

Elk Mountain Ranch

NATURAL RESOURCE MASTER PLAN

PART 2



Part 1 includes assessment summaries, management guidelines, and recommendations for improvements on the ground and through management practices. Part 1 is intended to be a tool for budgeting, planning and designing improvement projects.

Part 2 includes background information, the assessment specifics, data, and explanations. It is more voluminous and it provides the foundation upon which recommendations are made. Part 2 can be used as reference information to better understand the resource conditions by species, by vegetative type, or habitat.

Carbon County, Wyoming

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NATURAL RESOURCE MASTER PLAN
PART 2

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Note: *There are photos, maps, tables and charts in the fisheries section labeled on a system only for the fisheries discussion and section.*

I. INTRODUCTION

Ranch Management Goals

This is a Natural Resource Master Plan for the privately owned forested areas located on the Elk Mountain ranch. The following are the goals:

- Sponsor range and forestland ecological health,
- Increase habitat for game animals and predators,
- Reduce risk and vulnerability to large forest insect and disease outbreaks,
- Effective livestock management, and
- Increase populations of fish, game animals, and predators.

Location and Description_(see map)

The Elk Mountain ranch is approximately 3 miles west of the town of Elk Mountain and seven miles northwest of the Medicine Bow mountain range (Snowy Range). Within the Elk Mountain ranch there are approximately 7,400 acres of BLM Public Domain, 2,640 acres of State land, and 156 acres deeded for Hanna water supply. There are approximately 22,800 acres of deeded land that belong to the ranch and this includes over 600+-acres private trade of use (Section 1, T 20, R82). The grand total of all lands within the ranch is over 33,000 acres.

Primary access route to Elk Mountain ranch from Laramie, WY is north on Interstate 80 approximately 60 miles to Elk Mountain turnoff, exit 255. Turn west on CR 600 Rattlesnake Pass road for approximately one mile to the Ranch entrance.

Topography and Climate

The Elk Mountain Ranch is on the east side of the continental divide and north of the Snowy Range.

The topographic center piece of the ranch is Elk Mountain which rises in elevation to 11,056 feet. The entire mountain is forested with a mosaic of different cover types intermingled with patches of grassland and meadow. The ridges north and west of the mountain are characterized as foothills and are covered with shrub, grassland with a few stringers of aspen woodland. The primary ridge is called Halleck Ridge, elevation 8,047 feet, and it is located roughly north and northwest of Elk Mountain. The other ridge is Sheephead Mountain with an elevation of 8,828 feet and it is west of Elk Mountain. Both Halleck Ridge and Sheephead Mountain are considered to be “crucial winter range” for elk. The lowlands of the ranch between County Road 600 (Rattlesnake Pass Road) and the foot of the mountain on the north side are predominately irrigated pasture and meadow flanked by aspen woodland and divided by stringers of willow. This area is crucial winter range for mule deer.

Elevation and topography are dominant controls of local climates within the Ranch. The combination of elevation and mid latitude interior continent geography results in a cool, dry but invigorating climate. There are large seasonal swings in temperature and large day to night changes. Humidity is generally quite low; this favors rapid evaporation and a relatively comfortable feeling even on hot days. The thin atmosphere allows greater penetration of solar radiation and results in pleasant daytime conditions even during the winter. Outdoor work and recreation can often be carried out in relative comfort year round, but sunburn and skin cancer is a problem due to the intense high-elevation sunlight. At night, temperatures drop quickly, and freezing temperatures are possible in some mountain locations every month of the year.

There is a weather station in Elk Mountain 3 miles east of the ranch. The historical station records cover a 35 year period.

Average maximum temperature at the lower elevations can be expected to be about 53° F with highs in July averaging 79° F and lows in January of 14° F. Average minimum temperature can be expected to be about 30° F. On the mountain the average mean temperature is probably 10 to 15 degrees lower year around.

Total precipitation at the lower elevations averages about 12.3" per year most of which occurs between the months of March and November. The month averaging the most precipitation is May with a 35 year average of 2.26". The timbered high elevation part of the ranch probably receives 50 to 120% more annual precipitation than occurs at the lower elevations of the ranch.

II. BACKGROUND

Current and Historical Land Use

The history of human activity on the ranch goes back for many years. Centuries prior to the migration of Anglo-Saxon pioneers into the West, Native Americans used the area for grazing and hunting.

The recent ranch history (past 150 years) of uses includes wood products and wildlife meat for the Union Pacific Railroad, hay production, cattle, sheep, and bison production. The area is noted for its quality elk herds and abundant wildlife. On the south side of the ranch there is a small, old, and inactive copper mine. Generally, it is the presence of the valuable natural hay that accounts for the first pioneer occupation in the area. After Fort Halleck was established in the 1860s the area attracted homesteaders and early day entrepreneurs who harvested the hay, expanded the irrigation, and successfully operated as an agricultural production ranch for over a century.

On the USGS quadrangle map the names Quealy, Palm, and McGill all appear at old home site locations. These people all played a role in the settlement, the use and development of the ranch.

The use of the Elk Mountain Ranch stems back to the 1860s when “game getters” were hired by the Union Pacific Railroad company to supply fresh wildlife meat to the construction crews. The “game getters” killed bison, elk, deer, and antelope to provide meat for the workers (Personal communication, Mark Miller, State Archeologist, March 1999).

In 1862, the US Army established the 11th Regiment of the Ohio Volunteer Cavalry at Fort Halleck for the purpose of providing security along the Overland Trail and the Union Pacific Railroad. The Army actively maintained the Fort until 1866, at which time Robert Foote, the Fort Sutler, squatted on the land and eventually filed for ownership under the Homestead Act. Mr. Foote developed an enterprise harvesting and selling the natural meadow hay to the US Army for their horses and other livestock. He eventually developed the irrigation ditch system needed to increase annual hay production enabling him to not only supply the US Army but supply the hay needed for the mule and ox teams hauling timber for the construction of the Union Pacific Railroad.

In 1891 Mr. Micheal Quealy, who lived on Rattlesnake Creek a few miles west of Fort Halleck began to lease most of the land around the Fort. Mr. Quealy also acquired deeded land in the area through the Homestead Act.

During the 1890’s Micheal Quealy and his brother Pat started a cattle business with 400 head of cows. In the 1890s the site of Fort Halleck also became the location of the Home Ranch headquarters. In 1899 they constructed a large horse barn from ten foot props that were cut in “tie hack camps” and floated with the ties down the Medicine Bow River. Due to the abundance of old hay stack yards present in the meadows near the old Fort, some people believe that the hay production was increased at this time. Most of hay stack yards were removed in the 1990’s.

By 1910 Mike Quealy began running sheep with their cattle to take advantage of the lucrative sheep market. Mr. Quealy also obtained forest permits for summer grazing of sheep on the Medicine Bow National Forest. The Home Ranch continued to serve as the winter range for the sheep and the yearlong range for cattle. When Micheal Quealey passed the ranching operation on to his children in 1916, it encompassed approximately 150 sections of land including leased National Forest and BLM land and their intermingled private lands. They had about 4,000 head of cattle and 12,000 head of sheep.

The ranch was sold to the Palm Livestock Company on September 23, 1948. The Palms increased the land holdings of the ranch and continued the

operation by running both cattle and sheep until the early 1990s. Around 1991 and 1992 the Palm Livestock Company divided its assets among family members. From this time until the late 1990s, the Home Ranch maintained a herd of approximately 3,000 sheep and leased pasture to other cattle operators in the area. It included a little less than 22,000 acres of deeded land with a little over 6,700 acres of intermingled BLM leased land. Through some small land exchanges and purchases in the 1990s the ranch was slightly enlarged and some of the deeded areas consolidated.

On June 1, 1993 Elk Mountain Ranch LLC became the third owner of the original Quealy real estate including the Fort Halleck site. The Elk Mountain Ranch became the name for what was called the Home Ranch of the Palm Livestock Company. The 6,742 acre BLM grazing allotment used by the ranch, through a grazing permit, is called the Home Ranch Allotment.

On December 10, 1998, Peter Thieriot, General Manager of the Elk Mountain Ranch LLC signed Deed of Conservation Easement with The Nature Conservancy, for most of the deeded land. In 1999 the ranch switched from cattle to bison and until the end of 2005 approximately 1000 head of bison used the ranch.

In November 2005 the Ranch was sold to Iron Bar Holdings LLC. Iron Bar Holdings LLC will use the ranch for cattle production and limited outdoor recreation.

Conservation Easement

The Conservation Easement was certified in December 1998 and includes all deeded lands with a few exceptions listed in the easement. The Conservation Easement grants the continuation of eleven specific activities to the owners and prohibits seventeen specific activities. Generally, the owners have rights to continue to graze livestock and maintain or install facilities needed for operating the ranch and maintain the health of the ecosystems as well as to develop within the two building envelopes depicted. In general the Conservation Easement prohibits commercial development and or any major alteration of the ecosystems. All of the specifics are clearly stated within the Conservation Easement and Deed of Conservation Easement. (See Appendices in Part 1 and Part 2.)

The Conservation Easement includes a very well-written report describing the background, history, ecological features, and legal information pertaining to the ranch.

III. RESOURCE ASSESSMENT SPECIFICS

Vegetation and Physical Features

The Elk Mountain Ranch is comprised of twelve primary vegetation types. When considering variations within a vegetation type, there are numerous different units and/or stands to consider. Some vegetation types are forested and some are not forested. None of the vegetation types are homogeneous. In each there are variations. In many cases there are mosaics of sub-types or small patches of different vegetation. However, the vegetation type mapped represents the major vegetation as labeled. See the attached vegetation map

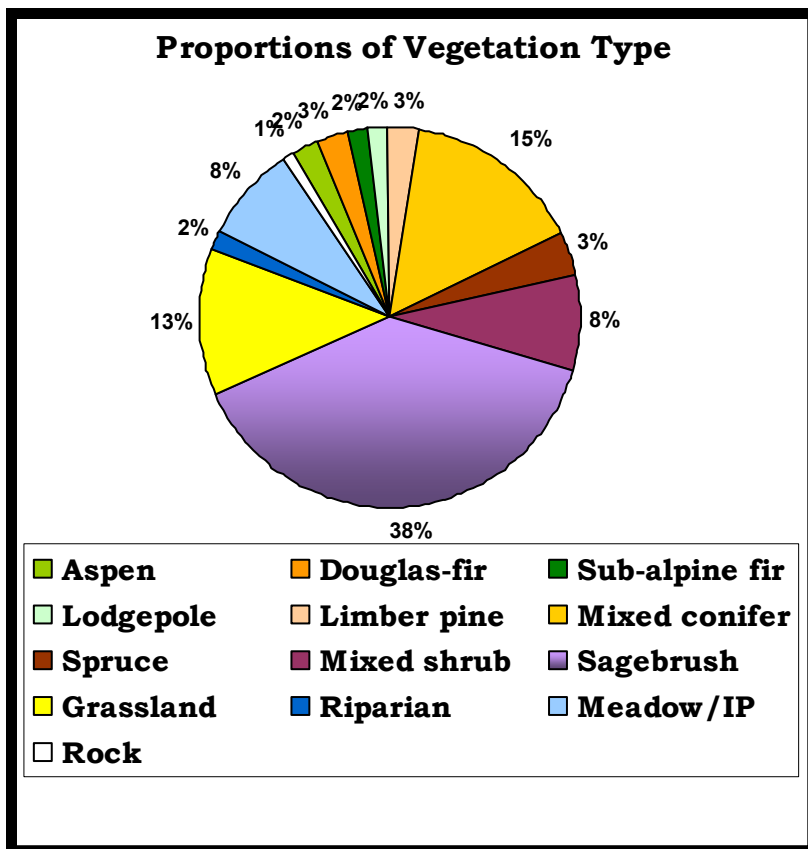


Chart depicts the proportions of vegetation type across all ownerships.

This assessment is primarily for the deeded lands within the Elk Mountain Ranch. At the end of this vegetation section is a summary of vegetation type proportions on BLM Public Domain and State lands within the Elk Mountain Ranch and summaries of vegetation type by BLM and State Sections within the Ranch. The summary information provided for the BLM and State lands

with the vegetation type map could be useful for land exchange proposals as well as coordination of management, projects and proposals.

Following is a summary of the vegetation types and descriptions of each vegetation type beginning with the forested areas.

Forests and Woodlands

Conditions

Forests are characterized by trees, but 90 percent of the plant species are in the under story. On the Elk Mountain Ranch property these include huckleberry, common juniper, Oregon grape, sagebrush, mountain mahogany, bitterbrush, serviceberry, snowberry, sagebrush; forbs such as heartleaf arnica, yarrow, geranium and various species of grasses and sedges. Many animals and legions of microorganisms coexist with the plants. Clearly, the ecosystems on the ranch cannot be understood by focusing on the trees and shrubs alone.

The density of trees and under story plants in the forests varies considerably. When tree density is high, the under story biomass is comparatively low because of competition for light, water, and nutrients. When the number of trees is reduced by some disturbance, the amount of under story vegetation often increases dramatically. Disturbances benefit herbivores (elk, deer and livestock) that depend on shrubs and herbaceous plants for food.

Like all forests the forests on the Elk Mountain Ranch property are characterized by canopy cover that oscillates over periods of decades or centuries between dense canopy cover and open space, and the under story biomass pulsates accordingly. This pulsating is not uniform throughout the forests, and canopy openings and flushes of under story growth occur at different times in different places. Though appearing to be static, forests change on the time scale of months as well as centuries. The Elk Mountain Ranch forests do not appear to be dominated by any particular species. Sub-alpine fir, limber pine, and lodgepole pine appear to cover larger proportions but spruce, Douglas-fir, and aspen can appear almost anywhere.

The vegetation patterns that have developed on the Elk Mountain landscapes were determined by disturbances as well as by environmental gradients. The effects of the disturbances are important in all landscapes, but in mountain forests they can occur over larger areas and their impacts last longer because of the usually dominant conifers are unable to sprout. Fires, windstorms, insect outbreaks along with human-caused disturbances often lead to tree mortality over large acreages. A forest develops again only after successful establishment of new seedlings or with the rapid growth of small trees that had been suppressed by the larger trees prior to the disturbance. This is in contrast with grasslands, where the primary disturbance - fire- does not kill most plants and new shoots are produced within a year by sprouting.

The frequency of disturbance varies with elevation and other environmental factors. For example, forest fires are less common at high elevations because fuels accumulate more slowly in the cooler environment and because the fuels that do accumulate are generally moister and consequently less flammable.

Disturbances in forests are long-lasting and give the impression of devastation or poor management, even though the causes of the disturbance are natural. For example, the insects of the Rocky Mountain region are usually native species that have coexisted with the plants for thousands and even millions of years.

The forests on the Elk Mountain Ranch property are comprised of seven species types. These types each have variations where they are intermixed with other vegetation creating a sort of zoning or mosaic. Vegetation mosaics on this ranch, coupled with the adjoining properties, facilitate a wide diversity of habitats and forest environments. Within each forest type there is vegetative variation. The Elk Mountain forests are a mosaic of lodgepole pine, limber pine, mixed conifer, Douglas-fir, aspen, sub-alpine fir, and spruce. They occur in patches or blends of two or more tree species intermingled with openings dominated by a variety of grasses. Within some of the wetter drainages there are small mountain meadows with a variety of forbs, grasses and shrubs. The forest diversity is due to the occurrence of natural disturbances, variations in soil and soil moisture, elevation and constant exposure to lower temperatures, and to different slope aspects facing the sun or away from the sun.

On Elk Mountain the diversity of species and relative medium age of most trees contributes to the forest resilience from some of the insects and diseases that exist within the vicinity of the ranch. However, the uplands of the ranch are affected by large-scale factors that extend beyond the Elk Mountain Ranch boundaries. Some of these landscape scale (larger scale) factors are as follows: high to extreme forest fuel continuity for perpetuating a large wildfire; a mountain pine beetle population build up due to the dense stands of lodgepole pine that are weakened by recent drought; and the build up of the spruce bark beetle following several blow-downs. The US Forest Service has detected small concentrations of mountain pine beetle, western balsm fir bark beetle (in sub-alpine fir) and white pine blister rust on the ranch. There are other natural disturbances working in the vicinity of the Elk Mountain Ranch such as the following: pine engraver, Ips bark beetle, mistletoe on the lodgepole pine, conifer broom rust (yellow witches' broom), fir engraver, spruce budworm on the firs and spruce. In the aspen there are at least 45 different insects and diseases that can infect aspen. Some of the more common are as follows: *large aspen tortex* which is a caterpillar that feeds on the leaves and buds and causes the leaves to curl and defoliate the tree; *western tent caterpillar* which also defoliates the plants and will develop colonies of caterpillars that produce a dense mat of silk in branch crotches. It also attacks other species of plants. There are also a number of aphids, flies, and wood boring insects that attack aspen and several galls and bracts that enter through wounds and cause a weakening of the tree and there are a few root rots and decay diseases.

Sometimes aspen are infected with a fungus that causes leaf damage, defoliation and a general weakening of the trees. There are several of these with names like *shoot blight*, *sector leaf spot* and *canker*, *shepherds crook*, *Mussolini blight* and *ink spot*. Under the right conditions, any of the above could have large-scale consequences. Risk, due to most of these disturbances could be reduced, through some active management practices designed to help with the natural forest renewal processes.

Forest vegetation is perhaps best thought of not as a uniform and stable cover but rather as a mosaic, with the character of each patch frequently changing and borders being periodically redefined.

The forest vegetation on the Elk Mountain ranch is generally in good health but dense in many areas and vulnerable to large scale disturbances from insects diseases and fire. One of the qualities that add to resilience is the diversity of tree species and tree age classes.

Elk Mountain Forest Insect and Diseases

Following are examples of forest insects and diseases observed on the Elk Mountain Ranch. Wildfire has not been a significant disturbance factor for many years.



Limber pine with mistletoe.



Sub-alpine fir with conifer broom rust.



Western Balsam Fir Bark Beetle



Sub-alpine fir infected with WBFBB



White pine Blister Rust(limber pine)



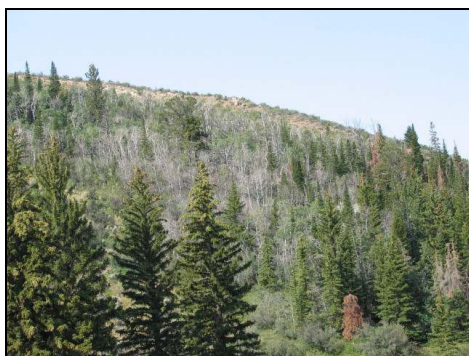
One of many patches of limber pine decline



Mountain pine bark beetle in Lodgepole pine.



Mountain pine bark beetle in Limber pine.

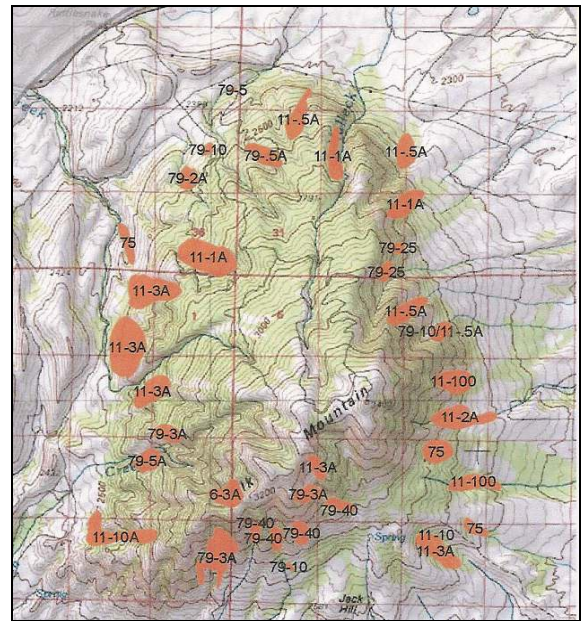


Aspen stand in decline are small sized but very common



Aspen with a bark disease & low vigor.

<http://www.fs.fed.us/r2/resources/fhm/aerialsurvey/>



Spruce
Lodgepole pine
Limber pine
Douglas-fir
Sub-alpine fir
Lodgepole pine
Aspen
Limber pine

Forests and Woodland Stand Summary

(Also in Part 1)

The forested areas have been inventoried as “Stands”. Each stand represents forests with similar characteristics, uniform in species composition, age class arrangement and condition. Each stand also has similar opportunities and limitations for management.

Poor access and slope are the primary factors influencing mechanical operability in the forested area. Operability is rated as follows:

High = 25% of the forested acreage

Medium = 47% of the forested acreage

Low = 28% of the forested acreage

For the purpose of conventional logging or mechanical treatment forested areas on slopes of 0-30% with short rises up to 40% are considered operable. Most of the forests on the south and west sides of Elk Mountain and at the mid-elevation where there are no roads are on slopes too steep for conventional logging operations. On the north, part of the east facing slopes, and in spots on the lower west side logging and applications of mechanical treatment are options depending on the costs and benefits. For recommended prescribed fire treatments there are no slope limitations.

The keys to all of the management issues are stand density and vegetation management. The forest vegetation on the ranch is generally in fair to good health. Stands are too dense in many areas and vulnerable to large scale disturbances from insects, diseases and fire. By prescribing treatment where it is economically feasible and not damaging to wildlife habitat or watersheds, the long term health and conditions can be maintained or improved.

Mason, Bruce and Girard (MBG), a forestry consulting firm out of Oregon conducted a cruise of the Elk Mountain Ranch in 1998. It provided an estimate of forest value and suggested silvicultural actions. There is a significant difference between MBG recommendations and those found here. First the MBG report is an estimate of what “might be obtained by cutting all merchantable sized trees into 16 foot logs”. This is a pretty typical approach when the value of standing timber is to be included in the purchase price of a large tract. If the new owner liquidated all the merchantable timber on the ranch he/she could expect to get the volume described in MBG’s report.

Estimates in this plan are not based on cutting all merchantable volume but rather on harvesting discrete stands for specific resource management goals. See Part 1 for management recommendations. In the current instance the present owner wants to enhance wildlife habitat. This objective is much different than a liquidation scenario and will yield a much different outcome than the MBG approach.

MBG mentions and perhaps even emphasizes that management of the timber resource on EMR will be capital intensive to get road systems up to decent standards for access and log truck use. They even infer that forest management on this property will be a “break even” opportunity at best.

Note: There is a good abundance of snags/standing dead on Elk Mountain. There are plenty of cavity nester condos.

There are 15 different forest type stands included with the forests and woodlands on the Elk Mountain Ranch. Treatment specifics are described in stand write ups and in “Recommended Improvement Projects” section of Part1. Descriptions of the forest type stands follow:

Forest and Woodland Stand Summary Table

Stand Symbol	Forest Type	Total Acres	Deeded Acres	General Treatments Recommended
A	Aspen (70% or more)	572	395	Treat for aspen regeneration and noxious weeds
A/MC	Aspen being succeeded by MC	181	177	Treat for aspen regeneration and noxious weeds
MC	Mixed Conifer (mosaic of three or more species (LP, DF, WP, F))	2,964	1,820	Confine and contain wildfire
MC/A	Mixed conifer with a scattering of aspen all through it	2,160	1,117	Treat for aspen regeneration and noxious weeds
DF	Douglas-fir (70% or more)	743	408	Fuel hazard reduction
DF/A	Douglas-fir dominating with scattering of aspen	98	98	Treat for aspen regeneration and noxious weeds; Fuel hazard reduction
LP	Lodgepole pine (70% or more)	581	307	Confine and contain wildfire
WP	Limber pine (70% or more)	372	208	Confine and contain wildfire; Fuel hazard reduction
WP/MS	Limber pine (40% or more) with mixed shrub	478	348	Confine and contain wildfire
F	Sub-alpine fir (70% or more)	409	155	Confine and contain wildfire
F/LP	Sub-alpine fir/Lodgepole pine	60	60	Treat for insect mitigation and noxious weeds
F/A	Sub-alpine fir with scattered Aspen	42	42	Treat for aspen regeneration and noxious weeds
S	Spruce (70% or more)	651	233	Confine and contain wildfire
S/F	Spruce/Fir with S dominate but neither over 70%	211	154	Confine and contain wildfire
S/LP	Spruce and Lodgepole	280	185	Confine and contain; Fuel hazard reduction wildfire
Total Acres		9,802	5,707	

Note: The forested summary acreage totals are rounded off and do not represent the total acreage of the Elk Mountain geographic area alone. In addition there are 350 acres of rock slides and outcrops (48 acres on deeded lands) and there are alpine grasslands on the mountain but accounted for in the non forest summary and not this one. Also, some of the limber pine and much of the aspen is included in the forested summary but not on the Elk Mountain geographic area.

Aspen Type

Map Symbol (A)

There are approximately 753 acres of aspen woodland on the Ranch (A+A/MC). Aspen is found as a forest type in association with other forest types on Elk Mountain and around its base and as woodland in stringers and patches associated with mixed Shrub land, sagebrush and grassland types. Most of the aspen are on marginal or very marginal growing sites. In some of the low elevation dry areas there is a high percentage of mortality due to the recent drought and the aspen stems are relatively small. In other spots at the lower and middle elevations small stands of aspen are being succeeded out by mixed conifer (A/MC) competition. In some places the aspen is almost shrub-like. Also, single aspen trees and small stringers and patches are found all over the mountain in association with all the coniferous cover types at all elevations and on all aspects.

Aspen grows in clones that appear as groves, with new trees developing from root sprouts. Seedling establishment is rare. Each grove of aspen develops as a genetically uniform clone. All of the trees are actually part of one or a few plants.

Because of its ability to sprout, aspen persists in some coniferous forests until the next disturbance. Sprouting greatly facilitates vigorous aspen regeneration (secondary succession) because the sprouts have more stored energy available to them than do seedlings.

Generally, aspen root sprouting is suppressed by auxin transported from the aerial parts of the tree. This phenomenon is termed "apical dominance." When movement of auxin into roots is halted or reduced by cutting, burning, girdling, or defoliation of the trees, auxin levels in the roots decline rapidly. This permits new sprouts to begin; it also allows preexisting primordia, buds, and shoots (sprouts) whose growth had been suppressed by auxin to resume growth.

Deteriorating over mature aspen clones often fail to regenerate because apical dominance is maintained over a shrinking root system.

Apical dominance also is important in limiting regeneration after an aspen stand is cut or burned. Elongating suckers (sprouts) produce auxins whose translocation into the root inhibits the initiation and development of additional sprouts.

The relatively large number of sprouts that arise regularly in many undisturbed aspen clones indicates that apical dominance is not absolute. This is not surprising, because auxin is a relatively unstable compound that must be transported a considerable distance from its source in developing buds and young leaves to the roots for it to have its effects. Apical dominance weakens as auxin travels down the stem because of immobilization, destruction, and age.

During normal seasonal tree growth, there are periods when apical dominance is weak enough to permit sprouting. For example, in spring, before bud burst and translocation of auxin to the roots, temperatures often are high enough for sprouts to begin and grow. Sprout formation is inhibited later, after the leaf buds open and apical dominance is reasserted.

On the Elk Mountain Ranch most of the aspen clones are determinate and do not need a disturbance to stimulate sprouting. Small clones or patches of aspen can be found all over the mountain in association with mixed conifer and other conifers usually at elevations below 9,500 feet in elevation.

However, with any forest disturbance on the Elk Mountain Ranch aspen regeneration will replace coniferous trees if the sprouts are protected. Where aspen regeneration is desired the sprouts should be protected from browsing animals for a few years until they attain enough size to endure periods of heavy use by elk, deer, and livestock. Generally, on the Elk Mountain Ranch, aspen is suffering from high browsing pressure with few young suckers successfully growing on to saplings.

The number of aspen sprouts produced can vary markedly among clones probably due to levels of carbohydrate reserves and hormonal growth promoters in the roots.

