection and forage availability by season, computing dietary overlap for different ungulates is possible. Including ecological condition data is therefore important because the analysis may show species overlap. However, if other herbivores are not using the site during the particular season, it is important to note the lack of overlap competition.

Laboratory Locations: Currently, there are a number of laboratories and /or research institutions equipped and staffed with trained personnel to contract microscopic fecal analysis for western rangelands. These include the Department of Range Science, Colorado State University, Fort Collins, CO; Department of Range and Wildlife, Texas Tech University, Lubbock, TX; Animal and Range Sciences, New Mexico State University, Las Cruces, NM; and Department of Natural Resource Sciences, Washington State University, Pullman, WA. Other laboratories are available in Canada and Mexico. Local universities should be contacted to determine whether a local laboratory is operational.

Fire Management

Most grasslands have evolved under the influence of natural and human ignited fires, and indeed, fire is essential to their long-term welfare. Many grassland plant species are so fire- adapted, that they depend upon burning for maintenance. Fires stimulate plant succession; reduce the incidences of woody plants, provide ash and nutrients to the soil, and increase herbaceous vegetation. Fires can be beneficial or detrimental to pronghorn habitat, depending on how they influence vegetation in specific sites at specific times.

The California Department of Fish and Game (1997) assessed the pros and cons of the effects of fire on pronghorn habitats. Wildfires were recognized as the principal factor changing shrublands to grasslands favorable to pronghorn. Nonetheless, extensive and repetitive burns can, at times, decrease preferred shrubs for winter browsing and when grazed by livestock, increase the invasion of noxious and alien plants.

Wildfires: Lightning ignited fires are, or were, of frequent occurrence on western rangelands. Most such fires occur naturally during the spring dry season, and if sufficient fuel in the form of residual grasses is available, were historically common in the grassland and shrub-steppe biomes and rare in the deserts. Courtney (1989) observed pronghorn grazing new grass and forb growth soon after fires burned grasslands in Alberta. Stelfox and Vriend (1977) reported pronghorn moved into burns within a month after prairie fires. At such times, pronghorn readily consumed large quantities of burned prickly pear cactus (*Opuntia* spp.).

Deming (1963) observed that pronghorn readily foraged burned shrub-steppes in Oregon. He attributed this to the grazing of new succulent forage growth that remained greener into the autumn compared with unburned sites. Similar use was confirmed by Van Dyke (1990) and numerous other biologists who speculated that wildfires enhance pronghorn habitat.

A valley occupied historically by pronghorn in California, but devoid of herds for more than 75 years, experienced a pioneering herd moving into the valley and remaining permanently after a wildfire of more than 30,000 acres (12,000 ha). Apparently the lightning-caused fire, followed with rangeland seeding, changed habitat conditions from poor to good quality, allowing pronghorn to become successfully established (Yoakum 2004e.).

Prescribed Fires: Prescribed fires can, and should be, used to simulate the role of wild fires for changing and invigorating grassland vegetation. Fire management is especially appropriate for tall grasslands and grasslands dominated by shrubs and small trees.

The Hart Mountain National Antelope Refuge in Oregon suppressed fires prior to 1990. Now, prescribed fires are the primary vegetation management practice (Pyle and Yoakum 1994, Gruell 1995). Field studies revealed that more than 90% of the shrublands were in late succession, with little herbaceous undercover. The landscape objective was to sustain a mosaic of vegetation in different serial stages and to increase the abundance of forbs and grasses. Providing diversity is essential for ecosystem health and resiliency. Diverse vegetative communities generally support more vigorous wildlife populations, including pronghorn. Present objectives of the Refuge include maintaining 20-30% of shrubs in early and mid- succession; consequently, a prescribed fire program was implemented in 1994. Prescribed fires have been used since to produce a mixed pattern of burned and unburned patches in roughly equal proportion. There have been no major problems with the invasion of alien plants primarily due to their scarcity prior to burning, and perhaps to the lack of livestock grazing. Burning has been practiced only on spring/summer pronghorn habitats where there is a need to increase herbaceous forage. No treatments have been performed on winter rangelands where shrubs are key forage for pronghorn.

Tall grasslands are historic and extant landscapes for pronghorn (Eccles et al. 1994). These prairies grow grasses 9 feet (2.7 m) high; however, they can be changed to suitable habitat for pronghorn when the vegetation structure is lowered through burning and/or grazing by large herbivores (bison historically, now cattle). This vegetation manipulation changes tall, old growth herbaceous vegetation to low growing forage meeting pronghorn habitat requirements. When fires are started the vegetation is low to medium height, the weather cool: much of the burning is done at night when temperatures are lowest and humidity highest. Also, fires are timed to take advantage of slightly damp vegetation; therefore, fire intensity generally is not high or catastrophic. Simpson (1992) reported pronghorn did not flee from the fires, but wandered in and around, seeking unburned sites for forage.

Figure 31. Prescribed fires can be used to simulate the role of disturbance for changing vegetation, especially in tall grasslands and shrubsteppes. Prescribed fire is being used to reduce brush encroachment in a shrubsteppe in northeastern Utah. Photo courtesy of Desert Land and Livestock Ranch, Utah.

Fire is also essential to maintain semi-desert grasslands as pronghorn habitat. Without fire, or with fire suppression, these grasslands are converted to shrub-lands, brush-lands or dense savannas, thus reducing or eliminating pronghorn populations. As with fires in shrub-steppe, reduced grazing is often necessary to provide sufficient fuel for a burn, which should be done in May or June to emulate natural conditions (Brown 1994). Failure to instigate proper grazing and fire regimes is today the biggest threat to semidesert grassland populations of pronghorn.

Recommended practices for prescribed fires are provided by Yoakum et al. (1980), Vallentine (1989), Payne and Bryant (1994), Riggs et al. (1996), and Yoakum (2004) provide a thorough discussion of objectives, current techniques, and results of prescribed fires to enhance ecosystems for wildlife, including pronghorn.