Chapter 4

Elk (Cervus elaphus)

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I. INTRODUCTION –

Consult "North American Elk: ecology and management" (Toweill and Thomas 2002) for comprehensive details about elk life history and management. Elk are distributed throughout forested habitats in Wyoming. Several herds also inhabit desert environments. The Wyoming Game and Fish Department manages 35 distinct herds encompassing more than 125 hunt areas. Management and research techniques commonly used in Wyoming are described in this chapter. Appropriate timeframes for surveys and management activities are outlined in Table 1.

Table 1. Schedule of elk surveys and management activities.

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
Age Composition of Harvest				XXXX	XXXX	XXXX	XXXX	XXXX				
Distribution Surveys (aerial)	XXXX	XXXX	XXXX				XXXX	XXXX	XXXX	XX		
Aging (tooth cross-sectioning)						X	XXXX	XXXX	XXXX	XX		
Calf Trapping	XX											XX
Harvest Field Checks				XXXX	XXXX	XXXX	XXXX	XXXX				
Harvest Questionnaire					XX	XXXX	XXXX	XXXX				
Herd Trapping							XXXX	XXXX	XXXX			
JCR's	XXXX									XX	XXXX	XXXX
Trend Counts		XXXX	XXXX				XXXX	XXXX	XXXX	XX		
Mortality Monitoring	xxxx	xxxx	xxxx	Xxxx	xxxx	xxxx	XXXX	XXXX	XXXX	XXXX	XXXX	Xxxx
Post-Season Classifications							XXXX	XXXX	XXXX			
Season Setting								X	XXXX	XXXX	XXX	
Pre-Season Classifications		XXXX	XXXX									

II. CENSUS –

Elk are normally counted when they congregate on winter ranges each year. Generally, elk winter in the same traditional areas, though a variety of sites including steep-walled canyons, ridges with scattered timber, open benches, meadows and feedgrounds are used as winter range. Each circumstance presents differing challenges that may require survey adaptations to obtain accurate trend counts. Counts can be done from the ground or air.

Personnel must have a thorough knowledge of the areas in which elk winter to assure coverage is complete as possible.

A. Trend Counts – Trend counts enable managers to detect populations changes over time. A trend count is typically treated as a minimum estimate under a given set of conditions. It is not a total population count. The efficiency of trend counts can vary. Therefore, it is important to conduct them under comparable conditions and during the same season each year. In particular, changing snow conditions can result in wide discrepancies. Unique properties of the herd should also be considered when trends are constructed from count data. For example, comparisons should be based on cow/calf counts if the distribution of large bulls is more variable year-to-year than the distribution of the rest of the herd. Though trend counts are not population estimates, they are useful for documenting population fluctuations and for refining population models.

1. Ground –

a. Rationale – Elk can be counted accurately from the ground when they congregate in locations where when they can be viewed clearly.

b. Application – During harsh weather, elk may remain in cover until wind or other conditions moderate. Generally, older bulls isolate themselves singularly or in small groups away from the rest of the herd, but often in the same locations year after year. When deeper snow accumulates, bulls typically winter in very secluded locations within heavy timber. In most cases, these areas are not visible from the ground.

Counts should be conducted after herds assemble on winter ranges, typically between 1 December and 15 March. The best background for locating and counting elk is complete snow cover. In many situations, elk move away from cover in late evening to feed. The observer can position himself at first light to count elk before they return to cover. In other situations, depending on light conditions and elk movements, counting can be more effective during the afternoon. Binoculars and a spotting scope are essential to count accurately. Dense groups exceeding 500 elk are difficult to completely classify from the ground due to a "stacking" effect as elk in the foreground shield elk behind them. Viewing elk from an elevated vantage can help in these situations. A hand-clicker can be useful to keep track of the count. The observer may recount the group several times until he is satisfied the highest count has been made. If several areas are surveyed, counts should be completed over the shortest possible interval and on the same day to minimize potential for double counting.

In Western Wyoming, elk are counted on feedgrounds attended by the majority of elk in each herd. Counts are usually made from a hay sled or feed truck. However, some feedgrounds are counted by methods similar to ground counts because elk avoid feedgrounds when humans are present.

c. Analysis of Data – Annual counts are compiled and compared to identify trends. However, the extent to which substantially differing weather may affect completeness of counts should be considered in these analyses.

d. Disposition of Data – Record counts on Wildlife Observation Forms (Appendix I). Data including hunt area, general location, number counted, date, time, weather, and observer should be forwarded to the appropriate biologist and entered in the Job Completion Report (JCR) database as soon as practical.