Soil temperature is important to aspen sprouting and sunlight is important to sprout growth.

As a woodland type patches and stringers of aspen appear in association with shrub land, sagebrush, and grassland on marginal growing sites. These patches and stringers probably exist primarily because of annual snow-drifts and deeper wetter soils that occur in some of the shallow drainages along Halleck Ridge and other places.

Canada thistle is frequently found within most of the aspen woodland stands.

Stand/Units A-1 through A-29



Both photos exemplify the size and density of the aspen in the stands around the foot of Elk Mountain

Vegetation Type: Aspen with common juniper, aspen, grass understory

Acres: 572 acres total with 395 on deeded lands Slope: 25%+

Basal Area: 120 to 160 sq ft/acre

Site Index: 40

Volume/Acre: Not calculated. Stand does not have commercial value.

Stand Condition: Aspen is relatively young with a moderate amount of aspen sprouting. These stands are in relatively good condition with younger trees and good sprouting. These stands provide a significant component to habitat for deer and elk. Elk and deer are, in places, suppressing patches of the aspen sprouts.

Road Access: Fair access especially for 4x4.

Fire Hazard: Low except in fall or dry winter when leaves have turned and grass has cured.

Silvicultural Recommendations: No action is needed at this time. Canada thistle should be treated.

Stems count: The stems per acre ranges from 300 to 2,000.

Stand/Unit A/MC-1, 2, 4, and 5



Both photos exemplify the encroachment and expanding competition from conifer species.

Vegetation Type: Aspen with mixed conifer expanding and in many small sized locations succeeding the aspen from the site.

Acres: 173 acres

Slope: 15%+

About 169 acres are on deeded lands.

Basal Area: 100 to 140 sqft/acre

Site Index: 40

Volume/Acre: Not calculated. Stand does not have commercial value.

Stand Condition: There are many patches of aspen on Elk mountain that are in decline and the reason for some the decline is competition from mixed conifer. Aspen is medium-sized with a moderate amount of aspen sprouting available. These stands provide a significant component of habitat for deer and elk. Elk and deer are, in places, suppressing patches of the aspen sprouts.

Road Access: Fair access especially for 4x4.

Fire Hazard: Low except in fall or dry winter when leaves have turned and grass has cured.

Silvicultural Recommendations: No specific action is needed at this time. However, disturbance will be needed in the future. Disturbance such as fire or patch clear cuts (2 to 10 acres) to provoke a fresh start for aspen and maintain habitat diversity will also help perpetuate the overall health. When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and existing roads for

control lines. Small to medium sized fires within these stands would, in the long term, help reduce conifer competition and provoke a fresh start for aspen. Use of the confine and contain techniques would also be the most cost effective way to control fires.

Canada thistle should be treated.

Stems count: The stems per acre ranges from 250 to 900.

Stands A/MC-3 (combined with **F/A -1** for management)



Decadent aspen with sub-alpine fir succeeding.



Aspen sprouts first year after clear-cut with brush fence protection on a ranch in Colorado.

Vegetation type: Sub-alpine fir with aspen

Note: This write up, including the volume, is duplicated in F/A-1

Acres: 8 acres of A/MC-3 deeded

Slope: 11-30%

This unit is combined with F/A-1 (42 acres) for 50 acres of deeded total.

Basal Area: 120 square feet/acre

Site Index: 60

Volumes/acre: By size Class

DBH	6"	8"	10"	12"	14"	TOTAL
Stems/Ac	255	161	73	15	9	513
Cubic Volume/Ac	491	758	820	251	275	2,595
Board feet	33	1,976	3,216	1,018	1,266	7,509

Stand Condition: Stand is dense and falling apart. Aspen has been over topped by Sub-alpine fir. Fire hazard and insect/disease vulnerability is high.

Soils: There is enough woody debris on site to ameliorate erosion from soil disturbance. Roads are in fair condition. Drainage is needed now.

Road Access: This stand lays on the lower end of the mountain. While roads are not good it will not be as expensive to access as stands further up hill. Good rolling dips are desperately needed on the road accessing this stand.

Fire Hazard: High to extreme due to canopy closure, fuel ladders and dead/down woody material.

Silvicultural Recommendation: Clear-cut this entire stand to rejuvenate aspen and recover what meager value is in the conifer. Shade tolerant sub-alpine fir is replacing much of the aspen in the forested zone of the ranch. Aspen provides important wildlife habitat, especially when the stands are found adjacent to openings and conifer stands. This treatment will assure that aspen is still present in the future. NOTE: Aspen sprouts are highly palatable to elk and deer. Clear cuts elsewhere in the central Rockies have had to have some means to reduce critter browsing on the young aspen sprouts for three to four years. After much experimentation we have found that brush fences constructed from logging waste material provides the surest protection for the least investment. Once the aspen sprouts become saplings over an inch in diameter they are capable of withstanding browsing pressure and the fence can be removed or allowed to deteriorate. Burning the debris windrow is not difficult and can be done with a good cover of snow to reduce fire escape potential.

Make sure all logging equipment is pressure washed before it comes on the ranch to prevent the spread of noxious weed seed. Treat noxious weeds as soon as they become obvious in the harvest area. This will diminish the chances of a large infestation getting started.

DBH	6"	8"	10"	12"	14"	TOTAL
Stems/Ac	10,710	6,762	3,066	630	378	21,546
Cubic Volume/Ac	20,622	31,836	34,440	10,542	11,550	108,990
Board feet	1,386	82,992	135,072	42,756	53,172	315,378

Potential piece count and volume from this treatment includes F/A-1.

Mixed Conifer**Map Symbol (MC)**

The majority of the forests at the middle elevations are mixed conifer. The mixed conifer is comprised of a mix that varies in proportions between limber pine, lodgepole pine, Douglas-fir, sub-alpine fir, a few ponderosa pine trees, and aspen (which is not a conifer). In some places the trees of three or more species are equally blended along a slope and in other places the mixed conifer is composed of a mosaic of small single species stands that are 1 to 7 acres in size. There are approximately 5,124 acres of the mixed conifer on Elk Mountain- 2,937 acres are on deeded lands (MC+MC/A).

Prior to when fires were controlled the mixed conifer probably contained much larger proportions of Douglas-fir and possibly ponderosa pine and the stands were much more open than they are today. When logging occurs or when there is disturbance from insects and disease the proportion of lodgepole and aspen increases.

The mixed conifer stands along the mountain's main access road were recently logged on a small scale and lodgepole pine appears to be the primary successor. On the east side of the mountain at the foot of the slope Mixed Conifer was logged as recently as 10 years ago and in other places 20 to 40 years ago.

Mixed conifer stands on the ranch are in good to fair condition. They are naturally thick. The combination of drought and insects are thinning pockets of trees within these stands. Mortality will continue until the drought breaks and a cold winter subdues insect populations.

Stand/Units MC-1 through MC-16



These stands are comprised of a mixture of Douglas-fir, sub-alpine fir, lodgepole pine, spruce and limber pine. Photo on right depicts typical pocket of mortality from mountain pine bark beetle.

Vegetation Type: Mixed Conifer (not logged)

Acres: 2964 acres total
About 1820 acres are on deeded lands.

Slope: 30%+

Basal Area: 160 to 200 square feet/ acre

Site Index: 55

Volume/Acre: None calculated. The area is too steep and inoperable for conventional logging techniques.

Stand Condition: These stands are generally dense. They are comprised of a mosaic of small stands and single trees consisting of Douglas-fir, sub-alpine fir, lodgepole, spruce and limber pine. This type provides some wildlife habitat and thermal hiding cover for elk and deer. Stand is moderately healthy with increasing density. Insect and disease mortality is also increasing. White pine blister rust, Mountain pine bark beetle, and Western Balsm fir bark beetle will continue to kill pockets of trees.

Soils: Rocky loam that is generally deep and well drained.

Road Access: Poor to none

Fire Hazard: High to extreme – Fuel Models 9 & 10 best describe the stands. Fuel ladders exist and crown fires can be expected under very high fire danger.

Silvicultural Recommendations: When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and

existing roads for control lines. Small to medium sized fires within these stands would, in the long term, help reduce fuel continuity and provoke a fresh start for aspen. Use of the confine and contain techniques would also be the most cost effective way to control fires.

Stem Count: Stem count ranges from 300 to 1600 stems/acre.

Stand/Units MC/A – 1, 2, 4 through 6, 8 through 12



These stands are comprised of a mixture of Douglas-fir, sub-alpine fir, lodgepole, spruce, limber pine and aspen on steep slopes.

Vegetation Type: Mixed Conifer with Aspen (not logged)

Acres: 1744 acres with 1075 acres deeded

Slope: 30%+

Basal Area: 160 to 200 square feet/ acre

Site Index: 55

Volume/Acre: None calculated. The area is too steep and inoperable for conventional logging techniques.

Stand Condition: These stands are generally dense. They are comprised of a mosaic of small stands and single trees consisting of Douglas-fir, sub-alpine fir, lodgepole, spruce, limber pine, and aspen. This type provides some wildlife habitat and thermal and hiding cover for elk and deer. Stand is moderately healthy with increasing density. In many areas aspen is being crowded out and succeeded. Insect and disease mortality is also increasing. White pine blister rust, Mountain pine bark beetle, and Western Balsam fir bark beetle will continue to kill pockets of trees.

Soils: Rocky loam that is generally deep and well drained.

Road Access: Poor to none

Fire Hazard: High to extreme – Fuel Models 9 & 10 best describe the stands. Fuel ladders exist and crown fires can be expected under very high fire danger and above.

Silvicultural Recommendations: When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and existing roads for control lines. Small to medium sized fires within these stands

would, in the long term, help reduce fuel continuity and provoke a fresh start for aspen at the higher elevations where it is needed the most. Use of the confine and contain techniques would also be the most cost effective way to control fires.

Stem Count: Stem count ranges from 300 to 1600 stems/acre.

Stand/Unit MC/A-7 and MC/A-3



Photos depict variations in canopy density. Both are good locations for small clear cut patches to reduce fuel continuity on the (L photo) and to stimulate aspen sprouting at both photo sites.

Vegetation Type: Mixed conifer with aspen (logged within past 30 years)

Acres: MC/A-7 = 221 acres deeded
MC/A-3 = 89 acres deeded

Slope: 11-30%

Basal Area: 60 to 80 sq ft

Site Index: 60

Volume/Acre: No commercial harvest is anticipated in this stand.

Stand Condition: Most of the merchantable Douglas-fir, lodgepole and sub-alpine fir were removed during a harvest in the past 30 years. The stand is comprised of patches of mixed conifer understory intermingled with very small older stands of aspen, sub-alpine fir, lodgepole pine, and Douglas-fir. On the driest sites the older trees and limber pine are stressed from the past few dry years and are succumbing to insects and pathogens.

Sub-alpine fir and, in spots, lodgepole pine seedlings and saplings are abundant and in good condition. Clumps and small stands of aspen are distributed throughout the unit but concentrations of browsing are keeping the aspen down.

Canada thistle is dispersed throughout the area.

Soils: Soils are rocky and well-drained. Roads soils are in fair condition. Drainage is needed after the next harvest is completed.

Road Access: Interior roads built during past logging entries provide good access. Skid trails are in place.

Fire Hazard: High to extreme due to some of the old logging slash accumulations and clumps of small conifer fire ladders.

Silvicultural Recommendation: Prescribe burn and/or patch cut (2 to 10 acres) to provoke a fresh start for aspen, maintain habitat diversity, and to reduce fuel continuity. Reducing sub-alpine fir reproduction, reversing sub-alpine fir succession in aspen, and breaking up sub-alpine fir thickets should be secondary objectives and will contribute to the above goals. Unless there is a market for small wood products it is not feasible to commercial harvest for another 40 or 50 years.

If harvesting some of the patches is viable in the near future the potential volume per acre is outlined in the following table.

DBH	10"	12"	16"	18"	20"	TOTAL
Stems/Ac	45	15	15	13	14	102
Cubic Volume/Ac	311	209	276	412	661	1,869
Board feet/Ac	964	879	1,167	1,878	3,098	7,985



Debris fences should be installed around clear cut patches for protection of aspen sprouts

Burn most of the old slash piles and logging debris.

Treat Canada thistle and other noxious weeds until suppressed.

Stem Count: The stem count for all size trees ranges from 90 to 2,000 stems per acre.

Douglas-fir**Map Symbol (DF)**

In most of the forested areas Douglas-fir is a component within the mixed conifer mosaics. Douglas-fir appears in many spots as a small stand intermingled with the other mixed conifer species. However, on the north end of the mountain at the mid-level elevations there are a few stands where Douglas-fir is dominates. Other conifer species are present but in quantities less than Douglas-fir. There are approximately 843 total acres of the Douglas-fir vegetative type on Elk Mountain. Approximately 506 acres is on deeded lands.

Most Douglas-fir stands on the ranch have been harvested within the past 40 years. Therefore, there are usually two age class generations. One generation has relatively young pole-sized trees and saplings with an average age of 10 to 40 years and an older generation of more notable trees that are two to four hundred years old. These over-mature trees are valuable wildlife habitat and provide a sense of wonder in the casual observer.

Drought and insects are killing a few of the young and old Douglas-fir. This is not an anomaly but rather natural processes dealing with thick trees under considerable stress.

Generally, Douglas-fir is a fire resistant species and its prominence is aided by the reoccurrence of ground fires. The older trees have a thick bark which enables the tree to survive many surface fires. Young Douglas-fir has thin bark and crowns that are close to the ground. They are more susceptible to even the mildest wildfire.

Stand DF-1 and 2



Stands DF-1 and 2 are with small-sized trees and some steep slopes.

Vegetation Type: Douglas –fir with occasional aspen.

Acres: 471 acres total with 136 acres deeded Slope: 11-30%+

Basal Area: 200 square feet/acre Site Index: 60

Volume / Acre: No commercial harvest is anticipated in this stand

Stand Condition: The characteristics of these stands are very similar to DF-3. These stands were high graded when logged. Most of the trees not removed are suppressed from the competition when the forest was too dense. There are a few places where slopes are too steep or rocky for logging. Stand density is too high.

Soils: Fair productivity and moderate erosion potential.

Road Access: There is a rudimentary road system in place. They are narrow and rough. Drainage is needed to reduce erosion and protect the road prism. Much of the area is too steep (>40% slope) for commercial forest management

Fire Hazard: Logging slash has not deteriorated and continues to be a fire hazard. Crown fire during high fire danger conditions is very likely.

Silvicultural Recommendation: When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and existing roads for control lines. Small to medium sized fires within these stands would, in the long term, help reduce fuel continuity and stimulate aspen as well as shrub growth. Use of the confine and contain techniques would also be

the most cost effective way to control fires. Ideally the area should be prescribe burned.

Noxious Weeds: Canada thistle is present in the stand. It will be important to check the areas charred by the burn piles and treat any emerging noxious weeds as they appear.

Volume Estimate: No commercial material will be produced by this treatment.

Stem Count/Acre: 500 and more

Stand DF-3



Stand DF-3 is one of the best stands on the ranch and is close to the main house.

Vegetation Type: Douglas –fir with occasional aspen.

Acres: 272 acres total deeded

Slope: 11-30%

Basal Area: 200 square feet/acre

Site Index: 60

Volume / Acre: No commercial harvest is anticipated in this stand

Stand Condition: The lower portions of this stand were logged in 1993. Many of the larger trees were removed at that time. The remaining stand has some good sized trees and many smaller stems. Stand density is too high. Logging slash has not deteriorated and continues to be a fire hazard. Overall forest health can be improved and fire hazard reduced with thinning and slash disposal.

Soils: Fair productivity and moderate erosion potential.

Road Access: There is a rudimentary road system in place. They are narrow and rough. Drainage is needed to reduce erosion and protect the road prism. Much of the area is too steep (>40% slope) for commercial forest management

Fire Hazard: This stand lays low on the mountain and dries out sooner than upper elevations. Debris from the 1993 logging operation is problematic. This stand is immediately adjacent to the new home site. Crown fire is very likely.

Silvicultural Recommendation: Two specific issues need to be addressed in this stand. There are too many small trees providing a fuel ladder directly into the tops of the larger trees and there is too much logging debris on the ground.

Small trees should be removed and all the dead-down woody debris should be hand piled and burned on slopes less than thirty percent.

Stem Count/Acre:

DBH (INCHES)	5	6	9	10	11	13	15	16	TOTAL
Stems before treatment	293	102	45	37	30	21	32	14	574
Stems after treatment	0	0	45	37	30	21	32	14	179
# Removed	293	102	0	0	0	0	0	0	395

This treatment will enhance forest health and reduce the fire hazard substantially. Fire intensity will be reduced and the remaining trees will be more likely to withstand the next wildfire in the area. It will also improve the aesthetic back drop for the new home.

Volume Estimate: No commercial material will be produced by this treatment.

Noxious Weeds: Canada thistle is present in the stand. It will be important to check the areas charred by the burn piles and treat any emerging noxious weeds as they appear.

Stand/Unit DF/A-1



General view of stand at foot of ridge on northeast side of mountain



Photo depicting stand density where logged 20 to 40 years ago.

Vegetation Type: Douglas-fir with aspen (logged within past 30 years)

Acres: 98 acres deeded lands Slope: 11-30%

Basal Area: 60 to 80 sq.ft . Site Index: 60

Volume/Acre: No commercial harvest is anticipated in this stand

Stand Condition: This stand was logged heavily in the past. Most of the merchantable Douglas-fir was removed during that harvest. Aspen has responded in most of the openings. There is also a mixed conifer understory led by sub-alpine fir.

Douglas-fir and sub-alpine fir seedlings and saplings are abundant and in good condition. Clumps and small stands of aspen are distributed throughout the unit but concentrations of browsing are keeping the aspen down.

Canada thistle is dispersed throughout the area.

Soils: There is enough woody debris on site to ameliorate erosion from soil disturbance. Road soils are in fair condition. Drainage is needed after the next harvest is completed.

Road Access: Interior roads built during past logging entries provide good access. Skid trails are in place.

Fire Hazard: High to extreme due to old logging slash accumulations and clumps of small conifer fire ladders.

Silvicultural Recommendation: Prescribe burn and/or patch cut (2 to 10 acres) to provoke a fresh start for aspen, maintain habitat diversity, and to reduce fuel continuity. Reducing sub-alpine fir reproduction and breaking up sub-alpine fir thickets should be secondary objectives and will contribute to the above goals. Unless there is a market for small wood products it is not feasible to commercial harvest for another 40 or 50 years. If patch cut timber can be marketed the following table depicts the stems and volume per acre available.

DBH	10"	12"	16"	18"	20"	TOTAL
Stems/Ac	45	15	15	13	14	102
Cubic Volume/Ac	311	209	276	412	661	1,869
Board feet/Ac	964	879	1,167	1,878	3,098	7,985



Debris fences should be installed around clear cut patches for protection of aspen sprouts

Burn most of the old slash piles and logging debris.

Treat Canada thistle and other noxious weeds until suppressed.

Stem Count: The stem count ranges from 70 to 250 stems per acre when counting trees of all sizes.

Lodgepole Type Map Symbol (LP)

There are approximately 581 acres of the lodgepole pine cover type on the Elk Mountain of which 307 acres are on deeded lands. There are places where lodgepole pine may be the dominant species but it often occurs in a variety of proportions with sub-alpine fir. In addition, the mixed conifer includes lodgepole pine as a major component and there are over 5,000 acres of mixed conifer on Elk Mountain.

Traditionally, lodgepole pine is considered to be a pioneer species because it does not appear to tolerate the forest under story environment and because of its ability to produce serotinous cones. Serotinous cones are produced during most years, but remain closed for many years until opened by heat, such as occurs during a fire or direct sunlight. The large store of accumulated seed is thereby dispersed by wind when a mineral soil seedbed and low competition for resources help to ensure seedling establishment. Often “dog hair” stands of young trees will develop. The under story of a lodgepole pine forest includes other shade tolerant species such as sub-alpine fir. The lodgepole pine seedlings are more common in gaps that have occurred due to windstorms, parasites, and insects. The new seedlings mature together creating a new canopy. Lodgepole pine establishment is thus episodic and patchy, resulting in a forest with two or three age classes.

Within the patches or in large-scale acreages, where disturbance hasn't occurred for a long time, lodgepole pine usually grows in even aged stands and tends to succumb to stand-wide disturbances such as fire and insects. Also, the even aged stands appear to create interdependence among the trees for wind firmness. When harvesting lodgepole pine it is important to design the cutting units for minimum wind throw of trees not harvested.

If a fire occurs or the mountain pine beetle infestation reduces the presence of lodgepole pine, aspen will often occupy and dominate the site until lodgepole can reestablish itself. If lodgepole becomes reestablished it will eventually succeed and shade out the aspen.

Stand LP-1 and LP- 3 through LP-10



Most of the lodgepole pine on deeded lands are small, on steep slopes and not commercially viable

Vegetation type: Lodgepole pine

Acres: 503 total acres with 229 acres on deeded lands Slope: 10 to >30%

Basal Area: 160 square feet / acre

Site Index: 60

Volume / Acre: No commercial harvest is anticipated in this stand

Stand Condition: These stands are generally dense. They are comprised of a mosaic of small stands and single trees consisting of lodgepole pine with small sub-alpine fir, aspen and an assortment of other species. This type provides some wildlife habitat and thermal and hiding cover for elk and deer. Stand is moderately healthy with increasing density. In many areas aspen is being crowded out and succeeded. Insect and disease mortality is also increasing. Mountain pine bark beetle, and Western Balsam fir bark beetle will continue to kill pockets of trees.

Soils: Fair productivity with moderate to high erosion potential depending on slope.

Road Access: Some stands have access and some are on steep slopes with not access..

Fire Hazard: The moderate to heavy fuel ladders and dense crown canopy cover make this stand an excellent candidate for crown fire. At a minimum it will burn very hot when it does burn.

Silvicultural Recommendations: When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and existing roads for control lines. Small to medium sized fires within these stands would, in the long term, help reduce fuel continuity and provoke a fresh start for aspen. Use of the confine and contain techniques would also be the most cost effective way to control fires.

Stem Count: Stem count ranges from 300 to 1000 stems/acre for all sizes.

Stand LP-2



**LP-2 represents the best of
old growth lodgepole pine
on the ranch.**

Vegetation type: Lodgepole pine

Acres: 78 acres on deeded lands

Slope: 10 to >30%

Basal Area: 160 square feet / acre

Site Index: 60

Volume / Acre:

DBH	6"	8"	10"	12"	14"	16"	TOTAL
Stems/Ac	51	57	86	109	40	7	351
Cubic Volume/Ac	85	288	655	2,048	1,252	198	4527
Board feet	0	1,154	2,573	8,680	5,818	905	19,129

Stand Condition: This stand is just what pine bark beetles are looking for. It is composed of old, dense trees that have poor vigor. There are many trees with dead tops and plenty dead standing. There are five distinct canopy layers. It is also a superb example of old growth lodgepole pine and has high biodiversity value providing superb wildlife habitat.

Soils: Fair productivity with moderate to high erosion potential depending on slope.

Road Access: A primitive road runs just west of the stand. In its present condition it is marginally drivable in a 4x4 pickup and does not provide log truck access. It is badly eroded and needs drainage. Substantial

reconstruction will be necessary to make the road passable with log truck sized equipment.

Fire Hazard: A combination of dead-down woody debris, heavy fuel ladders and dense crown canopy cover make this stand an excellent candidate for crown fire. At a minimum it will burn very hot when it does burn.

Silvicultural Recommendation: This stand provides a dilemma when it comes to making a silvicultural recommendation. If forest health, from a strict commercial forestry perspective was the only consideration, it is time to clear-cut this stand and replace it with young lodgepole pine. When wildlife habitat and biodiversity are considered, the path is less clear. Once cost to reconstruct the road to a minimum standard for log truck access is factored in, it shifts the balance toward no treatment.

Slope limits logging to about forty acres in this stand. This will produce the following commercial volume:

DBH	8"	10"	12"	14"	16"	TOTAL
Stems/Ac	2,280	3,440	4,360	1,600	280	14,040
Cubic Volume/Ac	11,520	26,200	81,920	50,080	7,920	181,080
Board feet	46,160	102,920	8,680	5,818	36,200	765,160

765 thousand board feet of lodgepole pine is expected to yield \$30,600.00 in revenue to the Ranch. This sum has normal logging costs taken out of it but does not include the cost of road reconstruction. The road work needed will cost more than \$30,000 making the sale a net financial loss.

No silvicultural treatment is recommended based on the net financial loss and other resource considerations.

Limber Pine**Map Symbol_(WP)**

Generally, limber pine is too knotty for commercial value. There are approximately 850 acres of limber pine on the Elk Mountain ranch, 556 acres, of which, are deeded. Limber pine trees or small clumps of trees are also associated with the sagebrush type.

The thin bark of young limber pine trees does not protect them from even low-severity fires. Because the bark at the base of older trees is often 2 inches thick, these trees can withstand stem scorch from low-severity fires. Terminal buds are somewhat protected from the heat associated with crown scorch by the tight clusters of needles around them.

Wildfires are less frequent in limber pine communities than in other conifer habitats because of limited productivity and fuel accumulation associated with poor soil development, short growing seasons, and late snowmelt. Scientist have categorized 38 pines within a series of 5 fire predictability regimes. They include limber pine among those pines growing in areas with very low site (and therefore fuel) productivity and unpredictable fire return intervals of up to 1000 years. Limber pine seed may be cached by Clark's nutcrackers and provide a seed source to establish limber pine on burned sites previously dominated by other conifers.

Limber pine is often killed by fire because of its relatively thin bark. Scientist argue that the lack of evolution of thick, fire-resistant bark in this species is a result of very long and unpredictable fire return intervals in the unproductive sites where it occurs. The degree of stem scorch usually determines the extent of fire injury to trees. Any fire that scorches their stems usually kills young trees. Mature trees with thicker bark can survive. The open stand structure, sparse fuels, and sparse undergrowth of limber pine communities reduce the vulnerability of this species to fire.

Some scientist suggests that periodic fires that reduce the undergrowth can maintain limber pine growing in open stands. Where limber pine and Douglas-fir co-dominate, fire can be a thinning agent that slightly favors limber pine over Douglas-fir in the younger age classes.

Stand/Unit: WP-1 through 9



Stands are moderately dense and (R) very often show decline due to white pine blister rust and bark beetle infestations.

Vegetation Type: Limber pine

Acres: 372 acres total with 208 acres deeded Slope: 5-50%

Basal Area: 40 to 100 square feet/ acre Site Index: 15

Volume/Acre: The stems in this stand are short and have a growth form not conducive for commercial uses.

Stand Condition: These stands are moderately dense. They, in several places, appear to be in stress from too much intra-tree competition coupled with drought and shallow soils. There are obvious pockets of decline all over the mountain. Pockets of mortality are due primarily to white pine blister rust and bark beetle. The decline will continue to expand until the trees are thinned to a level that allows the survivors to endure the dry cycles and pathogen attacks.

Soils: Rocky soils with low to fair productivity and moderate erosion hazard.

Road Access: Fair 4x4 access in some locations and no road access in steep areas.

Fire Hazard: Medium to extreme fire hazard with continuous fuels, fuel ladders and pockets of standing and down dead trees.

Silvicultural Recommendation: When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and existing roads for control lines. Small to medium sized fires within these stands

would, in the long term, help reduce fuel continuity and stimulate aspen as well as shrub growth. Use of the confine and contain techniques would also be the most cost effective way to control fires.

No stem count was done but it will range from 80 to over 500 stems per acre.

Stand/Unit: WP/MS-1 through 10



In the foreground of both photos are open stands of noncommercial limber pine in association with Mixed Shrub land.

Vegetation Type: Open Limber pine with sagebrush Mixed Shrub land as the understory. Mixed shrub consists of sagebrush, mountain mahogany, serviceberry, snowberry, bitterbrush and an assortment of other species.

Acres: 478 acres total with 348 acres deeded Slope: 5-50%

Basal Area: 0 to 20 square feet/ acre Site Index: 15

Volume/Acre: The stems in this stand are short and have a growth form not conducive for commercial uses.

Stand Condition: These stands are relatively open and, with the absence of wildfire, appear to be expanding. The limber pine mixed shrub provides good wildlife habitat and thermal and hiding cover for elk and deer. The stands are fairly healthy with increasing density over the years. Pockets of mortality due to white pine blister rust and bark beetle will continue to occur during and after droughts.

Soils: Rocky soils with fair productivity and moderate erosion hazard.

Road Access: Fair 4x4 access in some locations and no road access in steep areas.

Fire Hazard: Medium to extreme fire hazard depending on leaf moisture content of the shrubs.

Silvicultural Recommendation: When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and existing roads for control lines. Small to medium sized fires within these stands

would, in the long term, help reduce fuel continuity and stimulate aspen as well as shrub growth. Use of the confine and contain techniques would also be the most cost effective way to control fires.

No stem count was done but it will range from 30 to over 80 stems per acre.

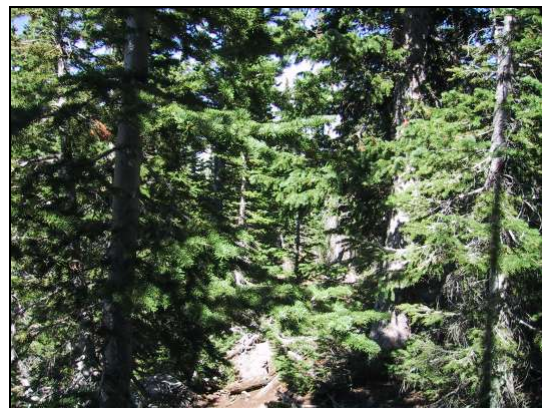
Sub-alpine fir**Map Symbol (F)**

There are approximately 501 acres of sub-alpine fir cover type on the Ranch or which 257 acres are on deeded lands. Most of this occurs in small patches and stringers scattered around the mountain. The majority of the sub-alpine fir is found in association with other species in the mixed conifer or with just one other species such as lodgepole pine or spruce. Approximately 100 to 200 acres, has commercial value. This association usually develops in cool, moist locations and experiences fire-free intervals of 100 to 150 years. Fire-free intervals are shorter where the type occurs on dryer, warmer sites.

Sub-alpine fir is easily killed by fire. It is very susceptible to fire because it has thin bark that provides little insulation for the cambium layer. As sub-alpine fir matures the bark thickens and some self-pruning of lower branches occurs but sub-alpine fir tends to retain lower branches that provide ladder fuels. Roots are shallow and susceptible to heat damage during a fire. Sub-alpine fir tends to grow in dense stands that are susceptible to crown fires. Some larger trees may survive light, surface fires but these often die later due to infection by wood-rotting fungi that enter through fire scars. Mortality in mature trees results from crown scorch, girdled stems from cambial heating and damage to shallow root systems.

Wind blown seed from surviving trees in protected pockets is responsible for most stand reestablishment. Reestablishment is more successful following small fires where surviving trees or trees on the margin of the burn provide a seed source. Seedling establishment is best on moist surfaces where fire has consumed most or the entire duff leaving bare mineral soil. Seedlings require some shade and do best on sites with standing dead trees or logs on the ground.

Stand F-1 through F- 3



Most of the sub-alpine fir on deeded lands are small, on steep slopes and not commercially viable

Vegetation type: Sub-alpine fir

Acres: 409 total acres with 155 acres on deeded lands Slope: 10 to >30%

Basal Area: 160 square feet / acre

Site Index: 60

Volume / Acre: No commercial harvest is anticipated in this stand

Stand Condition: These stands are generally dense. They are comprised of a mosaic of small stands and single trees consisting of small sub-alpine fir, aspen and an assortment of other species. This type provides some wildlife habitat and thermal and hiding cover for elk and deer. Stand is moderately healthy with increasing density. In many areas aspen is being crowded out and succeeded. Insect and disease mortality is also increasing. Western Balsam fir bark beetle will continue to kill pockets of trees.

Soils: Fair productivity with moderate to high erosion potential depending on slope.

Road Access: Some stands have access and some are on steep slopes with not access..

Fire Hazard: The moderate to heavy fuel ladders and dense crown canopy cover make this stand an excellent candidate for crown fire. At a minimum it will burn very hot when it does burn.

Silvicultural Recommendations: When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and existing roads for control lines. Small to medium sized fires within these stands would, in the long term, help reduce fuel continuity and provoke a fresh start for aspen. Use of the confine and contain techniques would also be the most cost effective way to control fires.

Stem Count: Stem count ranges from 310 to 1200 stems/acre for all sizes.

Stand/Unit F/LP -1 and 2



Dense sub-alpine fir with lodgepole pine and aspen. Mortality of the fir and lodgepole pine is high due to both Balsam fir bark beetle and Mountain pine beetle.

Vegetation Type: Dense sub-alpine fir with lodgepole pine

Acres: F/LP-1 = 6 acres

Slope: 11-30 %

F/LP-2 = 54 acres

Basal Area: 80 to 180 square feet/ acre

Site Index: 60

Volume/Acre: 1,650 cubic feet per acre or 6,368 board feet per acre.

DBH	8"	10"	14"	20"	TOTAL
Stems/Ac	95	41	9	5	150
Cubic Volume/Ac	559	391	349	350	1,650
Board feet/Ac	1,583	1,391	1,663	1,731	6,368

Stand Condition: This stand is dense. It is heavily infected with Western Balsam fir bark beetle as well as mountain pine bark beetle and continuation of high mortality is expected. Trees will continue to die and fall creating a untenable fuel bed and severe fire danger.

Soils: Fair productivity and moderate erosion hazard.

Road Access: Fair – a stream crossing over Rattlesnake Creek is needed and the historic marker and location for the “Big Nose George” murder incident should be protected.

Fire Hazard: High to extreme with continuous fuel ladders. This stand is a prime candidate for crown fire destruction under rather mild conditions.

Silvicultural Recommendation: Clear cut all of Stand F/LP-1 and 9 acres on the east end of F/LP-2 and patch cut 20% of the acreage in the other units to provoke a fresh start for aspen and to reduce fuel continuity. An overstory removal harvest is needed on the part of stands F/LP-1 between the clear cuts and patch cuts. If mortality from the insect activity is advanced more acres may need to be clear cut.

Debris fences should be installed around clear cut patches for protection of aspen sprouts.

Volume Estimate: Approximately 39,600 cubic feet or 152,832 board feet (Scribner) of sub-alpine fir and lodgepole pine will come off 24 acres in these stands. Rot/cull should be fairly low given the size class of the trees to be removed. If the entire 60 acres is clear cut the volume could be as high as 99,000 cubic feet available for harvest or 382,080 board feet. The following table depicts the total volume for the clear cut acres only.

DBH	8"	10"	14"	20"	TOTAL
Stems	2,280	94	216	120	2,710
Cubic Feet Volume	13,416	9,384	8,376	8,400	39,576
Board feet Volume	37,992	33,384	39,912	41,544	152,832

Potential volume from the overstory removal would primarily involve, but not limited to, the trees 20" dbh and larger. This is estimated to be another 12,600 cubic feet or 62,316 board feet raising the total volume available to 52,200 cubic feet or 215,148 board feet.

Stem Count: Stem count ranges from 300 to 1600 stems/acre for all sizes. For the merchantable trees only the stem count averages around 150 stems per acre.

Stands F/A-1

(combined with A/MC-3 for management)



Decadent aspen with sub-alpine fir succeeding.



Aspen sprouts first year after clear-cut with brush fence protection on a ranch in Colorado.

Vegetation type: Sub-alpine –fir with aspen

Note: This write up, including the volume, is duplicated in A/MC-3.

Acres: 42 acres

Slope: 11-30%

Combined with A/MC-3 (8 acres)for 50 acres total.

Basal Area: 120 square feet/acre

Site Index: 60

Volumes/acre: By size Class

DBH	6"	8"	10"	12"	14"	TOTAL
Stems/Ac	255	161	73	15	9	513
Cubic Volume/Ac	491	758	820	251	275	2,595
Board feet/Ac	33	1,976	3,216	1,018	1,266	7,509

Stand Condition: Stand is dense and falling apart. Aspen has been over topped by Sub-alpine fir. Fire hazard and insect/disease vulnerability is high.

Soils: There is enough woody debris on site to ameliorate erosion from soil disturbance. Roads are in fair condition. Drainage is needed now.

Road Access: This stand lays on the lower end of the mountain. While roads are not good it will not be as expensive to access as stands further up hill. Good rolling dips are desperately needed on the road accessing this stand.

Fire Hazard: High to extreme due to canopy closure, fuel ladders and dead/down woody material.

Silvicultural Recommendation: Clear-cut this entire stand to rejuvenate aspen and recover what meager value is in the conifer. Shade tolerant sub-alpine fir is replacing much of the aspen in the forested zone of the ranch. Aspen provides important wildlife habitat, especially when the stands are found adjacent to openings and conifer stands. This treatment will assure that aspen is still present in the future. NOTE: Aspen sprouts are highly palatable to elk and deer. Clear cuts elsewhere in the central Rockies have had to have some means to reduce critter browsing on the young aspen sprouts for three to four years. After much experimentation we have found that brush fences constructed from logging waste material provides the surest protection for the least investment. Once the aspen sprouts become saplings over an inch in diameter they are capable of withstanding browsing pressure and the fence can be removed or allowed to deteriorate. Burning the debris windrow is not difficult and can be done with a good cover of snow to reduce fire escape potential.

Make sure all logging equipment is pressure washed before it comes on the ranch to prevent the spread of noxious weed seed. Treat noxious weeds as soon as they become obvious in the harvest area. This will diminish the chances of a large infestation getting started.

Potential piece count and volume from this treatment includes A/MC-3.

DBH	6"	8"	10"	12"	14"	TOTAL
Stems/Ac	10,710	6,762	3,066	630	378	21,546
Cubic Volume/Ac	20,622	31,836	34,440	10,542	11,550	108,990
Board feet	1,386	82,992	135,072	42,756	53,172	315,378

Spruce Type**Map Symbol (S)**

This forest type is most prevalent on the higher elevations of Elk Mountain. There are approximately 1018 acres of the spruce type and spruce-fir mix with aspen and lodgepole. Approximately 572 acres are on deeded lands.

If spruce trees are over 10 inches dbh and have a straight growth form and minimal knots they can have the best commercial value. The spruce forest type occurs in a variety of forest and habitat types that evolved with a variety of fire regimes. It provides valuable habitat for a variety of wildlife including great thermal and hiding cover for elk and deer. This important particularly after calving season.

At the highest elevations Englemann spruce is the dominant species but a variety of trees occur in a variety of proportions including sub-alpine fir, aspen and lodgepole pine. This vegetative type occurs at elevations above the lodgepole pine forest and below the alpine. This vegetative type usually develops in cool, moist locations and experiences fire-free intervals of 100 to 150 years. Fire-free intervals are shorter where the type occurs on dryer, warmer sites. Even aged stands indicate a relationship to fire. Sub-alpine fir is commonly found in association with spruce and is found on sites that evolved with a variety of fire regimes. This thin barked tree with drooping branches is very sensitive to fire as a young plant but becomes moderately fire tolerant as a mature tree. Scattered individuals or pockets of Englemann spruce and fir trees commonly escape burning because they occur in wet locations where fire spread is hampered.

Engleman spruce is easily killed by fire. The spruce is very susceptible to fire because it has thin bark that provides little insulation for the cambium layer. Spruce tends to retain lower branches that provide ladder fuels. Roots are shallow and susceptible to heat damage during a fire. Spruce tends to grow in dense stands that are susceptible to crown fires. Some larger trees may survive light, surface fires but these often die later due to infection by wood-rotting fungi that enter through fire scars. Mortality in mature trees results from crown scorch, girdled stems from cambial heating and damage to shallow root systems.

Wind blown seed from surviving trees in protected pockets is responsible for most stand reestablishment. Reestablishment is more successful following small fires where surviving trees or trees on the margin of the burn provide a seed source. On large, high intensity fires that kill seed trees regeneration of the spruce-fir forest is a slow process. Seedling establishment is best on moist surfaces where fire has consumed most or the entire duff leaving bare mineral soil. Seedlings require some shade and do best on sites with standing dead trees or logs on the ground.

Stand/Unit S- 1 through 5



Spruce dominates the forest type at the higher elevations.

Vegetation Type: Engelmann spruce.

Acres: 527 acres total with 233 acres deeded Slope: 30%+

Basal Area: 160 to 200 square feet/ acre Site Index: 55

Volume/Acre: None calculated. The area is too steep and inoperable for conventional logging techniques.

Stand Condition: These stands are generally dense. They are comprised of Engelmann spruce primarily with single sub-alpine fir and limber pine. This type provides some wildlife habitat and thermal and hiding cover for elk and deer. Stand is moderately healthy with increasing density. Insect and disease mortality is probably going to increase. Stands S1&2 are both over 300 years old and cover only 18 acres of the operable ground.

Soils: Rocky loam that is generally deep and well drained.

Road Access: Poor to none

Fire Hazard: High to extreme – Fuel Models 9 & 10 best describe the stands. Fuel ladders exist and crown fires can be expected under very high fire danger and above.

Silvicultural Recommendations: When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and existing roads for control lines. Small to medium sized fires within these stands

would, in the long term, help reduce fuel continuity and provoke a fresh start for aspen at the higher elevations where it is needed the most. Use of the confine and contain techniques would also be the most cost effective way to control fires.

Stem Count: Stem count ranges from 300 to 1600 stems/acre.

Stand/Unit S/LP- 1 though 4



Spruce dominates but lodgepole pine with lesser amounts of sub-alpine fir are a sub-types.

Vegetation Type: Engelmann spruce/ lodgepole pine with sub-alpine fir.

Acres: 60 deeded acres

Slope: 30%+

Basal Area: 160 to 200 square feet/ acre

Site Index: 55

Volume/Acre: None calculated. The area is too steep and inoperable for conventional logging techniques.

Stand Condition: These stands are generally dense. They are comprised primarily of Engelmann spruce with small stands of lodgepole pine and single sub-alpine fir. Limber pine can be found in a few places. This type provides some wildlife habitat and thermal and hiding cover for elk and deer. Stand is moderately healthy with increasing density. Insect and disease mortality is probably going to spread until stands are thinned enough for survivors to endure dry weather cycles and attacks from pathogens.

Soils: Rocky loam that is generally deep and well drained.

Road Access: Poor to none

Fire Hazard: High to extreme – Fuel Models 9 & 10 best describe the stands. Fuel ladders exist and crown fires can be expected under very high fire danger and above.

Silvicultural Recommendations: When wildfires occur use confine and contain control techniques. This means, wherever possible, use natural barriers and existing roads for control lines. Small to medium sized fires within these stands would, in the long term, help reduce fuel continuity and provoke a fresh start for aspen at the higher elevations where it is needed the most. Use of the confine and contain techniques would also be the most cost effective way to control fires.

Stem Count: Stem count ranges from 300 to 1600 stems/acre.

Other trees

Other trees found on and around the mountain but not dominant or in great numbers are ponderosa pine and cottonwood. Ponderosa pine is seen occasionally at the lower elevations. Ponderosa pine was probably more common before logging occurred and fires were extinguished in the late 1800s.

Cottonwood is not common but found in small patches and stringers along Rattlesnake Creek as part of the riparian.

Social, Economic, and Market Conditions

Elk Mountain Ranch is located in Carbon County in the south central part of Wyoming. With a population of about 16,000, Carbon County is rural with historical industries of agricultural ranching and forestry, oil and gas, coal and increasing, year around outdoor recreation. The ranch is about 60 miles west of Laramie and about 42 miles east of Rawlins, with good transportation along the I-80 corridor.

Forest resource values vary within the area. While livestock grazing has been the predominant and traditional value on the ranch, a significant amount of commercial timber harvest has historically occurred on the mountain.

Sawtimber stumpage markets are subject to frequent fluctuation based on market and other influences—hence the following discussion and assumptions are subject to change. Local influences include, but are not limited to, competition between purchasers, quality of the timber, distance from the mill, road construction needs, silvicultural system applied and harvest system used.

Bighorn Lumber mill in Laramie is the closest operating mill to the ranch, with distances about 70 to 80 miles depending on the ranch unit. Currently the Intermountain sawmill in Saratoga (40 miles) remains closed but apparently is purchasing some stumpage and is expected to begin operations in the near future. The sawmill at Encampment (60 miles) also remains closed with no known date for reopening.

Opportunities appear good for marketing lodgepole pine or Douglas-fir and could be explored with the appropriate mills and operators when the ranch is ready to manage the forested areas. While lodgepole pine and Douglas-fir are the preferred species for milling at this time, occasionally and when the market is up for dimension stock, fir stumpage can also be sold. In addition, many stands on the ranch have smaller stems that would make good fence post/poles and corral material.

While some USDA Forest Service sawtimber sales have gone without a bid, some have been sold for \$40 to as high as \$150/MBF for good quality timber. Depending on the quality of logs, Bighorn Lumber is currently paying \$100 to \$500-\$600 per truckload of logs (rough estimate is 5 MBF per truckload) delivered at the mill. A rough estimate of haul costs from the ranch to the Bighorn mill at Laramie is about \$250 to \$300 per truckload. Incorporating logging costs and some needed road improvement costs, it appears that logging the pine stands may be economically feasible. Obviously, selling logs to the Intermountain mill at Saratoga will greatly reduce the haul costs and therefore make the economics much more favorable.

While normally allowing about 10% fir mixed in with pine, Bighorn Lumber will process a higher percentage of fir if the dimension/stud market is up.

The post and pole timber sales market also seems to be active in that the USDA Forest Service has recently sold post and poles at \$70/MBF. The following table gives potential markets and contacts for sawmills and operators:

It should be pointed out that because some of the units are adjacent to or in close proximity to public land, it may be advantageous to the ranch to coordinate with BLM or USDA Forest Service in designing and harvesting these units.

Table Depicting Potential Products and Processing for Forest Management

Product/Processing	Contact	Phone
Pine (w10+% fir) Sawtimber	Bighorn Lumber, Laramie, WY	307-742-3237
Pine Sawtimber	Intermountain Mill, Saratoga, WY (if they are currently purchasing timber)	
Fence Posts & Poles	Gary Bockman, Encampment, WY	307-327-5713
Logging	RJR Logging, Saratoga, WY	307-326-8833

At present, the Aspen market appears to be non-existent. While not active at this time, the use of aspen for mine props was an active market several years ago and may reemerge as a potential market in the future. Also, the use of forest management residues for chip fuel for small bioenergy plants is a market that is being developed in northern Colorado and should be explored if it develops in the area. There also appears to be a limited market in Northwest Wyoming for mulch. Costs for grinding (using a mid-sized, portable grinder) will likely be about \$20/ton for grinding aspen, pine and brush residues.

Non-Forest Land

The non forested areas have been inventoried as “Units”. Each unit represents vegetative type with similar characteristics, uniform in species composition, age class arrangement and condition.

There are 16 different units of non forest vegetation type on the Elk Mountain Ranch. Descriptions of each of units as they occur follow:

Non-Forest Unit Summary Table

(Also in Part 1)

Unit Symbol	Non Forest Type	Total Acres	Deeded Acres	Treatment Recommendation
MS	Mixed Shrub land	2,424	1,710	Grazing management
MS/ C	Mixed Shrub land with Ceanothus	79	78	Grazing management
MS/A	Mixed Shrub land with Aspen	202	125	Protect springs from livestock grazing
SB	Sagebrush	12,005	8,657	Grazing management
SB/WP	Sagebrush with Limber Pine	813	805	Spot prescribed fire and brush beating
G	Grassland	3,517	2,573	Grazing management
G-alpine	High elevation open grassland	152	0	None
G-Krumholz	High elevation grassland and conifer Krumholz	394	237	None
G/S	High elevation grassland with scattered Spruce	78	63	None
M	Meadow and irrigated Pastureland	2,261	2,030	Grazing management, ditch maintenance, control noxious weeds
MW	Wet Meadow	91	70	Clean ditches to provide drainage
M/R	Mosaic of Meadow and Riparian	205	185	Clean ditches and treat noxious weeds
R	Riparian	593	470	Control noxious weeds
R/A	Riparian dominated by aspen	44	44	Control noxious weeds
Rock	Rock outcrops or rock talus	3	0	None
Rock/WP	Rock outcrops with scattered Limber pine	347	48	None
Total		23,207	17,095	

Note: The non forest summary acreages are rounded off totals and do not represent the total acreage of the lands at the lower elevations away from the geographic area of Elk Mountain. There are several acres of lake and pond surface not included in the above totals and several acres of aspen and limber pine in the lowlands that are included in the forested acreage summary. On top of Elk Mountain there are alpine grasslands, rock slides and rock outcrops accounted for in the non forest acreage totals above.

Mixed Shrub lands**Map Symbol** (MS)**Mixed Shrub lands/Aspen****Map Symbol** (MS/A)**Mixed Shrub lands/Ceanothus****Map Symbol** (MS/C)

Mixed Shrub land occurs in association with Sagebrush Shrub land, grassland and aspen woodland on the lower slopes of Elk Mountain and on both Halleck Ridge and Sheephead Mountain. Mixed Shrub lands occur throughout the foothills of the ranch on a wide variety of sites. The type is a diverse, shrub-dominated type that occurs on mountains, hills, and drainage slopes. It occurs on upland sites with well-drained soils. Across the ranch there are approximately 2,700 acres or about 9 percent of the ranch covered by Mixed Shrub land. This vegetation type provides an important source of nutritious forage for livestock during the winter season when other plants are dormant and valuable habitat, cover and forage, especially in the winter, for elk, deer and other wildlife species.

The Mixed Shrub land association is influenced by many interacting and independent ecological factors, mainly climate, soils, topography, fire history, and grazing history. On the Elk Mountain Ranch these mixed Shrub land stands include a considerable amount of sagebrush that is intermingled with antelope bitterbrush, serviceberry, snowberry, rabbit brush, mountain mahogany, and chokecherry. Sagebrush is the primary shrub species found in most of the mixed Shrub land stands. .

Mixed Shrub land occurs as small patches in forest-dominated landscapes, but on the northwest side of Elk Mountain and west of the mountain occupies fairly large areas. It interfaces on a regular basis with sagebrush s in the lower part of the ranch and with limber pine, Douglas-fir, mixed conifer, and aspen communities elsewhere. In some stands there is a scattering of limber pine, aspen and sometimes sub-alpine fir on some slopes. A variety of native grasses and shrubs make up the under story and contribute to forage production in this vegetative type. The composition of grasses varies from site to site but the most common species include blue bunch wheatgrass, western wheatgrass, green needle grass, mountain brome and sedge. Common forbs include sulfur buckwheat, western yarrow, pea vine and lupine.

Compared to the grasslands, the distinguishing features of mixed ecosystems are the presence of a conspicuous shrub and a larger proportion of the annual precipitation occurring in the winter. Otherwise grasslands and mixed shrub lands are similar with water availability and the length of the growing season limiting plant growth. Potential evapo-transpiration is usually greater than the annual precipitation, and consequently nutrient leaching is rare; fire, drought, and burrowing animals are common disturbances. Sometimes insects or heavy continuous grazing can kill or reduce productivity of shrubs and grass. Plant and animal species have evolved to minimize competition by using different resources and by using them at different times of the year; coexisting herbivores interact in complex ways to affect nutrient cycling and productivity.

Several variants of Mixed Shrub lands that had unique characteristics and habitat value were identified even though the acreage was insignificant. These small islands of Mixed Shrub land dominated by aspen, ceonothus, and shadscale or antelope bitterbrush were distinctly different but all supported a mixture of palatable shrubs. Mixed Shrub land/Aspen (MS/A) occupied about 200 acres and Mixed Shrub land/Ceonothus (MS/C) which occurred on about 80 acres were mapped while the other smaller units were incorporated in the Mixed Shrub land vegetation type.

A Mixed Shrub land/Aspen vegetation type was mapped in small pockets or depressions and in association with springs and wet sites on Halleck Ridge and the ridges east of Rattlesnake Pass. There were 200 acres of small but important sites. Individually these Mixed Shrub land/Aspen islands were small in acreage but provide thermal cover and important habitat for wildlife during the dry summer season. They are a source of nutritious forage, cover and water for mule deer, birds and other wildlife species. The vegetation in these areas occurring as islands in the sagebrush reflected a much higher level of available moisture and protection from the prevailing wind. It is probably that these micro sites accumulate large amounts of drifting snow and this extra moisture results in a mesic site, often with associated springs that surface in the lower part of the drainage. These micro sites had a small stand of aspen and vigorous stands of mixed shrubs that extended well beyond the aspen clone both up and down the drainage. Species present included: mountain big sagebrush, current, choke cherry, service berry, antelope bitterbrush, snowberry, and Rocky Mountain maple in the most mesic sites. A variety of grasses and forbs that were found included: mountain brome, timothy, blue bunch wheatgrass, sedges, rushes, geranium, meadow rue and aster. Canada thistle a common noxious weed was found in most of these sites.

Another variant of Mixed Shrub land was Mixed Shrub land/Ceonothus (MS/C) that was identified where ceonothus dominated the shrub mixture. These unique vegetation islands occupied only 80 acres and were found in the southern portion of the ranch and on the eastern face of Halleck Ridge immediately below the crest of the ridge where they were sheltered from the wind and benefited from snow drifts in the lee of the ridge. Ceonothus, sometimes referred to as buckbrush, provides excellent browse for mule deer and where it occurred it was browsed heavily. Mule deer were observed foraging in the type even though it did not provide escape cover.

The mixed shrub stands on the Elk Mountain Ranch were in good to excellent condition with only light to moderate browsing under current management. However, there was indication that many sites had experienced heavier browsing in the past. Shrubs in the mixed shrub vegetation type provide an important source of nutrition for mule deer, elk and grazing livestock, including buffalo that were grazed in these pastures under past management.

The plant community in general appeared to be in good health and was being used by mule deer and a variety of other wildlife. Some stands may be getting a bit over mature and could use some form of disturbance to renew the stand but treatments to convert or modify the species composition of this type and a large scale are not recommended at this point. Sound grazing management practices that allow short periods of grazing followed by adequate rest (3 to 4 months or so depending on conditions) to allow plant recovery is the primary recommendation.

Several small islands of Mixed Shrub and Mixed Shrub/Aspen were identified in drainages and pockets on Halleck Ridge and the ridges east of Rattlesnake Pass that were considerably more mesic than the surrounding Sagebrush type. Most of these wet areas, especially those with springs, had infestations of Canada thistle. These sites are a focal point for wildlife and grazing livestock and should be treated to control this noxious weed before it spreads further.

Mixed Shrub land
Mixed Shrub land/Aspen
Mixed Shrub land/Ceonothus



Mixed Shrub land (MS) with service berry, mountain mahogany, sagebrush and antelope bitterbrush

Map Symbol (MS)
Map Symbol (MS/A)
Map Symbol (MS/C)



Mixed Shrub land MS/A) with aspen, sagebrush and service berry



Mixed Shrub land (MS/C) with ceonothus and service



Mixed Shrub land (MS) with antelope bitterbrush, snowberry and rabbit brush

Species List:

Mountain mahogany	Blue bunch wheatgrass
Wyoming big sagebrush	Western wheatgrass
Snowberry	June grass
Service berry	Green needle grass
Antelope bitter brush	Idaho fescue
Rabbit brush	Sulphur buckwheat
Wax Current	Western yarrow
Choke cherry	Sedge

Acres: Approximately 2,700 acres total for all subtypes

Vegetative Condition: Fair to Good with some sites Good to Excellent. The Mixed Shrub land type is characterized as excellent for diversity of species, good for absence of exotics and noxious weeds, good for structure and good for overall health.