2. Aerial –

a. Rationale – Elk can be counted from aircraft when topography, snow conditions or time constraints make ground counts impractical. However, weather can affect aerial surveys and planes are occasionally grounded due to high winds or poor visibility.

b. Application – Aerial counts are most effective when elk are away from cover and easily seen. The following types of fixed-wing aircraft are suitable: Interstate Tern, Piper Supercub, or Cessna 180 or 185. All are high-wing aircraft and can fly safely at 80 to 100 mph in mountainous terrain. In addition, the following helicopters are suitable: piston-fired Hiller for low elevations, and the Hughes 500 or Jet Ranger for higher elevations. Helicopters are especially useful to count groups exceeding 1,000 individuals. They are particularly suited for circumstances when greater maneuverability is needed because of topography, cover and elk distribution. The paramount concern is always observer safety. The data are not as important as your life! Optimal conditions for aerial counts include:

- Elk concentrated on winter ranges, usually by deep snow at higher elevations.
- Fresh snowfall present to assure good background contrast.
- Clear skies.
- Little or no air turbulence.

To ensure all elk are located, fly parallel transects approximately 0.5-1.0 mile apart (depending on topography) throughout each wintering area. Altitude above ground level will depend on the type of aircraft, method of surveying, topography, visibility, and wind conditions. Use a hand-held GPS unit to record exact locations of elk or the pilot can enter them into the aircraft's GPS unit (if equipped) and they can be downloaded later.

Counting options include real-time counts and photographic interpretations from still images or video streams. Photographic interpretations enable observers to complete very accurate counts after the flight. However, herds of up to several hundred elk can be counted accurately without the aid of photographic methods. Elk often string out as they move toward cover. This behavior enables observers to count them easily from an aircraft. If the observer believes a real-time count

would not be accurate, he should photograph the elk. When elk are scattered, they can be herded together by making a few passes with the aircraft at a moderate altitude. Plan passes so elk do not reach cover before they can be photographed. Have the pilot orient the aircraft with the sun opposite the direction photographs are taken, and fly at a high enough angle such that elk are not "stacked" (i.e., hidden behind one another). If herds are too large to cover in one photo, a series can be taken provided identifiable landmarks are present. However it is better to film each bunch on a single frame to avoid the possibility of duplicate counting.

Discernable images of elk herds can be taken using a 35mm camera and color slide film with an ASA of 64 to 200. The camera should be equipped with a 70- to 250-mm variable lens so the observer can adjust the magnification to record the maximum image size that fills the frame. Slides are projected onto white paper and elk are counted by marking individuals with a "dot" or an "x." Digital imagery has several advantages compared to traditional film, including more analysis, handling, and storage options. Digital images also provide far superior zooming and resolution capabilities. Images can be permanently stored on a computer and easily retrieved. Any digital still camera having a resolution of at least 3 Megapixels will work well.

Digital video is useful to record groups exceeding 700 elk, and provides greater flexibility than regular VHS, Hi-8, or still imaging. Digital video also provides superior color, contrast and clarity than VHS or Hi-8. Groups of 1,500 and more elk in snow-covered, grassy, open terrain can be counted accurately using digital video recorded from a fixed-wing aircraft. However, the hovering capabilities of a helicopter greatly increase the observer's ability to video all elk in a group. Specific recommendations include:

- When photographing elk, fly in flat light. Suitable photos can be taken 1 hour after sunrise, 1 hour before sunset, or on overcast days. Bright sun creates distinct shadows that appear as additional elk and can hide other elk.
- Adjust shutter speed to record at 1/2000th of a second or faster. This produces a sharper image. Set camera functions on manual and maintain focus on infinity, otherwise the camera will tend to automatically focus on the aircraft window. Record video with both eyes open to track elk not seen in the viewfinder.
- When approaching a group, video an overview before the elk mass together. After elk begin moving, wait until they string out. Then zoom in and fill the frame as much as possible. Begin at one end and either fly down the line of elk or allow them to pass by. Avoid panning the camera back and forth. Take sequential shots in one direction to avoid duplication.
- Avoid flying so low the elk appear "stacked" against one another.
- Number each group in sequence and use a hand clicker to keep track of the number assigned to successive groups. As you video each group, hold the camera microphone close to your mouth and state the location and group

number. The observer may need to video the same group several times. Identify repeat images on the audiotape.

- Bring a TV set to the airport and review the tape immediately after each flight to determine if the count was effective or if another flight is needed. About 15 minutes are required to review 1 minute of video frame-by-frame.

c. Analysis of Data – Data from aerial classifications are analyzed in essentially the same manner as data collected by ground counts (refer to Section II.A.1.c). However, differing biases are associated with each method. Accordingly, aerial and ground counts cannot be used interchangeably to evaluate population trends.

d. Disposition of Data – Record counts on Wildlife Observation Forms. Data including type of aircraft, hunt area, general locations, number counted, date, time, weather conditions and observer should be promptly forwarded to the responsible biologist and entered in the JCR database.