The mixed Shrub land vegetation type includes forage and habitat for all kinds of wildlife primarily antelope, deer, rabbits, squirrels, predators and a variety of birds.

Fire Hazard: High

Management Recommendations:

Livestock grazing management practices that allow for short periods of grazing followed by adequate rest (3 to 4 months or so depending on conditions) to allow plant recovery. Grazing should not remove more than half of the available herbaceous or shrub forage (40 to 50 percent) utilization on palatable species.

Pasture fences should be restored to working condition. Any new fences should be electric lay down fences that can be laid down when livestock are not in the area to facilitate free movement by wildlife. Spot treatments using small prescribed burns in the spring when soils are moist or using a brush beater on slopes that are 15 percent or less should be designed and implemented to create additional diversity and edge effect that will improve livestock forage, wildlife habitat and improve the area's potential for sage grouse habitat. Sites that appear to have potential for treatment were observed in the Frenchies and Waterworks pastures in the southwest part of the ranch. These sites appear to have deep soils and more available moisture than on the dryer part of the ranch

Sagebrush

Map Symbol (SB)

Sagebrush Shrub lands occur throughout the western and northern portions of the ranch but they form the predominant vegetation type on Halleck Ridge and the lower slopes of Sheephead Mountain. Sagebrush occurs on hills, ridges, and valley floors and provides the primary character of the non-forested area. It covers approximately 12,000 acres, which is about 36 percent of the ranch. It often occurs as a mosaic of sagebrush on the dryer ridge top sites with grasses and forbs more prevalent on the flats and bottomlands. The over story varies from open to completely closed with under story species density and diversity inversely related to over story closure.

Sagebrush Shrub land occurs as small patches in forest-dominated landscapes, but on the northwest side of Elk Mountain and west of the mountain occupies fairly large areas. It interfaces on a regular basis with mixed shrub lands in the lower part of the ranch and with limber pine, Douglas-fir, mixed conifer, and aspen communities elsewhere. A variant of the Sagebrush type was Sagebrush/Limber Pine type that was identified where limber pine was scattered through the sagebrush stand. In these stands there is a scattering of limber pine that appears to be invading the sagebrush stands but not enough to map it as a forest type. A variety of native grasses and shrubs make up the under story and contribute to forage production in this vegetative type. Associated shrub species include Wyoming big sagebrush, black sagebrush, big sagebrush, antelope bitter brush, rabbit brush, service berry and snowberry. The composition of grasses varies from site to site but the most common species include blue bunch wheatgrass, western wheatgrass, thick spike wheatgrass, Idaho fescue, June grass, green needle grass, mountain brome and sedge. Common forbs include broom snake weed, loco, geranium, sulfur buckwheat and western yarrow. Skeleton weed was observed in a few locations and cheat grass was common on roadsides and disturbed areas. Canada thistle was common near riparian and wet areas.

The sagebrush community is influenced by many interacting and independent ecological factors, mainly climate, soils, topography, fire history, and grazing history. Black sagebrush dominates the windswept ridges or slopes with shallow soils; Wyoming big sagebrush on adjacent slopes with more snow accumulation; and mountain big sagebrush is found in moist ravines and pockets that accumulate deep snow drifts.

Sagebrush is adapted for surviving in an environment where water becomes limiting by mid-to late summer. The sagebrush root system is deep enough to make use of deep soil moisture, extending down 6 or more feet, but the shrub also has shallow roots that enable it to use summer rainwater. The root system extends laterally to a distance of over 4 feet.

Generally, sagebrush is poor livestock forage and it competes with preferred grasses for water and nutrients. In contrast, wildlife biologists recognize

sagebrush as important browse for deer, elk, and pronghorn antelope during the winter. It also provides cover and breeding ground for sage grouse. Most of the other associated shrubs are good browse for both wildlife and livestock, particularly in the spring and winter.

Throughout the ranch, particularly on the lower elevations in the northwest part, the sagebrush Shrub land shows indications of past heavy grazing that probably occurred in the growing season. Because of continuous growing season grazing, the grass and forb community production is diminished from its potential.

Good quality grass and brushy cover, essential for sage grouse, occur sporadically. The height and density of herbaceous vegetation is lacking as is the plant diversity that contribute to good habitat for sage grouse. Sage grouse prefer areas that contain cover in scattered openings rather than evenly distributed. In most of the sagebrush Shrub land sagebrush is fairly dense and dominant and shrub diversity as well as herbaceous diversity is lacking.

Currently browsing seems to be relatively light. There is some indication that



browsing was more extreme at some time in the past. Forage conditions in the three Bull Pastures reflected heavy continuous use with evidence of trailing on hill sides and a high utilization on service berry, antelope bitter brush and other palatable shrubs. Very little precipitation has been received since the buffalo were removed and little recovery

Forage conditions in the three Bull Pastures reflected continuous use with evidence of trailing

has taken place. These pastures appeared to be in a degraded condition and the riparian vegetation on Rattlesnake Creek reflected the unraveling of these uplands.

The sagebrush under story vegetation in much of the area was comprised of a good mix of cool season grasses and forbs although it varied from site to site. Shrub height was usually less than 2 feet and generally made 15 to 30 percent of plant cover. For the most part there is no need to treat the sagebrush type on a large scale to reduce the sagebrush cover. However there is some potential to spot treat some of the area in the Frenchies and Waterworks

pastures and on Halleck Ridge that appear to have deeper soils and more available moisture. These spot treatments using prescribed burns in the spring when soils are moist or using a brush beater should be designed to create diversity and edge effect that will improve livestock forage, big game habitat and improve the area's potential for sage grouse habitat. Creating small openings in the sagebrush cover will also reduce the vulnerability to wildfire and the chance of a wildfire killing large areas of sagebrush.

Sagebrush Shrub land

Map Symbol (SB)



Sagebrush Shrub land (SB) with Halleck Ridge in the background



Sagebrush Shrub land (SB) with Sheep's Mountain in background

Species List:

Wyoming big sagebrush	Blue bunch wheatgrass
Mountain big sagebrush	Western wheatgrass
Snowberry	Green needle grass
Service berry	Bottle brush squirrel tail
Antelope bitter brush	Idaho fescue
Rabbit brush	Sulphur buckwheat
Limber pine	Western yarrow
June grass	Broom snake weed
Needle and thread grass	Gum weed

Acres: Approximately 12,000 acres

Vegetative Condition: Fair to Good with some sites Good to Excellent.
The sagebrush Shrub land type is characterized as excellent for diversity of species, good for absence of exotics and noxious weeds, good for structure and good for overall health.

The sagebrush Shrub land vegetation type includes forage and habitat for variety of wildlife antelope, mule deer, sage grouse, spruce grouse, rabbits, predators and a variety of birds.

Fire Hazard: High

Management Recommendations:

Livestock grazing management should include practices that allow for short periods of grazing followed by adequate rest (3 to 4 months or so depending on conditions) to allow plant recovery. Grazing should not remove more than half of the available herbaceous or shrub forage (40 to 50 percent utilization on palatable species).

Spot treatments using small prescribed burns in the spring when soils are moist or using a brush beater on slopes that are 12 percent or less should be designed and implemented to create additional diversity and edge effect that will improve livestock forage, wildlife habitat and improve the area's potential for sage grouse habitat. Sagebrush is vulnerable to fire and usually is killed by fire and seriously reduced by brush beating. Recovery of sites where sagebrush was killed by heavy livestock grazing (trampling) or small fires results in a dramatic increase in grasses and forbs. Sites that appear to have potential for treatment were observed in the Frenchies and Waterworks pastures in the southwest part of the ranch and on Halleck Ridge. These sites appear to have good soil depth and more available moisture than on the dryer part of the ranch.

Pasture fences should be restored to working condition. Any new fences should be electric lay down fences that can be laid down when livestock are not in the area to facilitate free movement by wildlife.

Wildfires should be managed under a "confine and contain" policy that reintroduces fire into the landscape as a natural component.

Sagebrush/Limber Pine

Map Symbol (SB/WP)



Sagebrush/Limber pine (SB/WP) has **sagebrush** with healthy under story and invading limber pine



Sagebrush/Limber Pine (SB/WP) stands on good site with invading limber pine

Species List:

Wyoming big sagebrush	Blue bunch wheatgrass
Mountain big sagebrush	Western wheatgrass
Snowberry	June grass
Service berry	Bottle brush squirrel tail
Antelope bitter brush	Idaho fescue
Rabbit brush	Sulphur buckwheat
Limber pine	Western yarrow
June grass	Broom snake weed
Needle and thread grass	Gum weed

Acres: Approximately 800 acres

Vegetative Condition: Good to Excellent. The sagebrush Shrub land/Limber pine type is characterized as excellent for diversity of species, good for absence of exotics and noxious weeds, good for structure and good for overall health.

The sagebrush Shrub land/limber pine vegetation type includes forage and habitat for variety of wildlife antelope, mule deer, sage grouse, spruce grouse, rabbits, predators and a variety of birds. It is occurs on productive ridge sides with good soils and moisture conditions.

Fire Hazard: High

Management Recommendations:

Livestock grazing should be continued but should include management practices that allow for short periods of grazing followed by adequate rest (3 to 4 months or so depending on conditions) to allow plant recovery before

regrazing occurs. Grazing should not remove more than half of the available herbaceous or shrub forage (40 to 50 percent utilization on palatable species).

Spot treatments using prescribed burns in the spring when soils are moist should be designed and implemented to create additional diversity and edge effect and kill as much of the limber pine that is invading these productive sagebrush stands as possible. The prescribed burns could be started low on the slope and let them burn uphill into the residual snow near the top of the ridge. The target should be relatively narrow linear burns that maximize edge effect without converting large areas of sagebrush to grass. Done right grasses and forbs will increase these new clearings in the sagebrush that will improve livestock forage, wildlife habitat and improve the area's potential for sage grouse habitat. Sites that appear to have potential for treatment were observed in the Frenchies and Waterworks pastures in the southwest part of the ranch and on Halleck Ridge. These sites appear to have good soil depth and more available moisture than on the dryer part of the ranch

Wildfires should be managed under a "confine and contain" policy that makes use of a wildfire to create openings in the sagebrush as long as it is not completely out of control.

Grassland

Map Symbol (G)

Grasslands occur primarily on the eastern flank of Elk Mountain and along ridge tops and flats between Elk Mountain and Halleck Ridge. These native grassland occur on the uplands in association with sagebrush and mixed Shrub land in the lower elevations and foothills, in patches between forest stands on Elk Mountain and in the alpine zone. Across the ranch there are approximately 3,500 acres of grassland or about 10 percent of the ranch on the lower elevations surrounding the mountain. They are valuable yearlong for livestock forage and habitat for a variety of wildlife species.

Grasslands develop on windy slopes or plateaus where snow does not accumulate in large quantities, where soils are too shallow for various shrub species, or where summer rainfall is higher. Grassland occurs throughout the full range of elevations on the Elk Mountain Ranch. They are generally the grass/forb communities on shallow soils and wind-swept ridges. Idaho fescue, bottlebrush squirrel tail, June grass, blue grama, needle and thread grass, green needle grass, alkali saccaton and mountain brome grass are some of the grasses observed throughout this vegetation type. In addition, western wheatgrass and bluebunch wheatgrass are typical cool season perennial grasses that are common in the area. Forbs that occur include broom snake weed, loco, Indian paintbrush, gum weed, western yarrow and globe mallow. Cheat grass is common especially in areas that have experienced recent soil disturbance such as along the roads and pond dikes. Cheat grass and skeleton weed patches were also observed in this type on the west side of the ranch. Livestock grazing on the Elk Mountain Ranch may encourage the presence of cheat grass, especially within or near the disturbed areas.

Several variations of the Grassland vegetation type were observed and mapped. Alpine grasslands (G-alpine) occurred on about 150 acres or about a half percent on top of Elk Mountain generally above 10,000 feet elevation on rocky, shallow soils that are exposed to high winds and cold temperatures.

Environmental conditions are not conducive to productive grasslands. Other variations included a mosaic of spruce forest and stringers of grassland with scattered spruce trees shown on the map as Grass/Spruce forest (G/S) on about 80 acres and a mosaic of open alpine grasslands and spruce Krumholz (G/S/K) on about 400 acres or about 1 percent of the area. These harsh sites provide important wildlife habitat but they do not provide an important source of livestock forage. The acreage of these grassland variants total only about 630 acres.

The grassland areas on the ranch have been exposed to extensive livestock grazing in the past. Recently buffalo have been grazed in much the same way that livestock did historically. Grazing habits of buffalo differ somewhat from cattle in that they spend more time on ridge tops instead of in the riparian areas but the overall impacts are similar. Currently the buffalo have been

removed and cattle are grazing the grasslands and meadows of the Elk Mountain Ranch.

Grasslands evolved under the influence of grazing by large herbivores but when fences were constructed and herbivores were confined to specific areas some ecological changes occurred. Species composition changed as the more palatable plants were grazed repeatedly and less desirable ones were left to prosper. Most of the upland rangelands have changed significantly in composition, structure, and function. The dominant bunchgrasses that are so critical to the ecological integrity of these ecosystems have been extirpated in many areas, and the abundance and distribution of remaining bunchgrasses have been drastically reduced in others. Exotic species (including Kentucky bluegrass, dandelion, and noxious weeds), and native increaser species (including yarrow, cinquefoil, and annual forbs) have taken the place of bunchgrasses in many places. This change in species composition has altered the structure of many of these grasslands from tall, bunchgrass-dominated community types to short, sod-dominated or forb-dominated types. Additional livestock grazing-related changes to the mountain grasslands include the reduction of litter, an increase in bare soil, increases in soil erosion and compaction resulting in a loss of soil productivity, and a decrease in native species richness.

Land development and land management activities have introduced exotic plants and noxious weeds into the grasslands. Roads and trails needed for timber sales and livestock grazing have been conduits for the introduction and spread of exotic plants into the forested landscapes where the grasslands occur. Equipment brought into the area for logging and haying are generally thought to be the primary means of introducing and spreading noxious weed seed. Mountain grasslands that have lost native species often have higher amounts of bare soil, which makes them susceptible to the establishment of exotic plants.

Although drought conditions were prevalent during field examination of the ranch, livestock watering facilities appeared to be inadequate in the grassland pastures. Cattle tend to go to water as a group and when there is not enough water stored or flowing through a watering point they crowd around and compete for the available water causing unnecessary impacts at the watering point. In cases where livestock water is inadequate or water storage is inadequate, it may be necessary to provide additional water storage to accommodate grazing livestock.

Grassland

Map Symbol (G)



Grassland on the west side of Elk Mountain



Grassland on the east side of Elk Mountain

Species List:

Wyoming big sagebrush	Blue bunch wheatgrass
Black sagebrush	Western wheatgrass
Snowberry	Idaho fescue
Service berry	Bottle brush squirrel tail
Antelope bitter brush	Gum weed
Rabbit brush	Sulphur buckwheat
June grass	Western yarrow
Needle and thread grass	Broom snake weed

Acres: Approximately 3,500 acres

Vegetative Condition: Fair to Good. The grassland type is characterized as fair to good for diversity of species, good for absence of exotics and noxious weeds, fair for structure and good for overall health.

The grassland vegetation type produces forage for livestock and habitat for variety of wildlife including antelope, mule deer, rabbits, predators and a variety of birds. It is occurs on productive open ridge tops and gently sloping areas with good soils

Fire Hazard: High

Management Recommendations:

Livestock should be managed to insure that goals are achieved and that grazing use is not detrimental to the ecological health of the grassland. There does not appear to be a need for mechanical treatments or prescribed burns to alter the species composition of the grassland type.

Livestock grazing should be continued at a conservative level to maintain the values associated with upland grasslands. Livestock grazing should include management practices that allow for short periods of grazing followed by adequate rest (60 to 90 or so depending on growing conditions) to allow plant recovery before re-grazing occurs. Grazing should not remove more than half of the available herbaceous or shrub forage (40 to 50 percent utilization on palatable species).

Wildfires should be managed under a “confine and contain” policy that serves to re-introduce fire into the management regime for managed grasslands.

Pasture fences should be restored to working condition. Any new fences should be electric lay down fences that can be laid down when livestock are not in the area to facilitate free movement by wildlife.

Where livestock water is inadequate or water storage is inadequate, it may be necessary to provide additional water storage to accommodate grazing livestock

Grassland - Alpine
Grassland-Krumholz
Grassland-Spruce

Map Symbol
Map Symbol
Map Symbol

(G- Alpine)
(G/S-K)
(G/S)



Grassland-Krumholz occurs in association with spruce or limber pine in areas exposed to scouring winds.

Grassland-alpine and Grassland-Spruce are open high elevation grasslands with a scattering of spruce.

Species List:

Engelmann spruce	Blue grass
Limber pine	Needle and thread grass
June grass	Western yarrow
Idaho fescue	Elk sedge
Sheep fescue	Dandelion

Acres: Approximately 630 acres

Vegetative Condition: Fair to Good. The grassland type is characterized as fair to good for diversity of species, excellent for absence of exotics and noxious weeds, fair for structure and good for overall health. These harsh sites provide important wildlife habitat but they do not provide an important source of livestock forage

Fire Hazard: High

Management Recommendations:

Grasslands at high elevations on Elk Mountain are scattered and cover only about a section. Due to the harshness of the sites and difficulty accessing the area, they are probably best reserved for wildlife. No treatments are envisioned for these areas

Wildfires should be managed under a “confine and contain” policy that serves to re-introduce fire into the management regime for managed grasslands.

Meadows and Irrigated Pasture**Map Symbol (M)****Wet Meadows****Map Symbol (MW)****Meadow Riparian****Map Symbol (M/R)**

Meadows and Irrigated Pasture (M) occur on relatively flat, low lying areas, mostly in the northern portion of the ranch, where water has been diverted from streams and moved through a system of irrigation ditches to provide irrigation water on areas that would have been sub-irrigated or dry under natural conditions. Irrigated pastures also have been developed on the east side of the mountain where stream flow has been diverted and spread for irrigation purposes. These sub-irrigated and irrigated meadows exist on 2,260 acres or about 7 percent of the ranch. They are very productive as irrigated pasture for livestock grazing and hay production and they provide important habitat for wildlife. The hay fields provide habitat enhancements for small ground squirrels and voles as well as a variety of song birds, raptors, deer, elk and antelope. During the current year the upper portion was harvested for hay and the lower meadows were being grazed by livestock. Many of these meadows were established in the late 1800's to provide pasture and hay for horses used by the military and continue to be a critical component of the ranches agricultural activity.

The Meadows and Irrigated Pastures vegetation type is really a mosaic of low lying drainages and stream bottoms that are naturally sub-irrigated and adjacent uplands that have irrigation ditches that carry water from spring snow melt and water diverted from Halleck Creek, Rattlesnake Creek and other drainages. These long standing ditches convey irrigation water to the upper edge of the irrigated meadows. Contour ditches run through the meadows to catch and spread irrigation water. Remnants of the native plant community are present and domestic pasture grasses and alfalfa have been seeded in the meadows in the past. Very little alfalfa appears to have survived historic grazing use and the drought leaving the meadows dominated by grasses. Grasses observed included: Timothy, alkali saccaton, fescue, smooth brome, wheatgrass, sedges and rushes. Forbs include: alfalfa, wild iris, dandelion, cinquefoil, wavy thistle, and Canada thistle. Noxious weeds in the area included Canada thistle and knapweed.

Irrigation ditches appear not to have been maintained for some time and are in need of considerable work to make the irrigation system work efficiently. Ditches that had not been maintained were grown up with grass which trapped silt and reduced the ditches' capacity to carry water. These overgrown ditches have had water overflow their banks and numerous washouts were observed. As a result water appears to be unmanageable and portions of the meadows have had excessive water while other areas dried out due to the inability to get water to flow to them. A program of annual maintenance for irrigation ditches is needed. It would be helpful to burn the accumulated vegetation in all ditches in the spring on an annual basis to prevent silt accumulation. When burning ditches adequate help and a source of water and fire fighting tools

should be close at hand. Before the irrigation season begins accumulated silt and vegetation should then be plowed out of ditches on an “as needed basis” and washouts from the previous year should be repaired.

Wild iris has invaded areas that have a history of being irrigated and then not being allowed to dry up. Livestock aggravate the problem by wading through these wet areas disturbing the soil and sometimes leaving hummocks. . Wild iris produces an underground tuber that assures its reproduction and ability to live on to another year. Once wild iris is established it is difficult to control because it tolerates saturated soils and is resistant to grazing. Control of wild iris basically involves causing the site to “dry up” between irrigations and to fertilize to give the grasses a competitive advantage. Changing use of the meadow from livestock grazing to hay production will also help with the conversion. In more difficult situations where it may not be possible to dry up the site, it may be necessary to use a herbicide to control the wild iris and then interseed a grass that can tolerate wet meadow sites such as Garrison foxtail.

Electric fences around the upper meadow were observed but they were not functional and are in need of repair. These electric fences are a good tool for controlling the way livestock graze irrigated pastures and should be maintained for the control they provide in a livestock operation. .

Several variations of the Meadow and Irrigated Pasture vegetation type were observed and mapped. Wet Meadows (MW) occurred on about 90 acres in the lower part of some irrigated pastures that were poorly drained. These areas were characterized by saturated soils and often exhibited standing water. Sedges and rushes are tolerant of wet soils and were the most common plants in these areas. Drainage ditches pulled through the lowest areas to the stream channel or to a contour ditch would help with drainage.

Another variation was the Meadow Riparian (MR) which was a mosaic of intermingled stringers of riparian vegetation where a defined channel does not exist and irrigated meadows and pastures. This complex was mapped separately because the components were too small to be mapped individually. They are simply small patches of irrigated meadow interlaced with riparian stringers and are used for livestock grazing and hay production. Because of edge effect and close proximity of the two types these areas are important for wildlife and birds and they provide effective escape cover and travel routes. They each represented the values of their own types but were in close proximity to each other.

**Irrigated Pasture and Meadow
Wet Meadow
Meadow/Riparian**



**Irrigated Pasture and Meadow
on Halleck Creek provide hay,
grazing and wildlife values**

**Map Symbol (M)
Map Symbol (MW)
Map Symbol (M/R)**



**Irrigated meadows not harvested
provide forage, cover and habitat
for wildlife**

Species list

Willow	Rushes
Alder	Wheatgrass
Shadscale	Slender wheatgrass
Timothy	Alfalfa
Smooth brome	Wild iris
Fescue	Dandelion
Alkali saccaton	Cinquefoil
Sedges	Canada thistle

Acres: Approximately 2,550 acres

Vegetative Condition: Fair to Good. The Irrigated Pasture and Meadow type is characterized as fair for diversity of species, fair for absence of exotics and noxious weeds, fair for structure and good for overall health.

The irrigated meadow type produces hay, forage for livestock and habitat for variety of wildlife including antelope, mule deer, elk, rabbits, predators and a variety of birds. It occurs on productive bottom lands and on gently sloping areas with good soils

Fire Hazard: High

Management Recommendations:

Livestock should be managed to insure that goals are achieved and that grazing use is not detrimental to the ecological health of the irrigated pastures. Livestock grazing should be continued at a conservative level. When pasture conditions allow (roughness, present of woody shrubs, boggy areas, etc) livestock grazing should be done in a rotational scheme with cutting meadows for hay. When an irrigated pasture is allowed to grow up and be cut for hay the plants have a chance to replenish stored food reserves in the roots which significantly improves plant health. Livestock grazing should include management practices that allow for short periods of grazing followed by adequate rest (45 to 60 days or so depending on growing conditions) to allow plant recovery before re-grazing occurs. Grazing should not remove more than half of the available herbaceous or shrub forage (50 to 60 percent utilization on palatable species). The key to a successful livestock grazing program is to limit the opportunity a cow has to “re-graze” a plant before it has had time to recover from the first grazing.

Pasture fences should be restored to working condition. Any new fences should be electric lay down fences that can be laid down when livestock are not in the area to facilitate free movement by wildlife.

Where livestock water is inadequate or water storage is inadequate, it may be necessary to provide additional water storage to accommodate grazing livestock

A program of annual maintenance for irrigation ditches is needed. It would be helpful to burn the accumulated vegetation in all ditches in the spring on an annual basis to prevent silt accumulation. When burning ditches adequate help and a source of water and fire fighting tools should be close at hand. Before the irrigation season begins accumulated silt and vegetation should then be plowed out of ditches on an “as needed basis” and washouts from the previous year should be repaired.

Control wild iris on wet sites in meadows. Basically this involves allowing the site to “dry up” between irrigations and to fertilize to give the grasses a competitive advantage. Changing use of the meadow from livestock grazing to hay production will also help with the conversion. In more difficult situations where it may not be possible to dry up the site, it may be necessary to use a herbicide to control the wild iris and then interseed a grass that can tolerate wet meadow sites such as Garrison foxtail.

Improve the quality of meadows and irrigated pastures by introducing legumes, forbs and desirable grasses. New plant species can be introduced by interseeding the existing pasture with species like alfalfa, and clover or by pulling a lightly weighted disk or harrow over the dry pasture to reduce competition from existing grasses and to create a seedbed before broadcast

seeding the seed mixture. Pulling a harrow over the pasture again to cover the seed will improve the chances of success.

Riparian

Map Symbol (R)

Riparian (R) cover type occurs in areas where a defined stream channel exists and where water is readily available. They can be narrow or wide and are best defined by plants that have a high water requirement and are not found in drier environments. These narrow bands of riparian vegetation make up about 637 acres which is less than one percent of the ranch.

On the Elk Mountain Ranch riparian vegetation occurs along Halleck Creek and Rattlesnake Creek. Rattlesnake Creek supports a complex plant community in the riparian zone with willow, alder, aspen occasionally mixed conifer and narrow leaf cottonwood being the primary woody species. In some areas aspen dominates while willow or alder characterized the riparian zone in other reaches. The riparian zone on lower Halleck Creek is characterized by a broad band of alder and willow growing in close proximity to the stream channel making it conspicuous because of the surrounding wet meadows and hay fields. Portions of the riparian vegetation type in the lowest part of the drainage are characterized by sedges with very little woody vegetation.

Riparian zones are valuable for several reasons. Though less than one percent of the ranch is classified as riparian, an estimated 80 percent of the native animals depend at some time during the year on this limited area for food, water, shelter, and migration routes. Water flows downhill, but animals move along the riparian corridors in both directions through an intricate network of water ways that sometimes pass through otherwise hostile environments. In addition, many riparian zones filter sediments and nutrients, thereby influencing water quality. Their capacity for storing water in alluvial sediments during the spring helps sustain stream flow later in the summer. If free-flowing stream water is impounded or diverted from the main channel, whether by beaver dams or irrigation systems, the nature of the riparian zone changes.

Physical factors that determine the nature of the steamside vegetation include stream gradient, sinuosity, channel-width-to-depth ratios, topography, and soil type. Beaver dams, water developments, and grazing by larger mammals are key biological factors. The soils of riparian environments are highly variable, having alluvial lenses of gravel, sand, silt, or clay. The vegetation is also highly variable and may include marshes, meadows, shrub lands, and tree dominated woodlands.

Canada thistle, a noxious weed, was observed in patches and individual plants in numerous locations in the riparian zone along Rattlesnake Creek and it was established throughout the ranch in wet areas, around springs and along irrigation ditches. Other noxious weeds that were observed or are known to be presenting riparian areas include knapweeds and hound's tongue. An aggressive program designed to control these noxious weeds should be

developed and implemented. While all should be treated, priority should be given to controlling the knapweeds.