3. Classifications –

a. Rationale – Elk are classified to assess reproduction, calf survival and herd composition. These data are incorporated into population models (POP-II) used to estimate population size. Elk are difficult to locate and classify prior to the hunting season. It is also generally infeasible to obtain an adequate sample of mature bulls on summer ranges. Post-season classifications are much more effective. However, mature bulls are underrepresented because they tend to winter away from cow/calf groups.

b. Application – Post-season classifications are generally conducted between December and mid-March, during periods of complete snow cover, when elk are concentrated on winter ranges ad visible. Classifications should be completed in as short a timeframe as possible to avoid duplication. Good light conditions are essential. Conduct classifications during the morning and late afternoon as elk feed in open terrain.

When classifying from the ground, the observer should station himself on vantage points that enable him to clearly see elk moving into open areas. Binoculars and spotting scopes are essential. Record tallies of cows, calves, yearling bulls, and adult bulls. A hand-held clicker with at least 4 independent number fields is very useful to keep track of the tallies.

Elk are classified on feedgrounds as they are counted each winter. Several observers tally bulls (adult and yearling), calves and total elk. Results are averaged to obtain an approximate estimate of each category. The number of cows is determined by subtracting the numbers of bulls and calves from the total. Classification ratios are approximate because some elk are missed or incorrectly classified. The composition of elk on a feedground may not accurately represent the composition of the herd because bulls and calves are more likely to avoid

feedgrounds than are cows. Elk wintering on native ranges should also be classified and the data combined with feedground classifications to determine the herd composition. Counts must be done concurrently on feedgrounds and native winter ranges to avoid duplication as elk move on and off feedgrounds.

Elk can also be classified effectively from a helicopter (suitable helicopters are described in Section II.A. – Trend Counts). Fly at low elevation (150-200 feet AGL) along side each group of elk as they string out, for best visibility to accurate classifications. A tape recorder is useful, especially when flying. However, transcribing data from tapes is tedious, and malfunctions often are not detected until the flight is over.

Regardless whether classifications are done on the ground or from an aircraft, the survey must cover major winter ranges thoroughly. Attempt to classify entire groups, especially when an aircraft is used. As elk escape toward cover, calves and bulls often bunch up at the rear so partial classifications can be biased.

c. Analysis of Data – Refer to Chapter 1, Section II.A.1.c. (Pronghorn – Aerial Classifications).

d. Disposition of Data – Data recorded during classifications include hunt area, date, time, observer, geographic location, number of cows, calves, spikes and bulls, and weather conditions. The information should be forwarded to the biologist responsible for the particular herd, and entered in the JCR database as soon as practical.

III. HARVEST DATA –

Elk harvest data are derived from 3 sources: (A) the Big Game Harvest Survey; (B) check stations; and (C) hunter field checks.

A. Harvest Survey –

1. Rationale – Managers rely on harvest estimates to determine license quotas needed to attain harvest objectives. Harvest information is incorporated into population models and can also be of some use (e.g., success, effort data) for tracking population trends among years.

2. Application – Harvest data are acquired through an annual survey mailed to a stratified sample of licenses holders. Statistics estimated from the harvest survey include total harvest, age (adult/calf) and sex composition of the harvest, hunter success, effort (avg. days expended per animal harvested), and total days of recreation. These parameters are estimated and summarized for each license type, hunt area, herd unit and statewide. A detailed summary of the Big Game Harvest Survey is provided in Appendix III.

3. Analysis of Data – Harvest data are evaluated each year during the Department's annual season setting process, and in JCRs compiled by each region. Changes in hunter statistics (effort, success) are reviewed to detect and confirm population trends.

4. Disposition of Data – Statewide harvest results are compiled in the Annual Report of Big Game Harvest published by the Wyoming Game and Fish Department. More detailed summaries of harvest data from each hunt are and herd unit are provided in the regional Job Completion Reports. Herd unit files and databases housed at the headquarters office in Cheyenne are repositories for current and historic information.

B. Check Stations –

1. Rationale – Check stations have traditionally been used to obtain some types of harvest information and to enforce conservation laws such as licensing and tagging requirements. The Department has operated check stations on both a permanent and temporary basis for many decades. Data obtained at check stations can include sex and age of harvested animals, location of kill, date of harvest and number of days spent in the field. However, data reported by a hunter may not represent his activities for the entire hunting season. Check station data can be summarized in daily, weekly or monthly increments and compared with data from prior years to assess ongoing harvest trends in a specific hunt area. Another use of check station data is to detect or verify reporting biases in the harvest survey (e.g., calves reported as adults, cows or calves reported as bulls).

2. Application – Strategically placed check stations, staffed full time or randomly, are a useful means to contact hunters, determine success rates and estimate sex and age composition of the harvest (Mohler and Toweill, 1982). Check stations also provide an opportunity to obtain specific information from hunters and to collect biological samples and other materials from game. For example, blood and tissue samples, teeth, jaws, ear-tags and neckbands can be collected.

3. Analysis of Data – Refer to Chapter 1, Sections III.A.3. and III.B.1.c. (Pronghorn – Harvest Survey, Tooth Replacement).