Vegetative Type Riparian**Map Symbol (R)****Riparian in lower
Rattlesnake Creek****Riparian along Halleck Creek****Species list**

Willow	Rushes
Alder	Tall wheatgrass
Aspen	Slender wheatgrass
Mixed Conifer	Alfalfa
Smooth brome	Wild iris
Fescue	Dandelion
Alkali saccaton	Cinquefoil
Sedges	Canada thistle
Shadscale	Timothy

Acres: Approximately 637 acres

Slope Range: 1 to 6%

Elevation Range: 7,200 to 10,000 feet

Vegetative Condition: The shrubs, trees, grasses, forbs and sedges occur within riparian zone because of the abundance of moisture and the cool-air drainage moderates the temperature. The riparian vegetation is confined to a narrow strip along the streams (or segments of streams called “reaches”) and is characterized by either a mix of willow and alder with some trees, like aspen, or primarily wet meadow grasses and sedges. Wildlife and cattle utilize and often concentrate these areas.

Vegetation within the riparian areas are in general in good condition. However, the vegetation in Halleck Creek #1, reach 1, Halleck Creek (main), reaches 4 and 5 and Johnson Creek, reach 1 are in poor and declining condition because of heavy grazing and cattle impacts. Concentrations of cattle in these riparian areas have resulted in over-use of grasses, forbs and some woody plant species.

Concentrations of a variety of noxious weeds is high. Most visible is the presence of Canada thistle.

Management Recommendations:

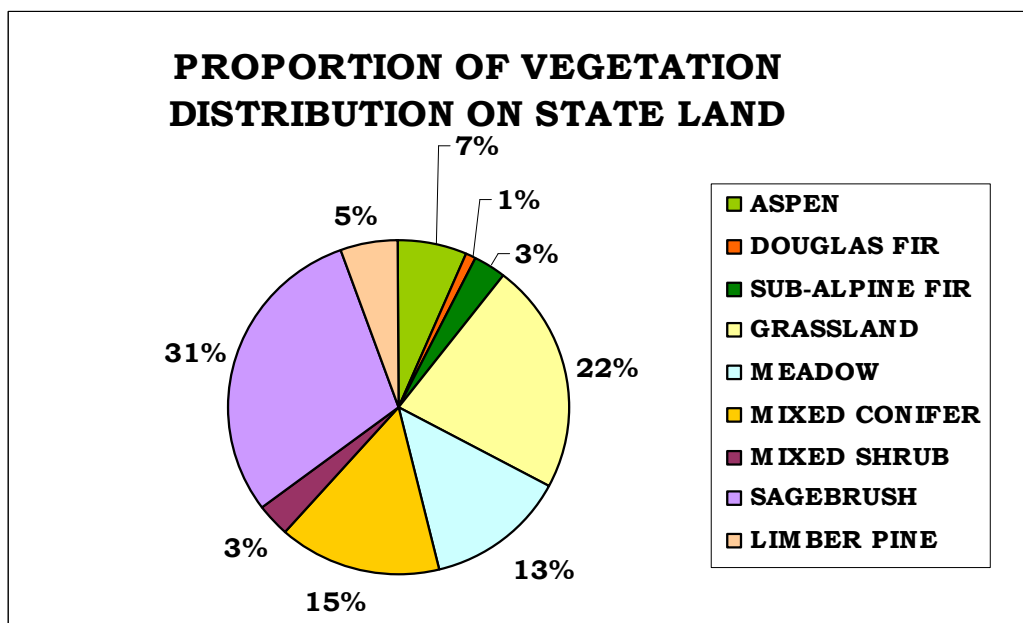
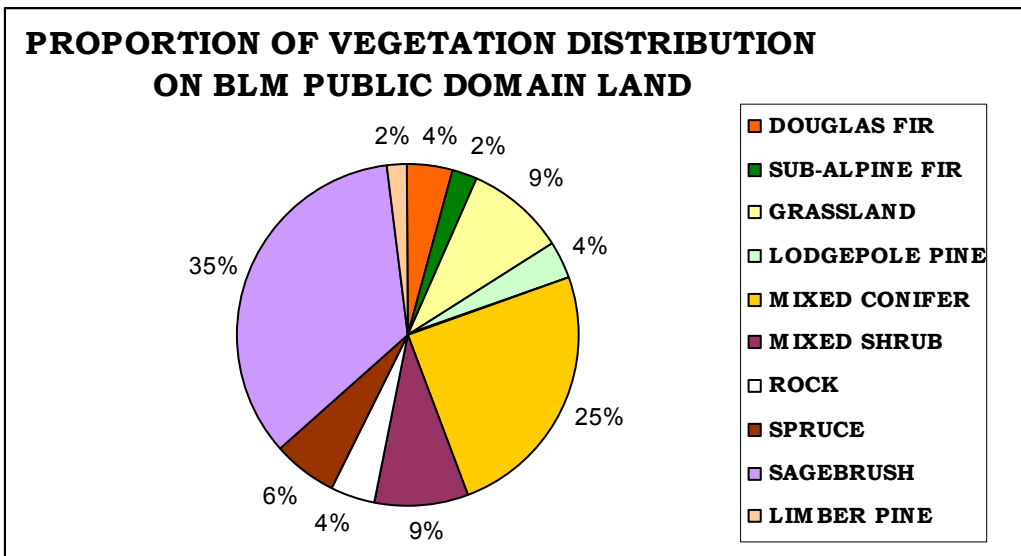
Rest the problem riparian areas from grazing. Move salt blocks out of the riparian areas.

Aggressively treat the noxious weeds, particularly Canada thistle.

BLM Public Domain, State, and Hanna Land Vegetative Summaries

Within the Elk Mountain ranch there are approximately 7,400 acres of BLM, 2,640 acres of State land, and 156 acres deeded for Hanna water supply. Following is a breakdown of the vegetative types on BLM public Domain, State Lands, and the Town of Hanna Property followed by a vegetative type breakdown by Section within the BLM, State and Hanna property ownerships.

At the end of this section is an explanation of the Public Land Survey and why some of the Sections are smaller than the normal 640 acres.

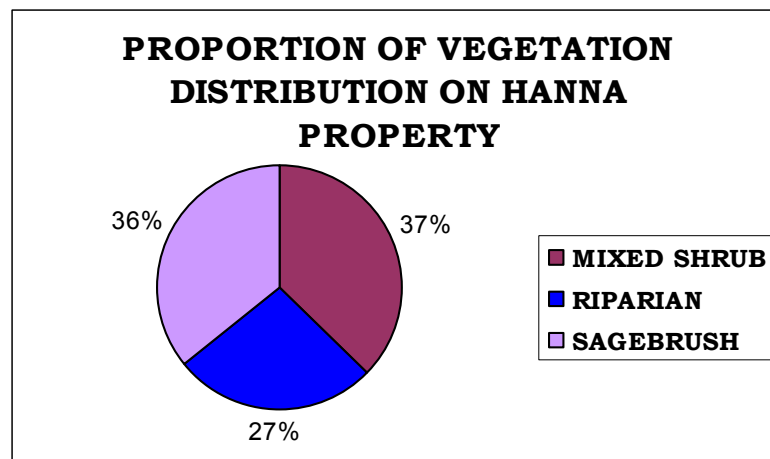


Commercial timber on the forested areas of BLM Public Domain and most of the State land have all been logged within the past 40 years. Some of the logging has been heavier than on the adjacent deeded lands.

Consequently, the fire hazard associated with logging slash is the same as it is on the deeded lands. Also, the need to protect aspen regeneration from browsing is something needed on the BLM lands.

If the forested and non-forested lands were under one ownership instead of three owners the resources could be managed much more effectively and efficiently to benefit the long term conditions. Here are a few examples:

- Resource information gathering and assessment would be more efficient.
- Fire hazard reduction, forest management, noxious weed control, insect and disease mitigation, wildlife management and habitat improvement, fisheries management, road management, and range management including fences and waters could all be done more efficiently and with a wider more effective impact.
- Roles and responsibilities with regard to fire control, insect and disease mitigation, road management and maintenance, public interest and public access, overall watershed management, and other management responsibilities would be clarified.
- Coordination within the larger resource neighborhood would be simplified and could be more effective, particularly with regard to the watershed and wildlife management.



BLM PUBLIC DOMAIN, WYOMING STATE LAND, AND TOWN OF HANNA

Acres of vegetative type by section beginning at the north end of the Elk Mountain Ranch going south.

Note: Refer to Elk Mountain Ranch Vegetation Type Map for vegetative type patterns.

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	MIXED SHRUB	MS	32	T 21 N, R 81 W	27.1
BLM	SAGE BRUSH	SB	32	T 21 N, R 81 W	219.1
Total					246.2

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	MIXED SHRUB	MS	34	T 21 N, R 81 W	2.8
BLM	SAGE BRUSH	SB	34	T 21 N, R 81 W	336.4
Total					339.2

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	MIXED SHRUB WITH ASPEN	MS/A	6	T 20 N, R 81 W	0.4
BLM	MIXED SHRUB WITH CEANOTHUS	MS/C	6	T 20 N, R 81 W	0.7
BLM	MIXED SHRUB	MS	6	T 20 N, R 81 W	15.8
BLM	SAGE BRUSH	SB	6	T 20 N, R 81 W	300.1
Total					317.0

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	MEADOW	M	8	T 20 N, R 81 W	0.8
BLM	SAGE BRUSH	SB	8	T 20 N, R 81 W	197.0
Total					197.8

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
STATE	GRASSLAND	G	16	T 20 N, R 81 W	168.5
STATE	MEADOW WITH RIPARIAN	M/R	16	T 20 N, R 81 W	20.1
STATE	MEADOW	M	16	T 20 N, R 81 W	228.6
STATE	MIXED SHRUB	MS	16	T 20 N, R 81 W	7.7
STATE	WET MEADOW	MW	16	T 20 N, R 81 W	20.5
STATE	RIPARIAN	R	16	T 20 N, R 81 W	79.5
STATE	SAGE BRUSH	SB	16	T 20 N, R 81 W	119.3
Total					644.1

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	DOUGLAS-FIR	DF	20	T 20 N, R 81 W	39.0
Total					39.0

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	ASPEN	A	28	T 20 N, R 81 W	0.2
BLM	GRASSLAND	G	28	T 20 N, R 81 W	77.4
BLM	MIXED CONIFER WITH ASPEN	MC/A	28	T 20 N, R 81 W	82.1
BLM	MIXED SHRUB	MS	28	T 20 N, R 81 W	0.1
Total					159.7
STATE	ASPEN	A	28	T 20 N, R 81 W	39.9
STATE	GRASSLAND	G	28	T 20 N, R 81 W	417.6
STATE	MIXED CONIFER WITH ASPEN	MC/A	28	T 20 N, R 81 W	23.3
Total					480.8

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	ASPEN	A	30	T 20 N, R 81 W	1.0
BLM	DOUGLAS-FIR	DF	30	T 20 N, R 81 W	271.3
BLM	SUB ALPINE FIR	F	30	T 20 N, R 81 W	16.1
BLM	LODGEPOLE PINE	LP	30	T 20 N, R 81 W	89.7
BLM	MIXED CONIFER	MC	30	T 20 N, R 81 W	236.6
BLM	MIXED SHRUB	MS	30	T 20 N, R 81 W	15.0
Total					629.7

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	SUB ALPINE FIR	F	32	T 20 N, R 81 W	2.5
BLM	GRASSLAND WITH SPRUCE	G/S	32	T 20 N, R 81 W	14.7
BLM	MIXED CONIFER WITH ASPEN	MC/A	32	T 20 N, R 81 W	24.7
BLM	MIXED CONIFER	MC	32	T 20 N, R 81 W	414.0
BLM	MIXED SHRUB	MS	32	T 20 N, R 81 W	138.7
BLM	SPRUCE	S	32	T 20 N, R 81 W	42.1
Total					636.7

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	MIXED SHRUB	MS	12	T 20 N, R 82 W	43.2
BLM	SAGE BRUSH	SB	12	T 20 N, R 82 W	568.3
Total					611.5

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	MIXED SHRUB WITH ASPEN	MS/A	14	T 20 N, R 82 W	21.5
BLM	MIXED SHRUB	MS	14	T 20 N, R 82 W	35.2
BLM	SAGE BRUSH	SB	14	T 20 N, R 82 W	569.4
Total					626.1

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
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BLM	GRASSLAND	G	24	T 20 N, R 82 W	276.1
BLM	MIXED SHRUB WITH ASPEN	MS/A	24	T 20 N, R 82 W	43.4
BLM	MIXED SHRUB	MS	24	T 20 N, R 82 W	133.7
BLM	SAGE BRUSH	SB	24	T 20 N, R 82 W	178.5
Total					631.7

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
STATE	GRASSLAND	G	26	T 20 N, R 82 W	4.0
STATE	MIXED SHRUB WITH ASPEN	MS/A	26	T 20 N, R 82 W	12.3
STATE	SAGE BRUSH	SB	26	T 20 N, R 82 W	295.0
Total					311.3
HANNA	MIXED SHRUB	MS	26	T 20 N, R 82 W	57.8
HANNA	RIPARIAN	R	26	T 20 N, R 82 W	42.3
HANNA	SAGE BRUSH WITH LIMBER PINE	SB/WP	26	T 20 N, R 82 W	6.0
HANNA	SAGE BRUSH	SB	26	T 20 N, R 82 W	49.4
Total					155.5
BLM	MIXED SHRUB	MS	26	T 20 N, R 82 W	14.0
BLM	SAGE BRUSH	SB	26	T 20 N, R 82 W	143.0
Total					157.0

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	MIXED SHRUB	MS	28	T 20 N, R 82 W	155.9
Total					155.9

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
STATE	ASPEN	A	34	T 20 N, R 82 W	135.6
STATE	MIXED SHRUB	MS	34	T 20 N, R 82 W	440.2
STATE	LIMBER PINE WITH MIXED SHRUB	WP/MS	34	T 20 N, R 82 W	17.8
Total					593.6

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
STATE	DOUGLAS-FIR	DF	36	T 20 N, R 82 W	24.5
STATE	SUB ALPINE FIR	F	36	T 20 N, R 82 W	76.4
STATE	LODGEPOLE PINE	LP	36	T 20 N, R 82 W	0.0
STATE	MIXED CONIFER WITH ASPEN	MC/A	36	T 20 N, R 82 W	322.6
STATE	MIXED CONIFER	MC	36	T 20 N, R 82 W	57.8
STATE	LIMBER PINE WITH MIXED SHRUB	WP/MS	36	T 20 N, R 82 W	112.3
STATE	LIMBER PINE	WP	36	T 20 N, R 82 W	14.0
Total					607.6

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	SUB ALPINE FIR	F	6	T 19 N, R 81 W	159.5

BLM	GRASSLAND W/ SPRUCE KRUMOLZ	G/S-K	6	T 19 N, R 81 W	0.9
BLM	LODGEPOLE PINE	LP	6	T 19 N, R 81 W	184.3
BLM	MIXED CONIFER WITH ASPEN	MC/A	6	T 19 N, R 81 W	143.0
BLM	MIXED CONIFER	MC	6	T 19 N, R 81 W	88.4
BLM	SPRUCE AND SUBALPINE FIR	S/F	6	T 19 N, R 81 W	43.7
BLM	SPRUCE	S	6	T 19 N, R 81 W	4.8
Total					624.6

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	GRASSLAND WITH SPRUCE KRUMOLZ	G/S-K	8	T 19 N, R 81 W	8.4
BLM	ALPINE GRASSLAND	G-alpine	8	T 19 N, R 81 W	152.4
BLM	MIXED CONIFER	MC	8	T 19 N, R 81 W	105.8
BLM	SPRUCE AND SUBALPINE FIR	S/F	8	T 19 N, R 81 W	13.4
BLM	SPRUCE	S	8	T 19 N, R 81 W	222.2
BLM	SPRUCE KRUMOLZ	S-K	8	T 19 N, R 81 W	123.8
Total					626.0

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	GRASSLAND WITH SPRUCE KRUMOLZ	G/S-K	18	T 19 N, R 81 W	147.3
BLM	MIXED CONIFER	MC	18	T 19 N, R 81 W	83.3
BLM	ROCK OUTCROPS WITH LIMBER PINE	Rock/WP	18	T 19 N, R 81 W	299.6
BLM	SPRUCE WITH LODGEPOLE	S/LP	18	T 19 N, R 81 W	82.4
BLM	SPRUCE	S	18	T 19 N, R 81 W	25.5
Total					638.1

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	ASPEN WITH MIXED CONIFER	A/MC	12	T 19 N, R 82 W	0.2
BLM	MIXED CONIFER WITH ASPEN	MC/A	12	T 19 N, R 82 W	337.6
BLM	MIXED CONIFER	MC	12	T 19 N, R 82 W	106.1
BLM	ROCK OUTCROPS AND SLIDES	Rock	12	T 19 N, R 82 W	2.7
BLM	SPRUCE AND SUBALPINE FIR	S/F	12	T 19 N, R 82 W	0.0
BLM	SPRUCE WITH LODGEPOLE PINE	S/LP	12	T 19 N, R 82 W	12.1
BLM	LIMBER PINE	WP	12	T 19 N, R 82 W	122.5
Total					581.2

OWNER	VEG TYPE	SYMBOL	SEC	TR	ACRES
BLM	ASPEN WITH MIXED CONIFER	A/MC	14	T 19 N, R 82 W	3.6
BLM	MIXED CONIFER WITH ASPEN	MC/A	14	T 19 N, R 82 W	110.0
BLM	MIXED CONIFER	MC	14	T 19 N, R 82 W	51.4
BLM	SAGE BRUSH WITH LIMBER PINE	SB/WP	14	T 19 N, R 82 W	2.6
BLM	LIMBER PINE	WP	14	T 19 N, R 82 W	27.5
Total					195.2

Public Land Survey System (PLSS)

The Land Survey Information System or LSIS is the *official* government Web site for the distribution of the **Public Land Survey System (PLSS) of the United States**. The Bureau of Land Management (BLM) cadastral survey program is responsible for the official boundary surveys for all federal agencies in the U.S. that together manage over 700 million acres. The Public Land Survey System also called the [Rectangular Survey System](#) is the foundation for many survey-based land information systems.

The Bureau of Land Management's (BLM) Geographic Coordinate Data Base (GCDB) is a collection of geographic information representing the Public Land Survey System (PLSS) of the United States. The GCDB grid is computed from BLM survey records (official plats and field notes), local survey records, and geodetic control information.

BLM collects the GCDB data on a township basis. The survey boundaries are delineated by computing the geographic positions of township, section, aliquot part, government lot, and special survey corners. Next, official land descriptions are assigned to each land unit in the grid. The records are then reformatted so Geographic Information System (GIS) software can be used to view the PLSS information spatially.

The BLM began collection of the geographic coordinate information in 1989 and the data collection effort continues today. GCDB data has been collected for approximately three quarters of the townships in the Western United States. The BLM Eastern States Office has collected GCDB for over 300 townships east of the Mississippi River.

GCDB data is available over the Internet from the Land Survey Information System (LSIS) as live streaming data or as downloadable ArcInfo shape files and original flat files. Just click on the GCDB Data-LSIS button to the left to go to the Land Survey Information System Web site.

The GCDB flat files for many townships are also available for download via the GCDB State Office web sites. Just click on the GCDB Offices button to the left and look for the blue links to the State Office Sites. Click here for a one page [summary of GCDB](#) (pdf file format).

This data is intended for mapping purposes only and is not a substitute for a legal land survey.

Noxious Weeds

There are several species of noxious weeds found on the ranch. Russian knapweed and spotted knapweed have been identified and are being treated by Elk Mountain Ranch in cooperation with the Carbon County Weed and Pest Control. The knapweeds were located along Rattlesnake Creek riparian areas, roads and in the irrigated pastures. Canada thistle and cheat grass was observed in all riparian areas, near springs, mesic areas and, in particular, along disturbed areas, roads and trails and in areas that have been logged on and around Elk Mountain. Skeleton weed was observed at a few locations in the grasslands and in the sagebrush. (See the Noxious Weed Map.)

Wildfire

Fire has been an important part of the Elk Mountain landscape since lightning and vegetation commingled. Fire scars on an old Douglas-fir stump near the main house indicated fires presence on the Ranch. The trees origin dates back to 1802. From 1802 until the tree was harvested in 1993 at least six fires burned hot enough to leave a scar in the trees cambium. These fires occurred in 1821, 1828, 1842, 1852, 1869 and 1876. This tells us that the area had an average fire return interval of eleven years before European influence interfered with the natural frequency that wildfires occurred and fire's cleansing action in the vegetation types on the ranch.

Without fires occasional visit dead woody fuel has accumulated on the forest floor and vegetative cover types have changed dramatically. Some trees and shrubs, like Douglas-fir, aspen, ponderosa pine, mountain mahogany, serviceberry and ceanothus are well adapted to fire and do well in its presence. Other trees like sub-alpine fir and the spruces are less tolerant of fire. A long term absence of fire on the Ranch has allowed less fire tolerant species to gain more prominence and fire dependent species to fade away. This has profound long term effects on vegetative diversity and plant densities.

Fire will come to the Mountain again. When it does it will burn hotter than fires of the past. More tree crowns will be killed and the process of reforestation will take longer.

Wildfire hazard on the Ranch is moderate to high. Data in the following table labeled "Expected Fire Behavior by Vegetative Type" provides some insight into how a fire may spread on the Ranch during periods of high winds and dry conditions.

Table Depicting Expected Fire Behavior by Vegetative Type

VEGETATION TYPE	RATE OF SPREAD FEET/HR	SIZE AFTER 1 HOUR ACRES	FLAME LENGTH FEET	SAFETY ZONE SIZE (AC)	WILDFIRE HAZARD
Grass	22,000	12,151	9	2.13	Moderate
Sagebrush & mixed shrub	12,600	2,940	14	8.83	High
Grass/Dense young conifer	18,678	6,375	37	28.32	High
Spruce, sub-alpine fir	448	4.1	2	0.32	Moderate
Ponderosa pine aspen leaves in fall	2,983	164	7	1.43	Moderate
Plentiful dead/down Debris in forested area	2,092	80	10	2.62	High
Light logging slash or blow-down	1,234	28	6	1.23	High

Note: All fuel models had spotting distances of 0.4 miles. The BEHAVE fire prediction modeling system predicts ground fire activity only. Crown fires are too unpredictable and dynamic to allow for reliable modeling. Sustained crown fires can occur anytime crown cover is greater than forty percent and ground fuels are heavy.

Geology and Soils

The Elk Mountain was initially mapped by Clarence King with the U.S. geological exploration of the Fortieth Parallel, and was published by the US Army in 1876. In 1937, J.T. Isberg, a graduate student at the University of Wyoming published the first detailed account of the geology of the area. Pete W. Jacoby Jr., in his 1971 PhD Dissertation, provided a good summary of the geology of the area as follows:

“Elk Mountain is part of a “strongly unsymmetric” anticline which dips from 15-30° to the west. The mountain is thought to be underlain by a “scoop shaped” fault with four additional faults to the west running north and south. In the latter area the Cloverly conglomerate forms two high ridges which influence the drainage pattern of Rattlesnake Creek. The resistant Madison, Fountain and Tensleep formations extend well up the mountain on the gentle western and northern slopes, but the majority of the mountain at higher elevations is composed of Pre-Cambrian granite. Most of the deformation occurred between Medicine Bow and North Park in the early to mid Tertiary age (Beckwith, 1941). Glaciation has not been influential on the mountain judging from the V-

shaped valleys below 9500 feet, and the mountain was probably never completely covered by Tertiary sediments.

The greater part of the lower watershed is covered by the Tensleep sandstone which does not appear to be in contact with other pervious strata. Therefore, water entering this formation flows through the sandstone to the point of contact with the fault at which time it may enter Rattlesnake Creek from below. This effluent nature of the stream may account for the perennial flow which has been constant for many years (Isberg, 1937)."

This interface of sandstone and granite probably has resulted in the perennial but intermittent nature of not only Rattlesnake Creek but also Halleck, Brush and Johnson creeks.

Available soil information is sketchy. Soil inventory within and around the Elk Mountain Ranch has not yet been completed by the Natural Resource Conservation Service (NRCS). However, there is a very limited amount of soil inventory on Halleck Ridge NE of the Elk Mountain Ranch and some of the inventory extends beyond the boundary and is applicable on that part of the Elk Mountain ranch.

Taken in part from Jacoby's dissertation and from field observations, there are different soil types throughout the ranch. Soils over granite materials are usually sandy loams, over sandstone are either sandy or sandy loams, and over the conglomerates are clays or sandy clays. On the upper slopes of the ranch, the soils are usually sandy or sandy loams with high erosion potential, but adequate water percolation and retention characteristics for re-vegetation by trees, grasses and forbs. Throughout the foothills of the ranch the soil is a generally deep clay loam, poorly drained and usually moist. Aspen woodland, grassland and shrub land are most often the dominant vegetation type. It can be easily re-vegetated with adaptable (especially on mesic sites) species.

Water Resources and Watershed Conditions

General Watershed Condition

In general, the watersheds on the Elk Mountain Ranch are in relatively good condition. With the exception of road drainage, disturbances from previous management activities, e.g. grazing, logging, and other uses, have or are in the process of recovering. While the mountainous portion of the ranch has shallow soils and steep slopes, ground cover is in good condition to help reduce surface runoff and sedimentation. Most riparian areas are demonstrating good recovery from previous uses (see riparian discussion in this report).

Roads and Trails

Except for the main entrance road all of the roads and trails on the ranch are classified as un-maintained or poorly maintained. They have no surface gravel and their stability depends entirely upon the characteristics of the natural soil and road design. Many of the roads and trails at the lower elevations are vegetated with grass and forbs and most of the ranch roads are for only for ATV or 4x4 wheel drive vehicles.

Ranch road use is light and the system is adequate for the current level of use. However, CR 600 has a potential for heavier use but because of the deep clay loam soil texture and lack of surfacing material the road is not passable in wet weather.

The main access road to the top of the mountain and the connector roads that feed to and from the mountain road would all need surfacing material (gravel) and maintenance to accommodate logging trucks or any heavy traffic. Adequate drainage is poor or non-existent on many roads throughout the ranch, particularly in the mountainous areas. Excessive rill and gully erosion is occurring on some road segments. Most of the drainage structures, e.g. water bars, installed during road construction or logging are no longer functional. Some of the low-water stream crossings need to be modified to reduce erosion and sedimentation.



Eroding roadway that needs water diversion to reduce channeling (north side of Mt.)



Road erosion due to water channeling in roadway for several years

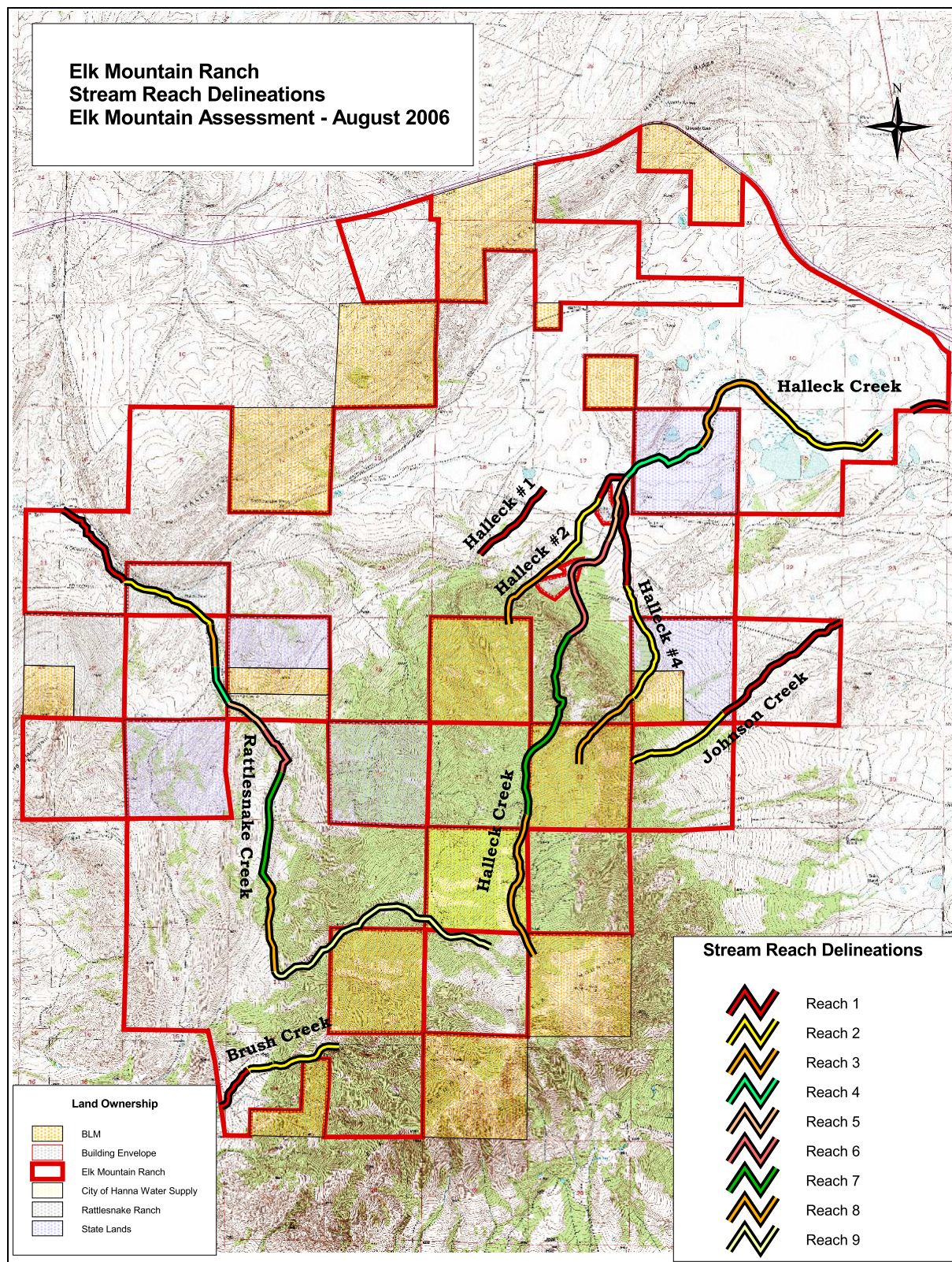
Streams

Elk Mountain lies on the watershed divide between the Medicine Bow River and Pass Creek watersheds, two major tributaries of the North Platte River in south central Wyoming. Within the Elk Mountain Ranch there are four perennial

streams and over 25 ponds and lakes. The headwaters of two major streams, Rattlesnake and Halleck Creeks, are found on the ranch. Two other lesser headwater streams, Brush Creek and Johnson Creek, also originate on the ranch. Rattlesnake Creek is one of the larger headwater tributaries in the Pass Creek watershed, and drains the entire western side of Elk Mountain. Brush Creek is a smaller tributary of Pass Creek, and drains the southwestern flank of Elk Mountain. Halleck Creek is a smaller headwater tributary of the Medicine Bow River, and drains the north and northeast flanks of Elk Mountain. Halleck Creek has four distinct headwater branches, which come together to form the main stem of the creek just below the headquarters of the ranch. Johnson Creek is a lesser tributary of Mill Creek, another of the many Medicine Bow River feeder streams, and drains a small portion of the eastern flank of Elk Mountain.

Assessment Methods and Protocols

For the purposes of this assessment, each stream was delineated into distinct reaches, or segments, based on valley type, channel morphology, perennial vs. intermittent flows, and administrative or physical boundaries. Reaches are numbered consecutively, beginning at the furthestmost downstream ranch boundary, and continuing upstream to the headwaters. Only streams that had detectable flow were assessed for fisheries condition and potential. Many of the dry streams were also assessed for riparian condition. The reach delineations are displayed on Stream Reach Delineation Map and Table.

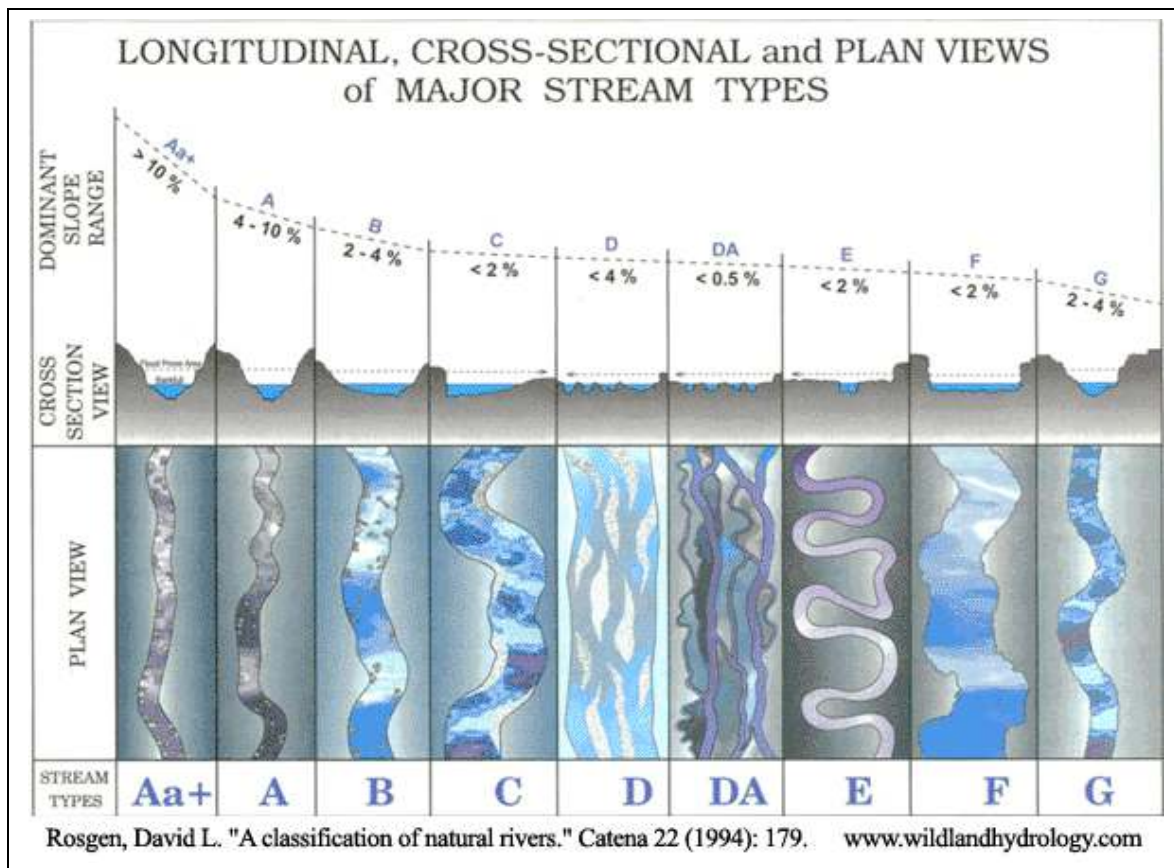


Stream Name Reach #	Stream Type	Flow	Riparian Condition **	Ownership *	Boundary	
					Downstream	Upstream
Brush Creek						
1	B	Dry	PFC	EMR	Ranch Boundary	D/S Limit of Flow near Hidden Meadow
2	B & A	Wet	PFC	EMR	D/S Limit of Flow near Hidden Meadow	Cnfl. w/ Headwater Tribs.
Halleck Creek						
1	C	Wet	FAR ↓	EMR	Ranch Boundary	Ranch Boundary
2	E	Dry	FAR ↔	EMR	Empoundment near Bndy	Road X-ing Weland Meadow
3	E	Wet	PFC	EMR / State	Road X-ing Weland Meadow	Ranch HQ Road X-ing
4	C	Wet	FAR ↓	State	Ranch HQ Road X-ing	Cnfl. w/ Halleck #2 Creek
5	C	Wet	FAR ↓	EMR	Cnfl. w/ Halleck #2 Creek	Road X-ing Above HQ
6	B	Wet	PFC	EMR	Road X-ing Above HQ	Waterfall Barrier
7	A & Aa+	Wet	PFC	EMR / BLM	Waterfall Barrier	Elk Mtn Summit Rd X-ing
8	Aa+	Wet	PFC	EMR / BLM	Elk Mtn Summit Rd X-ing	Headwaters
Halleck #1 Creek						
1	C	Wet	FAR ↓	EMR	Dry Channel near Eagle Lake	Rattlesnake Pass Rd X-ing
Halleck #2 Creek						
1	C	Dry		EMR	Cnfl. w/ Halleck Creek	Ranch HQ Road X-ing
2	C & B	Wet		EMR	Ranch HQ Road X-ing	Site of Proposed New Lake
1	A	Wet		EMR / BLM	Site of Proposed New Lake	Headwaters
Halleck #4 Creek						
1	C	Dry	FAR ↔	EMR	Cnfl. w/ Halleck Creek	Fenceline where creek is Dry
2	C & B	Wet	FAR ↔	EMR / BLM	Fenceline where creek is Dry	Gradient Change Near 8,200ft
3	A	Wet		EMR / BLM	Gradient Change Near 8,200ft	Headwaters
Johnson Creek						
1	C & G	Wet	FAR ↓	EMR	Ranch Boundary	Start of G Channel @ Rd X-ing
2	B & A	Wet	PFC	EMR	Start of G Channel @ Rd X-ing	Headwaters
Rattlesnake Creek						
1	C & F	Wet	FAR ↓	EMR	Ranch Boundary	Rattlesnake Ranch
2	C & F	Wet	FAR ↑	RR	Rattlesnake Ranch	Rattlesnake Ranch
3	C & F	Wet	PFC	EMR	Rattlesnake Ranch	Rd X-ing below Hanna
4	C	Wet	PFC	EMR	Rd X-ing below Hanna	Hanna Water Intake
5	B	Wet	PFC	Hanna / EMR	Hanna Water Intake	Rd X-ing below Beaver Pond
6	B	Wet	PFC	EMR	Rd X-ing below Beaver Pond	Spring where Creek Goes Dry
7	B	Dry	PFC	EMR	Spring where Creek Goes Dry	Gradient Change Near 8,000ft
8	A	Dry	PFC	EMR	Gradient Change Near 8,000ft	Downstream Limit of Flow
9	Aa+	Wet	PFC	EMR / BLM	Downstream Limit of Flow	Headwaters
<p>* EMR = Elk Mountain Ranch RR = Rattlesnake Ranch Hanna = City of Hanna WY</p> <p>** PFC = Properly Functioning Condition FAR ↑ = Functioning at Risk with an Upward Trend FAR ↓ = Functioning at Risk with an Downward Trend FAR ↔ = Functioning at Risk with Trend Unknown</p>						

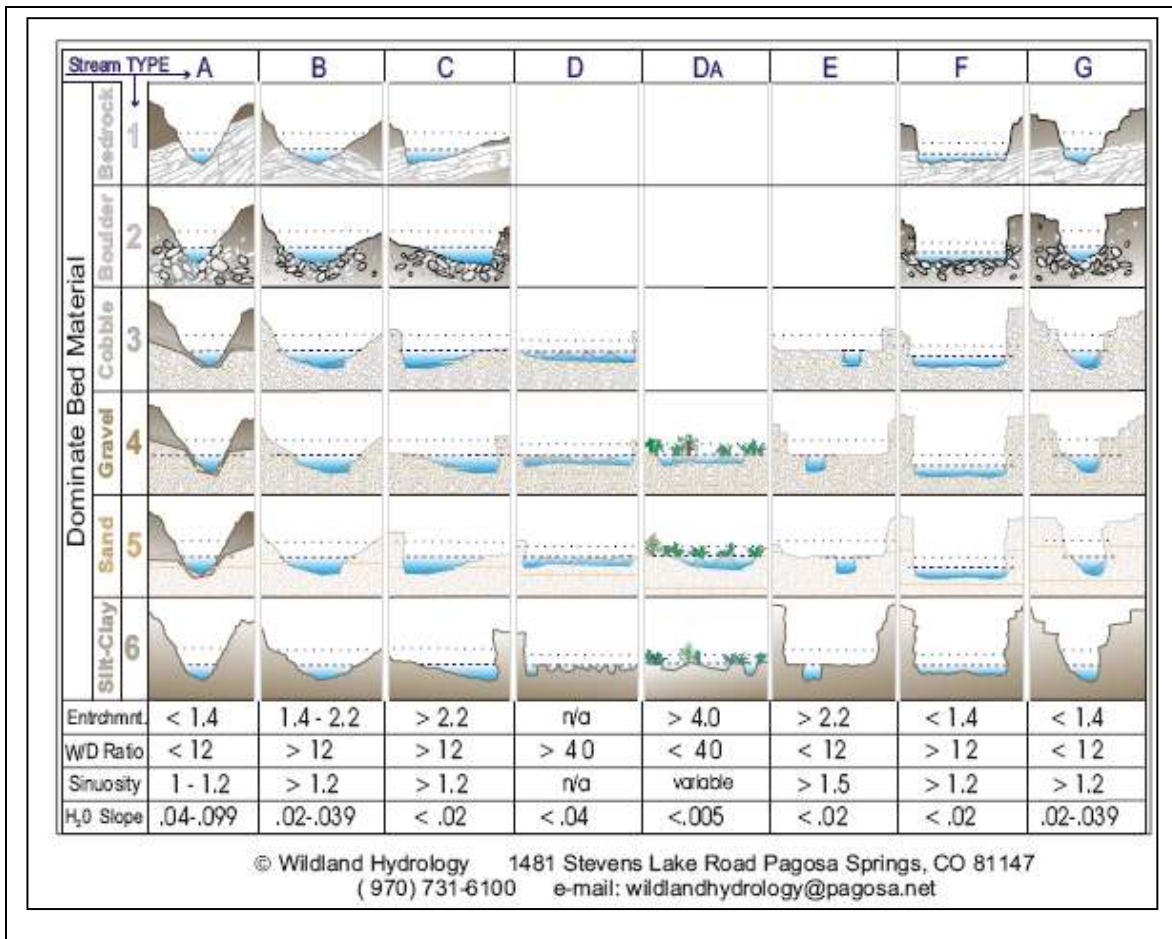
Stream Reach Delineation Table - Elk Mountain Ranch, Carbon County, WY. August 2006

Rosgen Stream Classification System

Stream reaches were classified using the Rosgen Stream Classification System (D.L. Rosgen, CATENA, 1994). The Rosgen classification system groups streams by similar channel geomorphology, gradient, sinuosity and function. The classification system is stratified into three progressive levels, based on channel form, dominant substrate, and gradient. A graphic depiction of the Level 1 classification is shown in the drawing below.

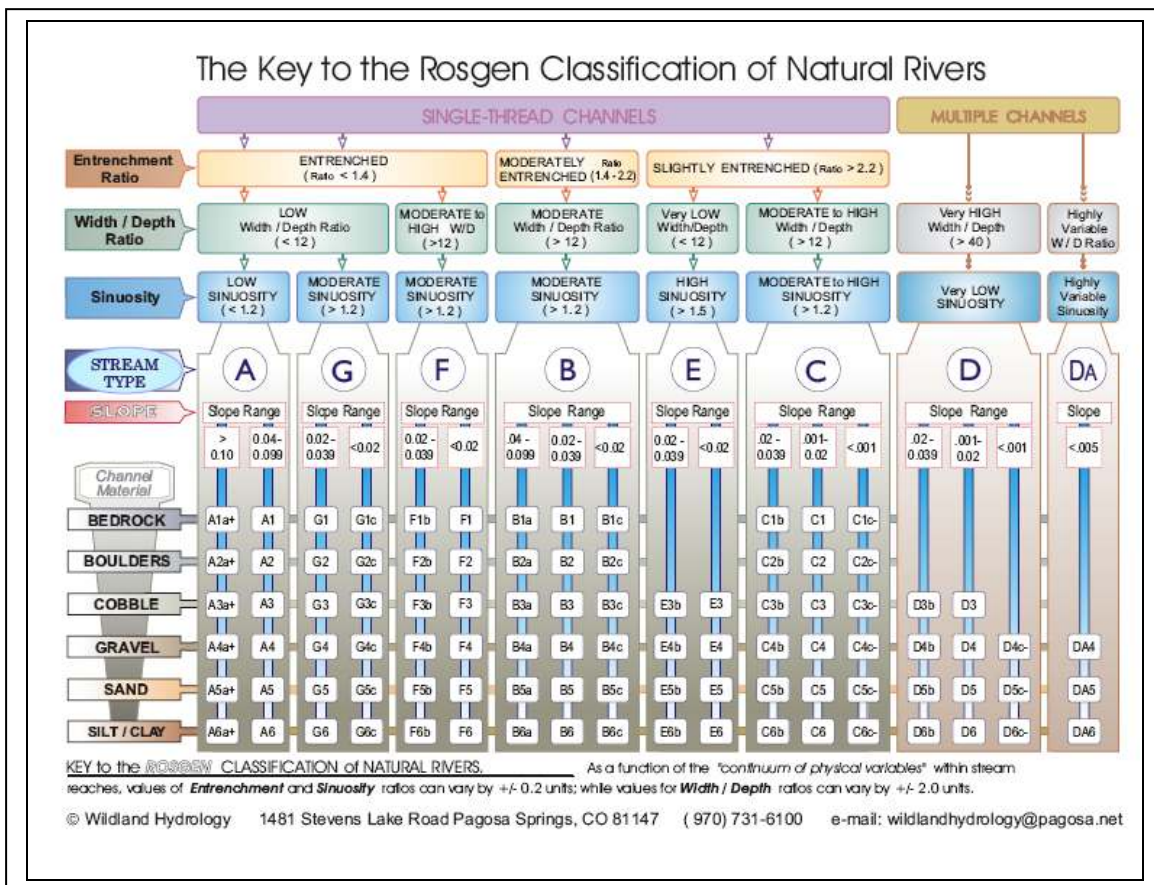


All channel types were observed on the ranch, with the exception of D and DA braided channels. Generally, A type channels are typically found near the headwaters of mountain streams. Lower gradient B channels are characteristic of streams flowing through alluvial plains and broad mountain valleys below the headwaters. C and E channels tend to be found in lower elevation reaches with broad floodplains and low gradients. Each of these channel type supports different assemblages of aquatic habitats, and each can be important in providing habitat complexity for trout. F and G channels are typically found in areas that have been subjected to some disturbance, such as a flood or significant down-cutting of the stream channel. Frequently, in recovering F type channels, a new C channel will begin to form in the flat bottom of the F channel, establishing a new floodplain at a lower elevation. The Level 2 classification stratifies dominant substrate composition, and ranges from 1, bedrock or native bed material, to 6, which represents fine particles of less than 1/4" diameter. A diagram of the Level 2 classification is shown below.



Level 3 of the Rosgen system includes more detailed gradient and sinuosity values. For example, a Rosgen A3a channel would be a steep (<10%), deeply entrenched, and confined channel that exhibits low width/depth ratios and low sinuosity. Channel materials are typically unconsolidated, non-cohesive materials, dominated by cobbles, but also containing some boulders, gravel and sand. The A3a type is generally found in landforms associated with slump/earth-flow and debris torrent erosional processes, and would likely exhibit fluvial entrainments, mass wasting of steep adjacent slopes and debris scour. A detailed diagram of the Level 3 Rosgen classification system is shown in the drawing on the next page.

The Rosgen classification system has been widely adopted by water professionals throughout the west, and is a useful tool for evaluation and comparative analysis of similar stream channels and habitat conditions.



Management recommendations for stream reclamation and fisheries improvement for specific reaches are contained in the Fisheries section of Part 1 in the "Recommended Improvement Projects" section.

Riparian Condition

The following table summarizes condition of the Riparian areas on the Ranch. The majority of the reaches are in proper functioning condition or functioning-at risk but in a stable or upward trend of recovery.

However, Halleck Creek #1, reach 1, Halleck Creek (main), reaches 4 and 5 and Johnson Creek, reach 1 are in poor and declining condition because of heavy grazing and livestock (buffalo) impacts. Concentrations of livestock (buffalo) in these riparian areas have caused raw, eroding banks, soil compaction and general over-use of grasses, forbs and some woody plant species.

Summary Table of Condition of Riparian Areas

STREAM & REACH *	CHANNEL TYPE	FUNCTIONAL RATING **	TREND	COMMENTS ***
Halleck Creek				
#1 -R1	C	Functional-at Risk	Downward	Heavy grazing impacts, raw banks
#2 -R3	A	PFC	Stable	Above new home pond site
Main-R2	E	Functional-at Risk	Not Apparent	Road impact subsurface flows
-R3	C&E	PFC	Not Apparent	
-R4&R5	C	Functional-at Risk	Downward	Heavy grazing impacts
-R6	B	PFC	Stable	Old bank cuts are re-vegetated
-R7	B&A	PFC	Stable	Road crossing blocking fish
-R8	A	PFC	Stable	Old road next to channel, high flow impact
#4 -R1	C	Functional-at Risk	Not Apparent	Old grazing impacts, bank erosion
-R2	B	Functional-at Risk	Not Apparent	Old grazing impacts, bank erosion
Brush Creek				
-R2	B&A	PFC	Not Apparent	Some bank erosion
Rattlesnake Crk				
-R1	C&F	Functional-at Risk	Downward	Vertical cutting/instability in stream bed
-R2	C&F	Functional-at Risk	Upward	Old bank cuts are being re-vegetated
-R3	C&F	PFC	Not Apparent	Old bank cuts are being re-vegetated
-R4	C	PFC	Not Apparent	Old bank cuts are being re-vegetated
-R5	C&B	PFC	Not Apparent	Old bank cuts are being re-vegetated
-R6	B	PFC	Not Apparent	Old bank cuts are being re-vegetated
-R9	A	PFC	Stable	Significant flood flows effect bank erosion
Johnson Creek				
-R1	C&G	Functional-at Risk	Downward	Heavy grazing impacts, raw banks
-R2	B&A	PFC	Stable	

* -- See Stream Reach Delineation Map for location of the streams and reaches

** -- PFC = Proper Functioning Condition

*** -- All riparian areas had noxious weeds (Canada Thistle) present.

Management Recommendations

- Rest the problem riparian areas from grazing.
- Move salt blocks out of the riparian areas.

Wetlands

There are several potential wetlands within this ranch where impacts may need to be considered if logging and the associated road improvement work is planned. They are within all the following drainages particularly Rattlesnake and all branches of Halleck Creek. These sites appear to be waters of the United States, and are subject to regulation Section 404 of the Clean Water Act. On-site wetland delineation is required to determine if they are wetlands subject to regulation. If needed a wetland delineation consultant could perform

the official delineation. More information available on US Army Corps of Engineers web site for regulations and permits at <http://www.usace.army.mil/inet/functions/cw/cecwo/reg/> .

A landowner can obtain authorization from the US Army Corps of Engineers under Section 404 of the Clean Water Act prior to commencing with any activities that include a discharge of dredged or fill material in wetlands or other waters of the United States.

Cultural and Historical Sites

On the ranch there appears to be several historical and cultural sites some of which date back to the 1860s and before. These sights continue to need protection. Their protection needs to be provided for as management activities on the ranch precede. If the owner is interested restoration would be very beneficial to preserving some of the historic artifacts and cultural features for future generations to appreciate.

Here are a few examples:



Blacksmith Shop built in the 1860s as a part of Fort Halleck



Equipment at Old Copper Mine developed, in the early 1900s, by the Elk Mountain Mining and Milling Company on west side of Elk Mountain (located on BLM parcel)



Monument in Rattlesnake Canyon where the Big Nose George murder Incident took place



Old Sawmill Site on BLM on north side of Elk Mt.



Firewood cut and stacked by Cavalry soldiers from Fort Halleck in the 1860s



Aspen Art – probably by a sheep herder several years ago (located on SW side of ranch).



Old cabin and residence on west side

On the ranch there appears to be several historical sites or cultural sites similar to the above. The following is a list:

- Ft. Halleck blacksmith shop
- Ft. Halleck Memorial site (1914) and cemetery (1862)
- Stone carvings by Ft. Halleck soldiers (1863)
- Siltamaki Homestead
- Indian burial ground and artifacts

Huey Cook Homestead (house, well, artifacts)
Joe Cook relatives homestead
Soldier firewood gathering area for UP locomotives (1862-1866)
Old Copper Mine
United Airlines DC-3 crash site (January 31, 1946)
Big Nose George shot the Sheriff (August 19, 1878)
Old Sawmill
Rattlesnake Ranch
Spruce Cabin
Mullen Ranch
Quaely Homestead (cabin)
Overland Trail
Hanna Water supply and site for World War I Army Barracks
Several Old Cabins of unknown origin

There is more information about some of the historic features in the Conservation Easement Report and in Appendix E. Also, there is more historic information available in local libraries and on the internet, particularly about Fort Halleck and the Overland Trail.

Most of the cultural and historical places would not be significantly affected by road improvement or logging activities on the ranch.

Wildlife

Within the Elk Mountain ranch property there is habitat for numerous species of mammals and birds.

Wildlife Species Occurrence and Distribution

Much of the species occurrence information provided in this document was obtained from the "Atlas of birds, mammals, amphibians, and reptiles in Wyoming", published by the Wyoming Game and Fish Department, Wildlife Division in June 2004. The publication provides the best and latest species occurrence and distribution information available. For species distribution and occurrence, data is displayed in 27-one degree of latitude by one degree of longitude blocks covering the state. The species displayed for this document are those listed as occurring in Latilong Block 26 which covers the southeastern 2/3 of Carbon County and extreme southwestern Albany County. A few species of importance that have been reported in the area have also been added to the list. The table in Appendix H displays all wildlife species likely to occur on the ranch. Species of special concern for the Elk Mountain area are displayed in the Appendix I table.

Wildlife Surveys

A series of wildlife surveys was conducted on the ranch from July 27 through August 2. A total of 140 points were sampled, covering most parts of the ranch. Survey routes were set up on roads and two track trails throughout the ranch. Sample points were established at .2 mile intervals. A pause of 2 minutes was used to allow things to calm down prior to the start of each count. The surveys were started at first light and continued until mid morning when the rising temperatures began to influence animal movements and visibility.

A general description of the vegetation was recorded at each location. A count period of 5 minutes was used at each location and all birds and animals seen and heard were recorded. The survey results are recorded in the table displayed in Appendix H. The column entitled “Actual on Elk Mountain Ranch” contains the point count survey information. The number on the left side of the column is the total number of survey points where the species was detected. The number on the right side of the column represents the total number of the species observed at all points for all surveys.

The most common and wide spread bird species recorded was the Clark’s Nutcracker for which 147 individuals were recorded and they were observed at 48 of the 140 points around the ranch. Flickers were quite common with 89 being observed at 42 locations and 83 mountain bluebirds were observed at 20 locations. Pronghorn was the most common big game species with 186 being observed at 25 locations. Elk were next in abundance with 96 being observed at 7 locations and 32 deer were observed at 9 locations.

A number of birds, animals, landscapes and habitats were photographed and some of them are displayed in Appendix G.