4. Disposition of Data – Harvest data are recorded on standard check station cards and ledgers. The Coordinator or Biologist in charge of a check station is responsible for assuring check station attendants accurately record data. All records must be summarized on the Check Station Report Forms soon as possible after the station is closed. The report should be distributed to appropriate field personnel and the Supervisor of Biological Services. At temporary check stations, harvest data are recorded on Wildlife Observation Forms or harvest data sheets. Afterward, the data are submitted to the biologist responsible for the particular herd, and are entered in the JCR database as soon as practical.

C. Hunter Field Checks –

1. Rationale – In many locations, field checks are the only practical means to contact a large sample of hunters. The types of data recorded are similar to those obtained at check stations. However, field checks are not a random sampling process, so data tend to be biased. The resulting information is often difficult to interpret because it is incomplete and the type, degree and direction of inherent biases are usually unknown and vary among sub-samples (Mohler and Toweill 1982). Despite these problems, hunter field checks are widely used not only for enforcement purposes, but to assess big game harvests.

2. Application – Hunter field checks are most useful in areas lacking well-traveled ingress/egress routes on which a check station might be operated effectively. As harvested animals are encountered in the field, record the animal's sex and age and the hunt area in which it was taken, on standard forms.

3. Analysis of Data – Refer to Chapter 1, Sections III.A.3. and III.B.1.c. (Pronghorn – Harvest Survey, Tooth Replacement).

4. Disposition of Data – Data from hunter field checks should be forwarded to the appropriate district biologist at the end of the hunting season. The data from each hunt area and herd unit are summarized in the Job Completion Report.

IV. AGE DETERMINATION –

Elk are long-lived and some females can live up to 20 years or more. On the other hand, few bulls live past 10 years. Knowledge about age structure of the population (particularly the female segment) and age-specific exploitation rates can often be derived from the age structure of harvested elk. Age structure data are important to anticipate near-term trends and to model populations. In Wyoming, elk are born primarily from late May to late June. When the majority of elk are harvested in September and October, they are about 4 months older than the birth date. However, by convention elk are aged in half-year intervals: [i.e., 0.5 (calves), 1.5, 2.5, 3.5, etc.]. The pattern of elk dentition is common to all Cervids, except upper canines are present. Age classification data are most useful when samples are representative of the herd age structure or at least the female age structure.

Field Aging, Tooth Eruption and Wear – Elk more than 2.5 years old can rarely be aged accurately based on tooth eruption and wear patterns. Teeth of bulls generally wear more rapidly than those of cows. The following table indicates approximate ages of elk based on tooth eruption and wear.

Chapter 4 ELK AGE DETERMINATION*										
AGE	INCISORS			CANINE	PREMOLARS			MOLARS		
	1	2	3	1	2	3	4	1	2	3
CALF	D	D	D	D	D	D	D	P		
1½ YEARS	P	D	D	D	D	D	D	P	P	
2½ YEARS	P	P	P	P	P[a]	P	P	P	P	(P)[b]
3½ YEARS	P	P	P	P	P[c]	P	P	P	P	P[d]
4½-7½ YEARS	P	P	P	P	P[c]	P	P	P	P	P[e]
8½+ YEARS	all teeth P, no infundibula on M1									

[a] straw colored no wear
[b] 3rd cusp not up
[c] stained purple-black
[d] 3rd cusp up no wear
[e] 3rd cusp shows wear, buccal crest even or below lingual crest
* D = deciduous, P = permanent

Laboratory Aging (Cementum Annuli) – The most accurate method to age elk is based on analysis of cementum annular rings. However, the technique can be expensive and time consuming. It is appropriate when detailed age composition data are needed, for example, to determine the age structure of a population or the oldest age class for modeling purposes. The central 2 incisors are used for this purpose because they are the first permanent teeth to erupt and are the most easily removed. Tooth samples obtained from harvested adult female elk are assumed to provide an unbiased age representation of the adult female segment. However, tooth samples collected from males are biased toward older age classes because of hunter selectivity. Adequate tooth samples from either sex can be used to establish the oldest age classes in the population. For a detailed description of this technique, refer to Appendix V.

Upper Canine Tooth – Deciduous upper canine teeth appear in elk calves a month after birth and are retained about a year. They are replaced when crowns of permanent canines erupt in June or July. Nearly a year is required for approximately half the crown to become exposed. Root extremities develop last and the tooth is completely formed between the second and third years. Wear becomes noticeable within a year after the permanent canine erupts through the gums, and continues throughout the life of the animal. The complete crown is exposed by age 7 in nearly all elk. The tooth has often worn to the root component in animals over 15 years. The formation, development and wear of canine teeth advance somewhat more rapidly in females than in males of the same age (Greer and Yeager, 1967).

A. Rationale – The age structure of the harvest can provide insights about hunter selectivity and availability of specific age classes for harvest. Age data are also used to align the harvest age structure simulated in population models. In addition, age structure data can be used to evaluate the effectiveness of various harvest strategies and to estimate age

structure and age-specific natural mortality rates, particularly in the female segment of the population.

B. Application – Large numbers of animals can be examined at check stations, locker plants, and during hunter field checks to determine ages based on tooth eruption and wear patterns. If more refined age information is needed, tooth samples can be collected during these hunter contacts. Tooth envelopes or boxes with instructions can also be mailed to hunters prior to the hunting season when a larger sample is needed. The middle incisors are easily loosened by cutting the gum on either side, and around the base of the teeth. The 2 teeth can then be pried forward and removed.

C. Analysis of Data – Before requesting tooth samples for laboratory analysis, the biologist should be confident an adequate sample will be available to make reasonable inferences about the harvest age structure. Otherwise, tooth samples should not be collected. Typically, teeth should be obtained from about 25% of the harvest. In areas with smaller harvest quotas of under 100 animals, tooth samples should be obtained from larger proportions of the harvest, up to 100%. Age data should be tallied according to age classes discernable by the particular methodology (tooth eruption and wear or tooth cross-sectioning). The harvest age structure may be used to estimate the population age structure, reproductive success, and/or age-specific harvest rates. The data may also provide insights about current and future population trends.

D. Disposition of Data – Refer to Chapter 1, Section III.B.1.d. (Pronghorn – tooth replacement).

V. MORTALITY – Principal sources of elk mortality include hunting, predation, diseases, parasites, malnutrition, exposure, harassment and accidents (Tabor et al. 1982). Little is known about the comparative importance of these factors, and they undoubtedly vary from location to location. Certain analytical means, modeling for example, are available to indirectly estimate mortality. Although it is seldom practical to estimate mortality by direct methods, mortality records can provide useful management information.

A. Incidental Observations –

1. Rationale – If they are diligently recorded, elk mortalities detected through incidental observations can help managers identify problem areas or significant mortality events such as disease outbreaks and poisonings.

2. Application – The biologist should establish a record of each dead elk encountered by completing a Wildlife Observation Form. The following information should be entered: date of observation, location, sex, age and cause of death. If the cause of death is unknown or associated with unusual circumstances, and the carcass has not seriously decomposed, a necropsy should be done. Either tissue samples or the entire carcass should be delivered to the veterinary laboratory in Laramie for this purpose. Procedures for collecting and shipping tissue samples are described in Adrian (1992).

3. Analysis of Data – Refer to Chapter 1, Section IV.A.3. (Pronghorn – Mortality Estimation).

4. Disposition of Data – Forward completed wildlife observation forms to the appropriate, regional wildlife management coordinator at the end of each month. All non-hunting mortalities and necropsy results should be discussed in the Job Completion Report for the applicable herd unit.

B. Winter Mortality Transects – It is seldom practical to establish winter mortality transects in typical elk habitat. Refer to Chapter 1, Section IV.B. (Pronghorn – Mortality Transects) for a detailed description of the procedure.

VI. DISTRIBUTION AND MOVEMENT –

A. Direct Observation –

1. Rationale – The distribution, movements and seasonal habitats of elk have been generally described and mapped in Wyoming. However, specific knowledge about some crucial winter ranges, migration routes and parturition habitats remains incomplete. As energy development and other activities continue to expand throughout Wyoming, more specific distribution data are increasingly needed to support land use decisions.

2. Application – Whenever elk are observed outside currently documented ranges, the location and activity of animals should be recorded on a Wildlife Observation Form. Distribution information should be collected within existing herd units when needed to better define seasonal ranges and migratory movements. The district biologist should identify the season(s) for which additional distribution data would be beneficial.

3. Analysis of Data – Guidelines for mapping wildlife distribution are provided in Appendix VI. Also refer to Chapter 1, Section V.B.3. (Pronghorn – Distribution and Movement, Aerial Surveys).

4. Distribution of Data – Forward Wildlife Observation Forms with distribution data to the appropriate, Regional Wildlife Management Coordinator at the end of each month. The information is entered into the Wildlife Observation System database. Distribution records provide documentation for updating seasonal range maps, and they are also accessed and compiled for other purposes such as commenting on proposed projects.

VII. CAPTURE, MARKING, AND TRANSPLANTING –

A. TRAPPING –

1. Corral Traps –

a. Rationale – Corral traps have been used successfully for many years to capture elk in Wyoming. Both permanent and temporary trap setups are employed. Although the initial cost of a permanent trap is greater, long-term costs may be lowered by reduced annual setup time and maintenance. Conversely, temporary corral traps are cheaper to build, but may cost more to transport, set up, and maintain each year. Permanent traps should be considered for long-term trapping programs in winter concentration areas, such as feedgrounds or Department Wildlife Habitat Management Areas. Portable traps may be more suitable for short-term operations or when elk are sampled from several different herd segments. Either trap is very effective for capturing and processing large numbers of elk, at relatively low cost. Three experienced personnel can operate a portable trap efficiently, but 4-7 may be needed to run a permanent corral trap, depending on its size.

b. Application – Permanent corral traps designed for elk are illustrated in Taber and Cowen (1969), Straley (1970), and Mace (1971). Plans for portable corral traps constructed of pipe frame panels and nylon impregnated canvas are available from the Jackson/Pinedale Region.