Birds

The Elk Mountain Ranch is rich in plant and animal diversity. The avian community is the most diverse of all the wildlife groups. Of the 265 species of birds likely to occur in Atlas Block 26, 262 species are likely to occur at some time on the Elk Mountain Ranch. About 70 percent of the birds likely to be observed on the ranch are migratory. Some, like the white-crowned sparrow may only travel a short distance to spend the winter at lower elevations along the Front Range of the Rocky Mountains. Other species like the Wilson's warbler and broad-tailed hummingbird may travel thousands of miles to spend the winter in the tropical rainforests of Central America. Unlike tropical migrants, some bald eagles may nest in the area and others may fly in from more northern regions to spend the winter here. Over half of those species likely to occur here are songbirds and most of them are migratory because they feed on insects and must move south to find a food source during the winter months. Some adjust their feeding habits during the winter months and feed on seeds and other food sources and avoid the long trip south.

Some species have strong ties to certain habitat types. Of the 262 avian species likely to occur on the ranch, 63 species have strong ties to coniferous and deciduous forests, 64 species need open water or marsh habitat, 31 species have strong ties to basin prairie shrublands and grasslands and 38 species have strong ties to riparian habitats. However, riparian habitats are used to some extent by at least 70 percent of the avian species.

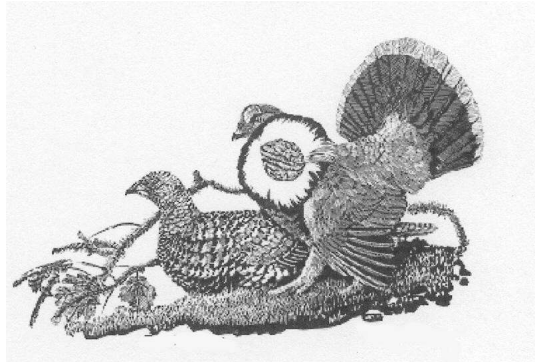
Inhabitants of the area include 8 species of woodpeckers. Each year these primary cavity nesters create new cavities, leaving the old ones for other cavity nesting species. Most of those cavities are created in snags or dead trees. As a tree dies, sections of it decay, creating soft wood where primary cavity nesters like woodpeckers can create cavities. They are very important in the ecosystem because the nest cavities they create are used by at least 21 other species of birds and mammals that occur on the property for nesting and shelter.

Birds of prey comprise at least 24 species of the avian inhabitants here. In addition to the bald eagle that winters in the area, there are several long distance migrants like the burrowing owl, peregrine falcon and Swainson's hawk that fly to the tropics to spend the winter. The Swainson's hawk makes a dramatic post-breeding shift to a diet of grasshoppers and migrates to Argentina to spend the winter (11,000 miles round trip).

Selected avian species are discussed in more detail in this section.

Game Birds

Blue Grouse



Distribution and Status

Blue grouse inhabit forested areas of the Rocky Mountains and the Pacific Coastal Ranges as far south as California and Colorado and as far north as the Yukon and southern Alaska. In Wyoming, this grouse occurs most frequently at elevations between 7,000 and 11,000 feet and is wide spread in the mountains and foothills in the western two thirds of the state. They typically exhibit a reverse altitudinal migration behavior, moving to coniferous forest types at higher elevations in the winter and to open habitat types at lower elevations in the spring. Blue grouse are considered a game species in Wyoming. Hunters harvest less than 4 percent of the population and are not a factor in determining population status.

Life History

This grouse can be distinguished not only by its large size (3 ½ pounds), but also by the pale band of gray on the tip of its otherwise black tail. In the spring, the skin on each side of the male's neck develops a deep yellow air sac that becomes encircled with a frill of white feathers when inflated. These air sacs produce the hoot of the male, a ventriloquial call sometimes heard over a mile away.

Blue grouse begin courtship in mid-April. The female builds a nest in a depression that is usually hidden under fallen branches, under shrubs or beside a log. Normally 6-12 eggs are produced. Incubation takes about 25 days, and the young leave the nest the day that all have hatched. They feed themselves, but stay within 15 yards of the supervising hen. Family units disband at the end of summer. In the winter, these birds spend most of their time in conifer trees where the winter diet of conifer needles is obtained.

Hatching success is usually high for this grouse. However, for those that hatch, mortality is usually 50 percent prior to the fall hunting season. This mortality is usually caused by cold, wet weather just after hatching, insufficient food, and predation. A variety of predators including coyotes,

bobcats, lynx, weasels, martens, golden eagles, hawks and great horned owls feed upon these birds during the winter months.

Habitat Needs

Rearing requirements: Males are territorial during the breeding season. The average territory is about four acres in size, within which the displaying male occupies the center. The majority of the breeding activities occur here. Mature conifer or aspen stands on southerly exposures with open or semi-open canopies and little understory are preferred for territories. Open space is essential for displaying by the males. Male territories do not overlap, however, female home ranges may overlap those of several males.

Blue grouse are ground-nesters, and nests are usually located along edges of openings within or adjacent to forested areas. Shrubs, stumps, logs, and rocks are often used as nesting cover.

Brood rearing areas are typically located in more open habitat types. Brood rearing areas normally have a mixture of grasses, forbs, and shrubs of sufficient height to conceal the hen and her brood.

Feeding requirements: The feeding habitats of blue grouse are highly variable, depending largely on what is seasonally available. Regardless of the season, these birds utilize needles and seeds of many conifers, with some preference shown for Douglas fir needles. Seasonal foods used by blue grouse include forbs and grasses in spring; grasses, forbs, shrubs, and insects in summer and fall; and conifer buds and needles in winter. Brood ranges consisting of mixtures of shrubs, grasses, and forbs, because they support insect populations and are particularly important in supplying the high protein dietary needs of young birds.

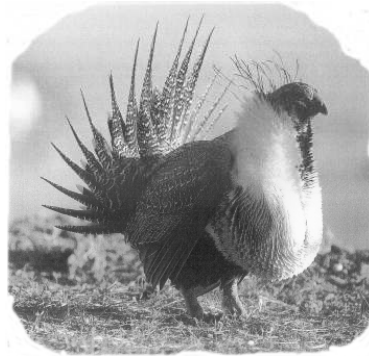
Cover requirements: Open stands of trees with shrub understories provide optimum cover conditions for blue grouse. Coniferous and deciduous trees and shrubs provide resting and escape cover.

Conservation Practices and Management Options

Blue grouse are forest dwelling species and are most likely to be found in association with the stands of aspen and coniferous forest on the ranch.

- I. Maintaining the majority of the forested stands as they presently exist will be important in sustaining current populations of blue grouse on the ranch. Creating small patch cuts and thinning projects over time will help to maintain the habitat diversity important to blue grouse.
- II. When blue grouse nests are discovered, restricting disturbing activities within 100 yards of the nest will be sufficient to allow successful hatching and fledging.

Greater Sage Grouse



Distribution and Status

Sage grouse range from southern Canada, southward through the interior mountain west to central Nevada, Utah, and Colorado. In Wyoming this grouse is reported as a breeder in all parts of the state. Populations are secure in portions of the state. General habitat preference is areas comprised largely of sagebrush interspersed with open meadows, grasslands and riparian areas. During field surveys, 15 sage grouse were observed on the ranch and all were on their summer brood range in wet meadows on the north side of the ranch.

Greater sage grouse are considered a game species in Wyoming and may be hunted in areas where secure populations exist.

Life History

Sage grouse are large chicken like birds. They are brown/gray with conspicuous black (belly, underthroat) and white markings (breast and undertail coverts of males). During the breeding season (late March and April) males have conspicuous neck plumes (white upper breast and yellow-green air sacks). Males weigh from 5 to 7 pounds, while females weigh from 2 to 4 pounds. Males range from 26 to 30 inches in length, and female's range from 19 to 23 inches long.

Sage grouse are dependent upon sagebrush, primarily a subspecies of big sagebrush, and do not occur throughout the year in areas where an abundance of this shrub is absent. Breeding activities occur from mid March to early June depending on elevation. The earliest activities occur in lower areas and the latest in high mountain parks. Male sage grouse display on leks (strutting grounds) in early the morning and late evening to attract females.

Females typically place nests at the base of live sagebrush plants. The female usually lines the nest with some grass, a few small sage twigs and a few feathers. A clutch of 6-12 eggs is laid. Incubation takes 27-28 days but unlike

most grouse species, sage grouse will commonly abandon a nest if disturbed during incubation. Hatching may start as early as May 5, but most eggs hatch in June with a peak by June 20.

The importance of wet meadow habitats to sage grouse has been demonstrated repeatedly throughout their range. The results of several studies have demonstrated that to leave a strip of sagebrush at least 100 yards and preferably 200 yards wide around wet meadows is important for proper interspersation of habitats and to allow sage grouse access to wet meadow habitats.

Habitat Needs

Sage grouse are relatively mobile birds and will move 20 miles or more to meet their seasonal requirements.

Lek Sites: Lek sites are openings with an abundance of sagebrush within 100 to 200 yards as escape cover. These lek sites may be in broad valleys or broad ridges, benches, and mesas. Sites used are generally close to or in large stands of sagebrush and have good visibility (to detect predators) and provide good sound carrying qualities. Various studies report that in locations where the breeding grounds were near irrigated valleys, the post breeding migrations of both sexes proceeded from the strutting grounds to alfalfa fields. Alfalfa is rich in vitamins A, B and E which enhance production of young and the health of both adults and young. No lek sites were documented during field surveys, however, numerous sites were observed that contained all the characteristics for suitable lek sites.

Rearing and feeding requirements: Females typically place the nests at the base of live sagebrush plants. After the eggs hatch, hens with chicks remain in sagebrush uplands as long as vegetation conditions are adequate. During this time, sage grouse feed on succulent forbs and insects. Ideal conditions are those where succulent green forbs and associated insects are abundant and grass cover is sufficiently tall to hide hens and chicks, with some live sagebrush plants for shade and cover. Free water is not required but will be used if available. As chicks mature and vegetation in the sagebrush uplands becomes dry, hens with broods move to wet meadow areas which may be irrigated hay meadows or riparian areas. Grouse prefer areas with an abundance of forbs, grasses for hiding cover, and with live sagebrush along the periphery for escape cover. Rearing and feeding habitats may occur throughout the lower elevations of the ranch. Sage grouse actively utilize the meadows in the northeast part of ranch during the summer months (See the wildlife features map).

Winter Habitat: Quality winter habitat may exist on several areas on the ranch. Sage grouse are completely dependant on sagebrush for forage and cover during the winter months. Extensive cutting of sagebrush in some areas

may be detrimental to winter habitat for this species. Areas available to sage grouse during the winter are largely determined by snow depth. Important areas during winters of deep snow are drainages because of tall, vigorous big sagebrush plants that are consistently available above the snow even during severe winters. Other areas providing important winter habitat include southerly and westerly aspects of slopes greater than 5 percent and flat, low areas with a slope of less than 5 percent.

The optimal habitat conditions for sage grouse wintering habitat would include big sagebrush on slopes with southerly or westerly aspects with a canopy cover of 15 percent minimum and an average height of 12 inches and big sagebrush in drainages with a canopy cover of at least 30 percent and an average height of 20 inches. Ideally low, flat terrain used by sage grouse during winter would have a big sagebrush cover of at least 25 percent and an average height of 16 inches. Areas of such habitat exist on the south facing slopes of Halleck Ridge, and also on the west and southwestern part of the ranch.

Conservation Practices and Management Options

Sage grouse are closely associated with sagebrush and are most likely to be found in sagebrush, riparian areas and wet meadows in the northern, western and southwestern portion of the ranch. A summer brood range map is displayed in Appendix F.

Lek area considerations:

- I. Monitor lek use: The number of birds using lek areas should be monitored and recorded each year. The number of birds using lek areas from year to year can be a valuable barometer of the status of local populations.
- II. Monitor lek conditions: The vegetation condition of known leks should be evaluated. If vegetation encroachment on the lek is evident, some light treatment may be beneficial.
- III. Ground disturbance: Ground disturbing activities resulting in fragmentation or loss of lek habitat or adjacent habitat should be avoided.
- IV. Domestic livestock management: Domestic livestock should not be permitted on or adjacent to lek areas from March 15 to May 15. Excessive livestock use can cause deterioration of hiding cover adjacent to leks and can lead to increased predation.
- V. Human disturbance: Disturbing activities from humans in viewing or hearing distances from leks should be avoided from March 15 to May 15. The most critical period is from daylight to noon each day. Excessive human disturbance of birds while mating can lead to increased mortality or cause some hens not to mate. Viewing of lek activities should be at a distance using binoculars. Driving of

vehicles through or near lek areas should be avoided from daylight to noon during the March through May mating period.

Brooding and summer habitat considerations:

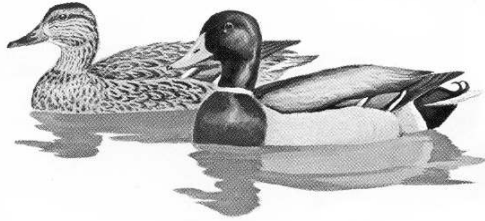
- I. Ground disturbing activities: Activities such as road construction, road maintenance and fence construction should be delayed until after the first of August if possible to minimize adverse impacts to broods of young sage grouse in occupied brooding habitats
- II. Vehicle disturbance: Routine vehicular travel through brooding and summer use areas that is not excessive should not have an adverse impact on brooding sage grouse.
- III. Domestic livestock use: Domestic livestock use of riparian areas used by brooding sage grouse should be avoided if possible. In mid to late summer the livestock feed heavily on grasses, forbs and green leaves of riparian shrubs and consequently directly impact the food and cover value of these areas for sage grouse. Such impacts can result in reduced survival of sage grouse on their summer range.

Winter Range:

- I. Coordinate with adjacent ranches to insure that future sage grouse winter range needs are considered when planning for winter recreation and domestic livestock activities.
- II. If domestic livestock use is to be permitted on winter range habitat, consider light, early season grazing.
- III. Avoid human disturbance of known winter habitat if possible during the winter months when grouse are present.

Waterfowl

Mallards



Distribution and Status

The mallard is distributed throughout North America, Europe, and Asia and has been introduced to many other parts of the globe. They are hardy ducks, wintering throughout southern and central Canada and throughout the United States. The great majority, however migrate to the central and southern United States, where lakes and ponds are ice-free throughout the year. Mallards are essentially freshwater ducks, although some may winter on coastal bays. The Mallard is a typical member of the surface-feeding group of ducks, known as the dabblers. It is often seen in the tipped-up position with its tail held vertical. Although the bird can dive in an emergency, it rarely does so. They are widely distributed throughout Wyoming.

Mallards are a migratory game bird and seasons and bag limits are regulated by state and federal statute.

Life History

Mallards pair in fall and early winter, and then migrate to breeding grounds where pairs select territories. By late March or early April, the first of the mallards are back on their nesting grounds. By this time, ice has melted from most lakes and ponds. The hen builds a ground nest of coarse plant matter, well concealed in dense vegetation. The hen lays a clutch of 7-10 eggs, and incubation takes about 28 days. Hatchlings huddle in the nest for only 12-24 hours before the hen walks the brood to water where they stay until fledging. About this time, the drake moves to larger wetlands to molt. The young gradually lose their down and grow their feathers. In about 10 weeks they have assumed a plumage that is much like that of the female. By that time, the female has abandoned them. The Mallard is an excellent mother. She will stop at frequent intervals to collect and brood, or warm, her young. If surprised by an intruder, she is likely to go flapping and squawking across the ground, as if injured. This feigned injury may not fool a human, but undoubtedly lures predators away. After the ducklings fledge, the hen also moves to a molting area.

Habitat Needs

General habitat preference: Open water with adjacent tall forb and grass vegetation or shrubby cover. The ponds on the northeastern part of the ranch provide important habitat for mallards and many other species of wetland and shore birds.

Food: Feeds on aquatic plants and insects. Ducklings eat mostly aquatic insects.

Water: They require and use water on a regular basis.

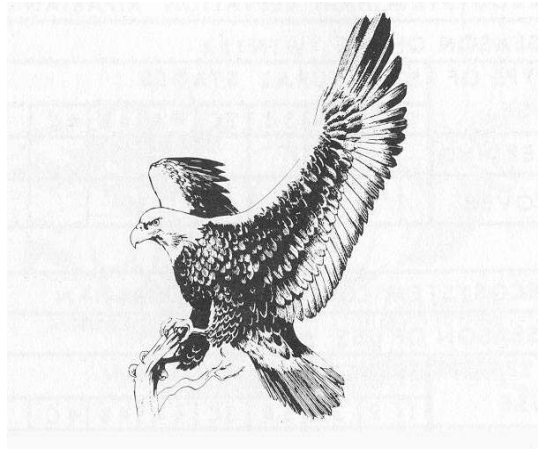
Cover: Mallards rest on open water in lakes and streams and often nest in adjacent grass, forb and shrub vegetation.

Recommendations

Water developments constructed for livestock drinking and recreational use are used by ducks for resting, nesting and feeding. Manage livestock so that some cover is retained in shallow areas and adjacent shore.

Birds of Prey

Bald Eagle



Distribution and Status

Bald eagles live throughout North America from Alaska to Newfoundland, and from the tip of Florida to southern California. With European settlement, their numbers declined dramatically as a result of nest disturbance and shooting. Contamination of their food supply by pesticides caused dramatic declines in this century. Banning of certain pesticides including DDT has caused dramatic increases in bald eagle populations and pairs are known to nest in many parts of the state today. Bald eagles are known to nest in Atlas block 26 and some migrate in from the north to spend the winter in the area. Two adult bald eagles and one fledgling were documented on the ranch during field surveys.

They are the most common on the eastern plains, western rivers and mountain parks.

The bald eagle is classified as a nongame species in Wyoming. Adults, young, eggs, and nests are protected since 1962 in U.S. by The Bald and Golden Eagle Protection Act. Amendments passed in 1978 authorize and regulate “taking” of unoccupied nests on resource development sites. Federal regulations outlawed use of aircraft to kill eagles in the U.S. 1962. The U.S. Fish and Wildlife Service authorizes permits to allow Native Americans to take and possess eagles and their parts for religious purposes.

Life History

Bald eagles build their nests in a fork near the crown of a large tree. They most often choose large cottonwood trees. An immense pile of sticks, the nest has a lining of grasses, moss, twigs, sod, and forbs. Nest occupation usually begins in late February and young have usually fledged by late June. The female lays 1-3 eggs and both parents incubate for 34-35 days until the eggs

hatch. Bald eagles do not obtain the white head and tail feathers until they are approximately 4 ½ years of age. They filter into the breeding population often by replacing a lost pair member. Bald eagles have strong nest integrity and will continue to use a nest over many succeeding years.

Habitat Needs

Rearing requirements: Bald eagles require large, open-crowned trees to support the bulky, stick nest. Freedom from human disturbance is essential during the nesting and brood-rearing season to prevent nest abandonment.

Feeding requirements: Both prey and carrion is utilized as food sources by bald eagles. Prey species frequently taken include fish, waterfowl, rabbits, muskrats and prairie dogs. While these eagles most frequently hunt from perches near water, they will range widely, up to 10 miles, during daily hunting flights. During the winter months, carrion becomes an increasingly important part of their diet.

Cover requirements: About the only cover requirements for bald eagles are large, open-branched trees, preferably near lakes, reservoirs, and rivers, for hunting perches and roosting sites. Roosting at some distance from water is known to occur. Cottonwoods are preferred for roosting and nesting.

Conservation Practices and Management Options

- I. Retain cottonwoods and other large trees near lakes, ponds and streams.
- II. If possible, avoid approaching too close to nesting, perched or roosting bald eagles.

Golden Eagle



Distribution and Status

The Golden Eagle inhabits a wide range of latitudes throughout the Northern Hemisphere and uses a variety of habitats ranging from arctic to desert. Rare in the eastern half of North America, it is most common in the West near open spaces that provide hunting habitat and often near cliffs that supply nesting sites. Northern breeders migrate hundreds of miles to wintering grounds; southern pairs tend to be resident year-round. As one of North America's largest predatory birds, this eagle has been prominent in human lore and culture, inspiring awe, reverence, and sometimes fear and hatred. Humans kill Golden Eagles both intentionally and accidentally by trapping, shooting, poisoning, and electrocution; at the same time, urbanization, agricultural development, and wildfires encroach on this eagle's traditional shrub-steppe foraging habitat. The species persists, but some U.S. nesting populations may be declining. They are listed as a breeder in all portions of Wyoming.

The Golden Eagle is classified as a nongame species in Wyoming. Adults, young, eggs, and nests are protected since 1962 in U.S. by The Bald and Golden Eagle Protection Act. Amendments passed in 1978 authorize and regulate "taking" of unoccupied nests on resource development sites. Federal regulations outlawed use of aircraft to kill eagles in the U.S. 1962. They are protected in Canada, Mexico, and the U.S. by the Migratory Bird Treaty Act. Used for falconry by a few individuals; rigorous standards limit the number taken from the wild. U.S. Fish and Wildlife Service authorizes permits to allow Native Americans to take and possess eagles and their parts for religious purposes.

Life History

Pair formation begins upon return to breeding areas from late February to mid-April. Courtship and nest selection can last more than a month. A study in Idaho, documented aerial displays, stick-carrying, and vocalizing started in late Jan, with a peak in mid-February. Residents add material to nests year-round and may begin refurbishing nests in autumn, with activity peaking from late January to early March. The duration of nest-building varies, and is probably longer for residents than migrants. Nest construction usually begins 1-3 months prior to egg-laying. Usually 2-3 eggs are laid. Incubation takes 43-45 days and is performed by both the male and female.

Golden eagles produce only 1 brood per season, but will reneest when eggs fail to hatch. Egg laying begins as early as late January and early February in the northern US. Latitude and elevation may account for variation in laying dates among populations with eggs laid later at more northern latitudes and higher elevations. In Idaho, hatching dates related to both winter severity and jackrabbit abundance; eagles hatched earlier when rabbits were abundant and later after severe winters. Hatching dates range from 10 March to 25 June in western North America. Young usually fledge when 45-48 days old. Post-fledging dependence period varies.

Golden eagles feed mainly on mammals (80–90% of prey items), secondarily on birds, and less often on reptiles and fish during the nesting season. They prey principally on leporids (hares and rabbits) and sciurids (ground squirrels, prairie dogs, marmots); the 2 groups combined constituted 49–94% of individual prey items reported in 24 studies throughout western North America during the nesting season. Gallinaceous birds (pheasants, grouse, and partridge) are the main birds taken.

Habitat Needs

This species breeds in open and semiopen habitats including shrublands, grasslands, woodland-brushlands, and also in farmland and riparian habitats. They avoid heavily forested areas.

They occur primarily in mountainous canyon land, rimrock terrain of open desert and grassland areas of the western U.S. In Wyoming, they nest primarily in grassland, shrubland, or riparian habitats and they are absent or rare in flat desert terrain, farmlands, and dense forests. They typically forage in open habitats: grasslands or steppe like vegetation. Nesting territories in southwestern Montana are at lower elevations and contain more sagebrush (*Artemisia* spp.) grassland habitat than unused areas. Nesting density in southern Idaho was higher in areas bordered by sagebrush grasslands than in areas bordered by agriculture. In northeastern Colorado, they nest primarily in grasslands near cliffs and avoid cultivated areas.

In the western U.S. and Canada, they may hunt over wetlands, agricultural areas, and grassy foothills during migration.

During the winter they prefer open habitats with native vegetation and avoid urban, agricultural, and forested areas. They use sagebrush communities, riparian areas, grasslands, and rolling oak savanna. In southwestern Idaho, they forage primarily in shrubland and avoid grassland and agriculture, with foraging points concentrated in sagebrush/rabbitbrush (*Chrysothamnus* spp.) habitat and cliff areas.

Conservation Practices and Management Options

Threats

Humans cause >70% of recorded deaths, directly or indirectly. Accidental trauma (collisions with vehicles, power lines, or other structures) is a leading cause of death (27%), followed by electrocution (25%), gunshot (15%), and poisoning (6%). Incidentally trapped and poisoned throughout western North America by attempts to bait and kill mammalian carnivores has also been a major source of mortality. Many golden eagles are killed by collisions with cars, fences, wires, and wind turbines. Nearly 1,000 golden eagles were killed on highways near Rock Springs, WY, in the winter 1984–1985. Fires since

1980 have caused large-scale losses of shrubs and jackrabbit habitat in areas used by eagles throughout the Intermountain West.

Recreation and other human activity near nests can cause breeding failures.

Conservation Practices

Advise residents and users of the ranch to use caution when encountering a road killed animal on a road that may have attracted a golden eagle.

Avoid disturbing active golden eagle nests during the nesting period (March through June).

Aggressive suppression of range fires may preserve livestock forage and golden eagle prey species habitat.

Red-tailed Hawk



Distribution and Status

The red-tailed Hawk ranges throughout North America to central Alaska and northern Canada, and south as far as the mountains of Panama. Although not truly migratory, they do adjust seasonally to areas of the most abundant prey. In winter many of the northern birds move south. The red-tailed hawk is a member of the Buteo group which are called soaring hawks. They have broad wings and tails and are readily seen because of their habit of circling high in the air or perching in a dead tree or on telephone poles. This Buteo group includes the Swainson's, rough-legged and the Ferruginous hawks. They are easily identified for when they leave their perch on slow, measured wing beats, or turn while soaring overhead, the red upper part of the tail is evident. They are one of the most abundant and widely distributed birds of prey in Wyoming.

They occur in most open habitats and are documented as breeders in all atlas blocks in the state.

Life History

The breeding season begins in March and continues through May. This period is accompanied with spectacular aerial courtship displays by the male and female. They circle and soar to great heights, they then fold their wings and plummet to treetop level, repeating this display a number of times. Nests are located in trees from 15 to 70 feet high and on cliffs. Both males and females assist in nest construction. Nest sites may be used year after year. The female usually lays 2 dull-white eggs with reddish splotches. Incubation takes 28-30 days and is maintained almost entirely by the female. During incubation the male hunts for both of them and brings food to the female at the nest. The young grow slowly and remain in the nest for up to 48 days before fledgling. Both parents provide food for the young. Red-tails typically do not begin breeding until their third year.

Habitat Needs

The red-tailed hawk is often found in grasslands, marsh or shrub habitat but is very adaptable and occurs in most habitats below 9,000 feet in Wyoming with openings for foraging. Their general habitat preference is open areas interspersed with forested patches.

Requirements:

Food - Feeds on a variety of small and medium sized mammals, birds and reptiles.

Water - They obtain necessary water from their diet.

Cover - Nests often in single tree in an open area. Nests are in a fork of the tree 15 to 70 feet above the ground.

Recommendations;

Avoid disturbing nest sites from mid-March to mid-July. Manage livestock grazing to maintain herbaceous ground cover for small mammals.

Retain large cottonwoods and other large trees near open areas, lakes, ponds and streams.

Songbirds

Lincoln's Sparrow



Distribution and Status

Lincoln's Sparrows breed from west, central Alaska across most of Canada, south along the Pacific Coast to southern California, and the Rocky Mountains to northern New Mexico, and into the northern Lake States and northern New England. They are common summer residents in higher mountain riparian shrublands and marshes above 7,000 feet. They are migratory and winter from southern California, southern Arizona, Texas, and New Mexico south throughout Mexico to Costa Rica.

Life History

Lincoln's Sparrows return to the higher mountains in the state by early May. They breed in riparian willow shrublands, shrubby meadows, and with considerable frequency, these sparrows also use aspen groves. They build a cup nest on the ground lined with fine grass or hair. Usually four or five eggs are produced and they hatch after 12-14 days of incubation. The female incubates the eggs and broods the young. These sparrows sometimes produce two broods in a nesting season. Lincoln's sparrows have vacated their high elevation breeding grounds by late September. They may be common in western valleys and on the eastern plains until late October.

The Lincoln's sparrow is a ground feeder. They forage on the ground in wet areas close to where the bird breeds in dense foliage. Their diet consists of spiders, millipedes, grass and forb seeds.