Corral traps should be erected in areas where elk normally concentrate in winter. The handling chute should be positioned to provide an unobstructed escape route when animals are released. Sites for permanent and portable corral traps should be as level as possible, but must drain to prevent ice buildup in corrals and chutes.

Various baits, including alfalfa hay, grass hay, apple pulp, or salt are used to lure animals into these traps. However, baits such as alfalfa or apple pulp attract deer and can disrupt the elk trapping operation. If deer are present, use native grass hay to attract elk.

Check corral traps just after sunrise each day. Elk can be held several hours following capture. However, animals should be moved into chutes, marked, and either released or loaded onto transport vehicles as soon as practical to reduce stress and injuries. Animals caught in large, permanent traps should be moved into the smaller holding pen to minimize chances for injury. Elk left unattended in a large corral can become exhausted from continuous running, or can be seriously injured if they attempt to jump out.

Corral traps are generally used to capture elk during winter. Portable traps baited with salt or water can be deployed on other seasonal ranges.

c. Analysis of Data – Refer to Section VII.B.1.c. (Marking).

d. Disposition of Data – Refer to Section VII.B.1.d. (Marking).

2. Clover Traps –

a. Rationale – Clover traps are suitable for capturing small numbers of elk during short duration trapping operations, especially when a mobile trap design is required. Generally, elk are caught one at a time a large sample is difficult to obtain. However, Clover traps are much easier than portable corral traps to transport and utilize in remote sites. Clover traps can often be moved into desired locations during winter when vehicular access is limited.

b. Application – Designs of Clover traps are illustrated in Clover (1956). Traps are set up in areas of fresh elk sign and baited with alfalfa hay or apple pulp. Always place Clover traps on level ground that is adequately drained to prevent ice build-up under the trap. Captured, elk are handled in several ways including: 1) chemically immobilize the animal; 2) cover the trap with canvas to restrict elk movements; or 3) collapse the trap to restrain the animal. Check traps each morning to prevent elk from being injured by fighting the netting. Crews of 2 persons are required to check traps and process captured animals.

c. Analysis of Data – Refer to Section VII.B.1.c. (Marking).

d. Disposition of Data – Refer to Section VII.B.1.d. (Marking).

3. Netguns –

a. Rationale – Trained professionals using netguns can capture elk very efficiently from helicopters. Several companies now specialize in this technique. Depending on terrain and elk densities, an experienced crew can capture, mark, and release up to 30-50 elk in a day. Biological samples can be collected as well. With proper instruction, a good crew has the ability to place collars on animals well distributed throughout a seasonal range, in a short amount of time.

b. Application – Show pilots and crews where to capture elk on detailed topographic maps. It may also be acceptable orient the crew during a reconnaissance flight prior to capture operations. However, for safety, Department personnel should not participate as a crewmember once the capture operation begins. Depending on the company's equipment inventory, the Department may need to supply ear tagging pliers or other capture equipment.

Animals captured in most netgun operations are marked and released on site. However, crews can also transport animals to a central staging area for processing or relocation. During these types of operations, animals may be tranquilized to reduce the stress of capture and aerial transportation. Trailers

used to transport elk should be equipped as described in Section VII.C.1 (Transport).

c. Analysis of Data – Refer to Section VII.B.1.c. (Marking).

d. Disposition of Data – Refer to Section VII.B.1.d. (Marking).

4. Immobilization –

a. Rationale – Tranquilizing drugs can be used to immobilize and capture small numbers of elk in specific locations. Elk in traps are often immobilized to assist with handling.

b. Application – Refer to Appendix VIII for a discussion of various immobilizing agents, their properties and dosages. Drugs can be administered by a variety of devices including dart rifles, pistols, blowguns, and jab sticks. Darting from helicopters is the preferred method to capture elk on all seasonal ranges. However, aerial darting is usually more effective after animals have congregated on winter habitats. Elk can also be darted from the ground when personnel are able to get close enough. At certain times of year, calls are effective to attract animals within darting range – specifically: 1) a calf call is used to attract females and young bulls during calving season (June 15-July 7); and 2) a bugle is used to attract adult bulls during the rut (September). In addition, elk can be darted from hay wagons or other equipment that is familiar to them on winter feedgrounds. After elk are captured in corral or Clover traps, they are sometimes immobilized to facilitate handling or transport.

c. Analysis of Data – Record a detailed account of each immobilization. Note the drug type, dosage, and the age, sex, and approximate weight of the animal. Document induction times and length of anesthesia for future reference and to help refine dosage rates.

d. Disposition of Data – Summarize immobilization records and forward them to Veterinary Research Services. Report results of any operation involving immobilization in the Job Completion Report for the applicable herd unit.

B. Marking Studies –

1. Neckbands and Ear Tags –

a. Rationale – Important geographic data are obtained from observations and recoveries of marked elk. This information enables managers to delineate and refine seasonal ranges and migration patterns of sub-populations. Harvest strategies can be developed to target specific herd segments. In some applications, elk are marked to evaluate the integrity of existing, herd unit

boundaries, or to refine estimates of harvest rates, natural mortality rates or longevity.

b. Application – If elk are to be trapped and marked at several sites in a herd unit, a differently colored neckband should be assigned to each site. Symbols or codes imprinted on neckbands must be sufficiently large to be read easily. Unique symbol patterns should be used at each trap site to eliminate duplication. Individual elk can also be marked with cattle ear tags that are colored and numbered. Colors of ear tags should correspond to specific trap sites as well.

   When elk are fitted with neckbands, attach numbered aluminum ear tags with return instructions to both the animal's ears. Elk sometimes lose collars, but seldom shed both ear tags.

   Newborn elk calves can also be uniquely marked with ear tags. Long-handled nets are an effective means of capturing calves shortly after parturition. However, this method is very labor-intensive and typically returns minimal data. It is appropriate for unique circumstances in which a large sample of calves can be marked.

c. Analysis of Data – Each trapping and marking project should include a provision for extensive monitoring to document subsequent locations of marked animals. Record Universal Transverse Mercator (UTM) coordinates of elk locations and enter these into a Microsoft Access database. Geo-referenced databases are used to construct distribution layers in a Geographic Information System. These layers help biologists delineate seasonal ranges, migration routes, and interchange among herd units. They also provide documentation to support impact analyses and mitigation recommendations.

d. Disposition of Data – Immediately after a marking operation is concluded, collate and forward records to the Supervisor of Biological Services for entry into the Department's Marked Animal Database. At a minimum, this information should include the dates elk were marked, ear tag numbers, ages of the elk, locations of trap sites (UTM coordinates), and locations of release sites if different from capture sites. Summarize trapping data, marked animal locations, and mortality returns in Job Completion Reports for applicable herd units.

2. Radio Telemetry –

   a. Rationale – Radio transmitters cost substantially more than traditional neckbands, however the quantity and quality of data acquired are much greater. Radio telemetry can be used to identify migration routes, refine seasonal range delineations, estimate home range size (an indication of habitat quality), and assist in analyzing habitat selection patterns. Recent advances in Global Positioning Satellite (GPS) technology enable modern telemetry systems to track, record, and store thousands of individual animal locations. From such

high-density data, biologists can monitor fine-scale movements, enabling them to identify daily activity patterns, habitat selection, exact migration routes, and many other attributes without disturbing the animal after it is collared.

b. Application – Elk must be captured and restrained or immobilized to attach telemetry transmitters. Appropriate trapping techniques depend on goals of the marking operation (refer to previous subsections). To facilitate observation of telemetry-marked elk, a neckband sheath of 4-inch wide, rubber-impregnated material can be affixed with pop rivets to the standard transmitter collar. These sheaths are available in a variety of colors and can be numbered for individual identification.

c. Analysis of Data – Several software packages are available to plot locations obtained from telemetry data, and to calculate home range sizes. Each has strengths and weaknesses depending on the number of relocations of each marked individual. Since software is constantly evolving, biologists should consult the Cooperative Fish and Wildlife Research Unit at the University of Wyoming, for advice about current technologies and their suitability for specific study objectives.

d. Disposition of Data – Immediately after the marking operation is concluded, collate and forward records to the Supervisor of Biological Services for entry into the Department's Marked Animal Database. At a minimum, this information should include: the date the elk was marked, ear tag numbers, radio collar colors and numbers, transmitter frequencies, sex and ages of the elk, locations of trap sites (UTM coordinates), and locations of release sites if different from capture sites. Summarize trapping data, marked animal locations/home ranges, and mortality returns in Job Completion Reports for each, applicable herd unit.

C. Transplant and Relocations –

1. Transport – Historically, elk were transplanted from capture sites in northwest Wyoming via horse drawn wagons to railheads in eastern Idaho. There, they were loaded onto railroad stock cars and transported to various release sites for reintroduction or augmentation across Wyoming. As technology improved during the 1900s, the Department began using vehicles to relocate elk. Due to the prevalence of CWD and brucellosis, any elk transplanted from within Wyoming would need to be tested, making it unlikely elk from Wyoming would be used in future transplants.

a. Rationale – Elk currently occupy most suitable habitats in Wyoming. In fact, elk are beginning to disperse into open rangelands and agricultural regions where the Department does not wish to establish new populations. Accordingly, there is no biological reason to relocate elk for reintroduction or augmentation within

Wyoming. Occasionally, we may provide elk to other states or provinces for reintroduction. Sometimes, problem animals are relocated.

b. Application – Several precautions are necessary to minimize stress and injury when elk are transported. Currently, 4-horse or larger stock trailers are preferred. Most openings on trailers should be covered with panels of plywood or other materials to minimize noise and other stressful stimuli. Fit panels such that they allow adequate ventilation when the trailer is stopped, and provide shelter and thermal insulation during transport. Separate adult elk from calves by installing dividers in the trailer, or by hauling them in different trailers. Similarly, separate bulls from cows. Trailers used to transport elk should have low beds for easier loading. Spread wood chips, sawdust, or clean hay throughout the trailer to provide traction and bedding. Trailers set up to transport wildlife are maintained within most Department Regions.

c. Analysis of Data – Refer to Section VII.B.1.c. (Marking).

d. Disposition of Data – Refer to Section VII.B.1.d. (Marking).

2. Release –

a. Rational –.

b. Application – Additional precautions are necessary to release elk with a minimum of stress and injury, without jeopardizing safety of personnel or spectators. Select release areas that afford open escape lanes. Assign personnel to assure the area is clear of obstructing objects and to control spectators. Keep news media and other spectators out of escape lanes. Back transport trailers into position and release elk from all trailers simultaneously if possible. Minimize noise and encourage spectators to leave the area as soon as possible so animals can adjust to the unfamiliar environment.

c. Analysis of Data – Refer to Section VII.B.1.c. (Marking.)

d. Disposition of Data – Refer to Section VII.B.1.d. (Marking).

VIII. DISEASE MANAGEMENT – A range of infectious diseases and parasites have been documented in elk populations. Thorne (1982) identified these and described their distribution, transmission, pathogenesis, diagnosis, and control. More recently, Williams and Barker (2001) published a comprehensive treatise on wildlife diseases resulting from viral, prion, bacterial, and mycotic infections. Among the diseases that affect elk in Wyoming, brucellosis probably receives the greatest attention and its management accounts for the expenditure of resources.

A. BRUCELLOSIS MANAGEMENT –

1. Surveillance –

   a. Rationale – Brucellosis is potentially transmitted between elk and cattle that commingle during the late winter/spring period and poses risks to the State's livestock industry. A major objective of elk management in western Wyoming is to reduce the distribution and seroprevalence of brucellosis.

   b. Application – Elk are bled and tested for the presence of antibodies for the bacterium *Brucella*. Blood samples are collected from live-captured animals (corral traps, chemical immobilization, net-gunning, etc.) via jugular venipuncture. Samples are also collected from hunter-harvested animals typically by mailing blood kits to licensed hunters in a specific area targeted for surveillance.

   c. Analysis of Data – Testing is conducted by WGFD at the Wildlife Disease Laboratory in Laramie. Data from each herd are compiled and reported in annual Job Completion Reports.

2. Vaccination –

   a. Rationale – Research has demonstrated vaccinating elk with the Strain 19 (S19) inoculum reduces Brucella-induced abortions (thought to be primary mode of transmission).

   b. Application – Elk are ballistically vaccinated with lyophilized S19 vaccine loaded into hydroxycellulose "biobullets." Vaccinations are typically conducted from a feedsled on feedgrounds during winter.

   c. Analysis of Data – Elk have been vaccinated on the Grey's River feedground since 1985, but were never vaccinated on the Dell Creek feedground. Efficacy of the S19 vaccination program has been evaluated by comparing seroprevalence estimates collected from these treatment and control sites. Efficacy is also interpreted based on trends in brucellosis seroprevalence of elk over time (pre vs. post-vaccination) at Grey's River.

3. Habitat Enhancement –

   a. Rationale – Healthy, intact and available winter range for elk spatially separated from potential livestock conflict areas can reduce elk dependence on supplemental feed (i.e., feedgrounds) and concurrently reduce potential for intraspecific transmission events. Strong correlations exist between artificial feeding season length (and end feeding date) and exposure rates of brucellosis in elk on feedgrounds. Reducing feeding season length and/or stopping feeding seasons early may result in reduced brucellosis seroprevalence in elk.

b. Application – WGFD has limited relatively limited land ownership. Most large-scale habitat enhancement projects must be coordinated with federal landowner agencies. Funding needed for projects is sometimes immense, and grants should be submitted to as many funding agencies as possible.

c. Analysis of Data – Treated/control vegetation monitoring transects can be erected to determine effects of treatment. Browse and fecal transects or animal marking can be employed to determine use.

4. Prevention of elk-cattle commingling –

a. Rationale – Transmission of brucellosis from elk to cattle, or vice-versa, is not possible if contact between the two species is prevented.

b. Application – Livestock producers typically report commingling events to local wardens and elk are hazed away from the situation by various means

c. Analysis of Data – Warden report?

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