Habitat Needs

Lincoln's sparrows prefer to breed in boggy habitats across the northern third of the continent. Lincoln's sparrows are strongly associated with middle and high elevation willow carr communities. However they have also been documented nesting in aspen groves and in areas with a mosaic of wet meadows dominated by shrubby cinquefoil. Regardless of the community,

these birds typically build their nests at the base of a shrub or in a thick growth of sedges.

Conservation Practices and Recommended Management

Maintain willow carr and wet, willow-covered meadow as adequate habitat for Lincoln's sparrows. Limit domestic livestock use in willows to prevent degradation of Lincoln's sparrow habitat.

Vesper Sparrow



Distribution and Status

Vesper sparrows breed from the southern Northwest Territories south through British Columbia, Alberta, Saskatchewan and Manitoba and throughout the western United States to southern New Mexico and Arizona. They also breed throughout the northern Great Plains and east through the lake states into New England and southeastern Canada. This species is migratory and winters from the southeastern United States, through the southwest southern Mexico. Vesper sparrows breed throughout the state.

Life History

Vesper sparrows begin breeding activities in early May. Usually three to four eggs are produced. Incubation takes 11 to 13 days. Normally, two broods of young are produced in a nesting season. Young are fledged from early June through the end of August. The male cares for the first brood while the female begins the second nest. Most vesper sparrows that breed in Wyoming have left for their wintering grounds by mid-October.

Vesper sparrows are omnivorous and about half of their diet is insects and about half is seeds from grasses and forbs. They have a strong propensity for dust bathing and neither drink or bathe in water.

Habitat Needs

Vesper sparrows prefer dry, open areas with short, sparse and patchy vegetation over much of their range. In Wyoming, vesper sparrows are strongly associated basin-prairie and mountain-foothills shrublands and grasslands. In

a study examining the relationship between vegetation and bird density in montane grassland, shrubsteppe, and tallgrass, mixed-grass, and shortgrass prairie in Colorado, Kansas, Montana, Nebraska, Oklahoma, Oregon, South Dakota, Texas, Washington, and Wyoming, Vesper sparrows occurred only in shrubsteppe and montane meadow habitats. Quality of territories and the number of pairs using areas may be affected by availability of elevated song perches.

Conservation Practices and Management Recommendations

Some control of sagebrush is beneficial to vesper sparrows. They prefer areas of low vegetation with scattered perches. Control sagebrush in small patches by prescribed burning or chaining during spring before breeding territories are established or in late summer or early fall after birds have left the area.

Singing perches are important to this species. Retain fence lines and vegetation along road edges, ditches and drainages, especially in areas where forbs are sparse, to serve as perches.

Hairy Woodpecker



Distribution and Status

This woodpecker is resident in forests of North and Central America from near the northern limit of boreal forest in Canada and central Alaska, south to western Panama and northern Baja California, and east to n. Bahamas. In the western U.S., it is absent from large (non-mountainous) portions of eastern Washington, Oregon, southeast Alberta and southeast Saskatchewan, central and southern California. It is considered an uncommon breeding resident over most of the state of Wyoming.

Life History

The breeding season with courtship and nest building begins in mid-May in the central Rocky Mountains for this species. They excavate a cavity in dead trees or diseased portions of live trees. This species favors aspens for their nest sites, but snags of conifers are also used. Both sexes participate in nest cavity excavation which takes 2-3 weeks. Usually 4 eggs are laid and incubation

takes 11-15 days. The female incubates during the day and the male at night. The male brings food to the incubating female during the day. Both parents participate in feeding nestlings. Fledging occurs at 28-30 days after hatching. Parental care continues several weeks after fledging. During the summer, the majority of their diet is insects, and during the winter it includes seeds, nuts and cached insects.

Habitat Needs

These woodpeckers utilize a wide variety of coniferous, deciduous and mixed forest types. In Wyoming they utilize coniferous forests and aspen from 6,000 to 9,000 feet. They occur at lower elevations in winter, especially in cottonwood-riparian.

They nest in cavities that they excavate in snags and dying trees. They excavate a new cavity each year. The old nest cavities are an important source of nest cavities for secondary cavity nesters.

Conservation Practices and Management Recommendations

Recommendations:

Leave snags and cavity trees for nesting and gleaning when harvesting timber. Leave snags standing that are not creating a safety hazard. Manage livestock use to maintain trees and shrubs in riparian areas.

Clark's Nutcracker



Distribution and Status

The Clark's Nutcracker is a member of the crow and jay family. It is a very noisy bird and frequently makes a nasal "kra-a-a" call. It is widely distributed in western North America in mountain conifers from British Columbia south to Baja California and New Mexico. In Wyoming, the species is found in coniferous forests and woodlands up to timberline in all but the eastern most portion of the state. This nutcracker is abundant and widely distributed in forested areas on the ranch. It occurs irregularly as far north as central Alaska

and as far east as South Dakota, Nebraska and Kansas. The Clark's Nutcracker was first known to science when encountered by Willard Clark (whose name it bears) on the Lewis and Clark Expedition.

The Clark's Nutcracker is classified as a nongame species in Wyoming.

Life History

This species begins breeding in early spring when deep snows keep the breeding grounds safe from potential predators. By mid-March the breeding season has begun in most areas. Nests are usually built near seed stores made the previous fall. Nests consist of a platform of twigs woven together and secured to small outer branches in a fork on the leeward side of the tree. Two to four pale green eggs are laid and incubation takes 18-20 days. Both the male and female participate in incubation, brooding and feeding of the young. The young fledge in 18-21 days. The young remain in family groups with parents until independent, at about 3.5-4 months old. The young are fed by the parents until mid-July to late August, depending on nesting phenology. The young are fed seeds retrieved from caches made the previous late summer and fall, and seeds from new cone crop.

Conifer seeds are the primary food source of this species and the primary tree species providing seed sources in Wyoming are whitebark, piñon, limber and ponderosa pine. However they also feed year-round on insects and spiders, gleaned from vegetation, soil and fallen cones.

Clark's Nutcrackers are part of a crucial symbiotic relationship with pine nut-producing species of pine trees including piñon, limber, and whitebark pines. The trees offer pine nuts as high-energy food to the birds and the birds cache the nuts in the ground. Those nuts that they don't eat have a good chance of sprouting new pines.

Even though a single nutcracker will cache between 20,000 and 30,000 nuts each year, unlike squirrels, nutcrackers make up to 1,000 little caches. Some caches may contain as few as 4-5 nuts while others may contain 30-50. Lots of smaller caches not only make it harder for the bird to lose its supply to theft, it also benefits the trees because it increases the chances that some nuts will be placed in a good growing location.

Habitat Needs

Forest communities used for nesting include piñon-juniper woodland, ponderosa pine, Douglas fir, and mixed coniferous subalpine communities, usually with whitebark or limber pine.

From early June on, populations increase at higher (subalpine) elevations. At upper subalpine zones and tree line, preferred habitats are open to semiopen, with stands of shrubby whitebark or limber pine, sometimes mixed with fir,

spruce, or other pines, growing on steep, rocky slopes or on small hills or ridges interspersed with moist meadows, small lakes, and creeks. The understory is usually herbs and grasses.

In higher mountain regions most nutcrackers descend to lower elevations from about late September through November. They spend fall and winter in the piñon-juniper woodland.

Conservation Practices and Management Options

Maintain healthy stands of limber pine and piñon-juniper of varying age classes to support food and habitat needs.

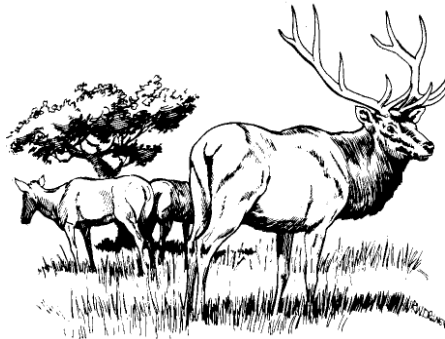
Mammals

The Elk Mountain Ranch also has a rich diversity of mammal habitat which results in a rich animal diversity. At least 6 species of big game mammals are likely to occur on the ranch. They include Rocky Mountain Elk, black bear, mule deer, white-tailed deer, pronghorn, and mountain lion. At least 29 species of medium sized mammals may occur on the ranch. They include upland game mammals like desert cottontail, snowshoe hare and eastern fox squirrel. A number of predators like coyote, gray fox, red fox, swift fox and bobcat may also occur on the property. Furbearers like beaver, muskrat, marten, mink and otter may also occur on the property. At least 31 species of small mammals may occur here.

Selected mammal species are discussed in more detail in this section.

Big Game Animals

Rocky Mountain Elk



Distribution and Status

Prior to European settlement elk numbers were estimated to exceed 10 million in North America. This species was broadly distributed in a variety of habitats and ranged from the Atlantic to the Pacific Ocean and from Northern Mexico to the Canadian sub-arctic. The Rocky Mountain Elk is one of four subspecies that are widely distributed in western North America. The other three species are the Manitoba Elk, the Roosevelt Elk, and Tule Elk. Rocky Mountain Elk inhabit the central and northern Rocky Mountains, including northern Saskatchewan, most of Alberta and eastern British Columbia, as well as eastern Oregon and Washington, Idaho, western Montana, Wyoming, Colorado, Utah, Nevada, New Mexico and Arizona. In Wyoming, they range over much of the state. They are common in all of the forest and woodland areas on the ranch.

Elk were nearly extirpated from much of the west in the early 1900s when market hunting reduced populations in many areas. Elk are common to abundant in most of the mountainous areas in the western two-thirds of the state.

Life History

The breeding season for elk begins in early fall with the peak of the rut occurring during late September and early October. Breeding activity usually starts by early September and is over by late October in the state. During the rut, elk have swollen necks and expend considerable energy in wallowing, bugling and thrashing about which serve to attract other bulls and sparring encounters result. Bulls typically compete for females and gather harems of adult cows and calves. Most of the breeding is done by bulls three years of age or older. Other bulls continually attempt to steal cows in the harem. As a result of this constant activity, herd bulls lose considerable weight during this time of the year. Harem size typically ranges between 15 and 20 cows. Elk have a 240-255-day gestation period and most calves are born in late May or early June. Yearling cows can breed, but less than one third of them are successful at producing offspring that survive into the fall, compared to about three fourths of adult cows. Calving grounds (parturition areas) are carefully selected by the cows and are generally in locations where cover, forage and water are in close proximity.

Females with calves isolate themselves from the remainder of the herd for two to three weeks in parturition areas. Then they begin to gather up into herds. By mid-July herds of 400 animals are common on some summer ranges. During the spring and summer adult bulls usually segregate from cows, calves and younger bulls and are alone or form small herds of five or six animals. Younger bulls are usually mixed with cow-calf herds. While the bulls may be the boss of the harem, the older cows are the true leaders of the herd. They usually sound the alarm and lead the rest of the herd away from real or imagined danger.

Elk tend to inhabit higher elevations during spring and summer and migrate to lower elevations for winter range. The length of seasonal migration varies from just a few miles to nearly 50 miles in some cases. When early winter snows begin to accumulate, cows, calves and most bulls begin to move down to winter ranges and where they usually stay from December through March. During winter, elk form large, mixed herds on favored winter range and more than 1,000 animals may be observed together. As winter begins to moderate in late March, the cows, calves and young bulls start a gradual movement back up to their summer ranges and the cycle begins again.

During winter, cow elk tend to use more shrub habitats and less open timber types. Cows typically used moderately steep areas on south facing to west

facing aspects on the middle to lower elevation portions of the winter range. Bulls often use small benches or ridge top areas near the upper portion of hillsides. From spring to autumn, elk shift from using a high proportion of shrub and open timber habitats to timbered habitats. Throughout the year, elk in areas with roads use habitats with greater cover.

Mortality in elk is mostly due to predation on calves, hunting, and winter starvation. Black bears can become skilled at locating and feeding on young calves. Coyotes may be important predators in some areas. Some studies report mortality almost equally distributed among starvation of calves, hunting and predation. Elk can live up to 20 years, but in hunted populations the average life span is much less. Males may live three years or less while females may average five years or less.

Habitat Needs

Rearing requirements: Elk calves are born in late May or early June, usually when cows are on their way to summer ranges. Elk may utilize the same parturition areas in succeeding years. Because elk are sensitive to harassment from people, dogs, and predators during calving, traditional parturition areas that can be identified should be afforded maximum protection from disturbance during May and June. Cow elk appear to prefer calving areas on slopes of less than 15 percent with adequate hiding cover and food near by. Water is usually in close proximity. Elk calving areas are typically found on south facing slopes of rolling terrain with aspen benches and dense understory of shrubs. Summer ranges are generally used from July through September.

Cover Requirements: Cover to protect elk from the cold may not be a requirement. Elk have been observed bedded down on open mountainsides in very heavy snowstorms. In the same areas elk have been observed bedded down in heavy spruce-fir timber, apparently attempting to escape the storm. During very cold, clear weather, wintering elk seem to favor bedding down in aspen groves or on oakbrush mountainsides. Elk apparently are very susceptible to hot weather and thermal cover may be more important during summer. They have been observed bedded down on snowbanks as long as the snow lasts. After the snow is gone, elk can be found bedded down in dense timber on north facing slopes apparently taking advantage of the shade and lower temperatures. Elk winter ranges are generally utilized from November 15 through March 15.

Elk need hiding, resting, and escape cover. Preferred range will contain approximately 40 percent timber in order to provide adequate cover. At least one-half of the cover should qualify as thermal cover. Thermal cover for elk consists of timber stands 30 to 60 acres in size in the sapling-pole stage or older with canopy closures of at least 70 percent. Multi-storied stands provide better thermal cover. Dense stands of timber on north facing slopes may serve as thermal cover in both summer and winter. Hiding cover consists of

vegetation capable of hiding 90 percent of an adult elk from human view at a distance of 200 feet or less. Thermal cover can also serve as escape and hiding cover for elk. To be most effective, hiding and escape cover should be at least 1,200 feet wide or 600 feet in radius. Topographic features, such as ridges with low saddles and canyons can also provide effective escape cover. Travel cover in the form of timbered riparian areas, ridges and timbered stringers can be important cover to facilitate protected movement.

Openings in dense forest canopy increase forage production. The use of openings by elk decreases with size. In Arizona, 45-acre openings were found to be optimal for elk in ponderosa pine while 20 acres were optimal size in spruce/fir. Openings greater than 40 acres have been found to be used less than smaller ones.

Elk will consistently avoid forest roads. The amount of vehicular travel on roads appears to be the key factor that causes elk to avoid them. Elk habitat effectiveness decreases by approximately 25 percent with a density of one mile of road per square mile of land, and by at least 50 percent with a density of 2 miles of road per square mile.

Water: Water does not seem to be a limiting factor for elk. Elk make regular use of ponds, springs, streams and lakes. They get much of their moisture needs from the vegetation they eat, especially during the summer months. During the winter, they consume snow to satisfy much of their water requirement. During the calving period, water is needed within 1/2 mile of the parturition areas. The availability of water may have an effect on use of other resources within a given area and elk have been found to prefer to stay within 1/4 mile of water during the mid-March to September period.

Food: Generalist feeders, elk are both grazers and browsers. Grasses and shrubs comprise the bulk of the winter diet. Plant growth in late April or early May causes elk to turn away from the coarse browse forage of winter ranges and to seek out new grass growth. Some studies indicate that grasses comprise from 77 to over 90 percent of the summer and fall diet. Browse constituted over 56 percent of the winter diet on those studies. Some studies indicate that forbs become more important in late spring and summer while grasses gain dominance in the fall.

Most studies of competition between elk and other species suggest that conflicts and impacts are minimal. Forage availability on the winter range in many areas is a limiting factor. Carefully timed, summer livestock use on winter range can benefit elk. Carefully timed grazing that results in termination of growth prior to culm production traps nutrients in the foliage and increases digestibility of the plants.

Conflicts can arise as a result of fences placed in high use or migration corridors. In high use areas, fence design and construction can include elk jumps, top rails or lay-down fences to reduce elk/domestic livestock conflicts.

Conservation Practices and Management Options

Elk are wide ranging animals that are likely utilize all portions of the ranch and transition between the ranch and adjacent lands. *Key habitat maps for elk are displayed in Appendix G.* Following are suggested management guidelines and practices to help reduce conflicts with elk and help enhance conditions on the ranch for this species:

- Maintain adequate hiding, feeding, resting and thermal cover for elk in suitable portions of the ranch. These habitat components appear to be adequate for the existing elk herd.
- Elk need patches of hiding and escape cover that are at least 1,200 feet wide or 600 feet in diameter.
- Patches of dense conifer on north facing slopes of 30 to 60 acres in size provide important thermal cover.
- Manage to maintain or improve vegetation condition in riparian areas that are used as foraging areas and movement corridors by elk.
- Riparian areas may provide important movement corridors for elk. Limiting the amount of human activity and maintaining the quality of vegetation there may be important for elk.
- Protecting known calving areas from any disturbing activities from April through June will be important.
- In known elk wintering areas use light and carefully timed summer livestock grazing to improve winter forage quality for elk.
- In high use or migration areas elk jumps, top rails or lay down fences may be used to minimize elk/livestock conflict.

Mule Deer



Distribution and Population Status

Mule Deer are widely distributed in western North America. As recognized today, there are seven existing subspecies, including the black-tailed deer along the west coast of the US and Canada. The Rocky Mountain mule deer is the most widely distributed subspecies, extending from the western Great Plains west through central New Mexico and Arizona to California and north through western Canada to the Northwest Territories. The Rocky Mountain Mule Deer is the subspecies found in Wyoming and they occur throughout the state.

Life History

In Wyoming, mule deer breed in November and December. About 70 percent of the breeding occurs in a 20-day span in some populations. The gestation period is about 203 days. Yearling females typically produce a single fawn, while older females in good condition produce twins. Fawns are precocious at birth and weigh 8 to 10 pounds. They start consuming vegetation at two to three weeks of age, but are not weaned until fall. Does are solitary during fawning. They form small groups of yearlings, does, and fawns when the young are several months old. As winter approaches the size of herds increases and large numbers may congregate on wintering grounds. When not in rut, adult males often form pairs or small groups of three to five individuals.

Mortality in mule deer varies with age class and region. Fawn mortality is due primarily to predation and starvation. Some studies have found annual fawn predation to vary from 27 percent 67 percent. Predators include coyotes, bobcats, golden eagles, mountain lions, black bears and domestic dogs. Adult deer mortality is due primarily to hunting and winter starvation.

Mule deer may survive up to 20 years in the wild, but such longevity is rare, and population turnover is high. Most bucks in hunted populations are less than eight years of age. Does are fully-grown at two years of age, but bucks continue to grow until 9 or 10 years of age.

Habitat Needs

Rearing requirements: Fawning may take place in any habitat type found on the ranch. However, fawns are most often found on sites with slopes of less than 15 percent that have good ground cover in the form of herbaceous vegetation mixed with low shrubs or small trees 2 to 6 feet in height. Normally these areas are within 600 yards of a water source and in areas that have quality forage for the doe that assures adequate milk production.

Cover Requirements: Cover may be a key factor that determines the amount of use deer will make of foraging areas. In optimal deer range 40 percent of an area will be in cover type habitat. Ideally, cover habitat is comprised of 50 percent hiding cover and 50 percent thermal cover. Hiding cover generally is any vegetation that will hide 90 percent of a deer at 200 feet or less. Optimal

winter range contains thermal cover consisting of evergreen trees with 75 percent or greater canopy closure. Spring and summer thermal cover may be as important as winter thermal cover for protection from high temperatures. Spring and summer thermal cover may be provided by coniferous or deciduous trees which provide at least 75 percent canopy closure. Escape cover used by deer may include thermal or hiding cover. Broken terrain or topographic features are also used as escape cover.

Water: Water is not likely to be a limiting factor for deer on the ranch. Water is well distributed throughout the ranch in the form of streams, ditches and lakes. Snow provides for moisture needs during the winter months when other water sources may not be available.

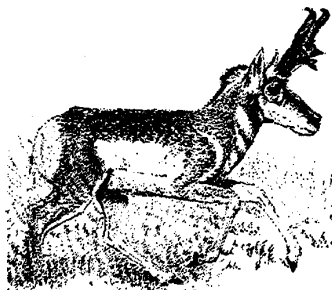
Food: Deer food habits are primarily influenced by availability of plant species rather than by a species selection process. Diets are highly variable from year to year and between habitat types. Deer are intermediate feeders rather than browsers or grazers. In general, a mix of plant communities is more important to deer than monoculture plant communities. Studies in Colorado have shown that the winter diet is comprised of browse from trees and shrubs (74 percent) and forbs (15 percent). In the spring, browse contributes 49 percent of the diet, and forbs and grasses make up about 25 percent each. Summer diets are 50 percent browse, and forb consumption increases to 46 percent. Browse use increases in the fall to 60 percent while forb consumption declines to 30 percent.

Conservation Practices and Management Options

Key habitat maps for mule deer are displayed in Appendix G.

- Retaining the distribution of coniferous and deciduous trees will be an important factor in sustaining a healthy deer population on the ranch.
- Protecting known fawning areas from any disturbing activities from April through June will be important.
- Protecting known winter ranges from excessive human disturbance (November 15 to March 15) will be important (See Appendix G Maps).

Pronghorn



Distribution and Status

Pronghorn belong to the family Antilocapridea. That family of animals is exclusively North American and the Pronghorn is the only living member alive today. For eons of time, the vast grasslands of central North America supported tremendous herds of pronghorn. Around 1800, prairies and grasslands in central North America supported 30 to 40 million pronghorn. Their numbers reached a low of about 13,000 in the 1920's. Within a decade their population had rebounded to more than 130,000. There are well over ½ million pronghorn in the wild today.

Life History

Pronghorn breed from late summer to early fall when bucks fight for harems of as many as 15 does. Often the mating season lasts only two to three weeks. The gestation period lasts 250 days, and does give birth in solitude during May and June. Does usually have a single fawn at the first birth and twins each year thereafter. Although fawns occasionally breed, pronghorns usually mate for the first time when they are 15-16 months old. At birth, fawns weigh 5-7 pounds. During the first week of life, fawns remain inactive, growing and gaining strength. At about five days of age, they can outrun a man. Within three weeks fawns begin nibbling on vegetation, and by three months they have acquired an adult-like coat of hair.

Coyotes and bobcats are the most important predators especially on newborn fawns. Adult pronghorn mortality is mostly due to hunting.

Males and most females have horns that are composed of laterally flattened bony cores arising from the frontal bones, covered with a keratinous mass of fused hairs that form a sheath. The sheath is shed annually following the breeding season. Horns of females are usually very short, un-forked nubs. Average male horns are 12 inches in length and have a short branch arising from the upper one half of the horn and extending forward. Upper parts of the body for both sexes are reddish-brown to tan. Males have black cheek patches on both sides of the neck, while females do not.

The timing and length of pronghorn movements vary with altitude, latitude, weather and range conditions. These movements usually are related to seeking the basic habitat requirements of forage and water. During the spring and summer, daily movements are generally about ½ mile as forage and water are usually plentiful. Distances traveled daily during the fall and winter are usually greater (2-6 miles). This is the mating season and a time of reduced forage. The diameter of the home range for most herds is usually 5 to 10 miles.

Habitat Needs

Preferred habitat: Quality and quantity of vegetation appear to be the major factors affecting pronghorn densities. The following characteristics of sagebrush-grassland communities have been found on preferred ranges:

- Ground cover averaging 50 percent living vegetation and 50 percent nonliving vegetation.
- The general preferred mix of vegetation is 40-60 percent grass, 10-30 percent forbs and 5-20 percent browse.
- Pronghorn like a variety of species of grasses, forbs and shrubs.
- During the summer, pronghorn prefer a variety of succulent forbs.
- Open rangelands having a variety of vegetation types are preferred over monoculture rangelands.

The Elk Mountain Ranch appears to have adequate quantity and good quality habitat for resident pronghorn. Nearly 200 head were observed on the ranch during the field inventory and a herd of 12 pronghorn were observed above timberline near the west tower on Elk Mountain.

Water: Pronghorn obtain water from springs, streams, lakes and snow. When succulent forage is available they only need about 1 quart of water per day. During dry periods they may need 1 to 1 ½ gallons per day. Water distribution through ditches, streams and lakes on the ranch appears to be adequate to meet water needs of the resident pronghorn population.

Food: Some studies show that the average year-round diet is approximately 43 percent forbs, 43 percent browse 11 percent cactus, and 3 percent grass. The mix in the diet will change depending on the forage availability in a given area. Food sources for pronghorn on the ranch appear to be adequate to meet the current needs of the resident herd.

Conservation Practices and Management Options

- For new fence construction in pronghorn habitats, consider positioning the bottom wire 16 inches above ground level to reduce obstruction to pronghorn movement as has been the standard with the newer fence constructed on the ranch.
- Some brush beating and prescribed burns in small patches (5-10 acres) in sage brush may improve habitat diversity for pronghorn.

Black Bear



Distribution and Population Status

Black bears have historically inhabited much of North America. Populations have been extirpated from much of the East. They are locally common in suitable habitats in Wyoming. Fresh bear tracks (Sow and cub) were documented near Hidden Meadow and bear foraging sign (overturned logs and rocks) was observed at several locations on the ranch.

Black bears are considered a game species in Wyoming. The Wyoming Game and Fish Commission regulates hunting seasons and bag limits.

Life History

Black bears breed from early June to mid-August. The gestation period is seven to eight months and cubs are born in the den in late January or February, while the mother is in hibernation. Litter size is usually two or three cubs. At birth, the cubs weigh only about ½ pound and are blind, naked, and helpless. The cubs grow rapidly and are weaned by September. They stay with the mother during the first year of life and den with her the first winter. They disperse at the age of one and one half in spring or summer.

Winter denning may begin as early as the first week in October and extend to late December. Peak of denning activity occurs in late October for females and mid to late November for males. Black bears generally use rock cavities or excavations under shrubs and trees for den sites.

Black bears are typically solitary, except for family groups (a sow and cubs), or aggregations at concentrated food resources, where they may show relatively high tolerance for each other. Bears may forage at any hour, but tend to be most active during the day or near sunrise and sunset. Most nocturnal activity is in the spring and fall.

Signs of bear activity in an area include large piles of scat, rotten logs ripped open and broken, stripped or broken branches of fruiting bushes. Bears can climb trees and it is not unusual to see climbing scars on large aspen trunks, particularly in drainages.

Habitat Needs

Black bears use all forested ecosystems. Although seldom seen by the casual observer, they may be common in some areas.

Rearing requirements: A good food supply is essential to reproductive success in black bears. Severe forage shortages have been implicated in complete reproductive failures.

Since the helpless young are born while the mothers are in their winter dens, satisfactory denning sites for pregnant females must be available to sustain a population in an area. Although bears will sometimes utilize slash piles or blown down trees for denning sites, caves, rock crevices, and excavations under large boulders are better dens.

Cover Requirements: The black bear needs cover for escape and concealment. Thick stands of conifers are used for concealment when traveling between feeding areas. Bears will use rough terrain, standing trees, and caves to escape their enemies. Elk Mountain contains an abundance of good bear habitat.

Food: Highly versatile feeders, black bears use a wide variety of food sources, many of which are only available seasonally. Items consumed by this opportunistic feeder include leaves and fruits of plants, insects, birds, other mammals (including domestic animals) and carrion.

Grasses, grass-like plants, and forbs are most important in the spring and early summer diet and continue to constitute a significant portion of the diet during other seasons. Carrion from winter-killed animals is another important source of food in spring.

By summer, insects and their larvae become an important component in the diet of black bears. Stumps, rocks, snags, and down logs become important foraging areas because they provide homes for many insects.

In late summer and fall, berries, pine nuts, and other mast are highly relished by bears. When these foods are not locally available because of late spring frosts, drought, or other causes, black bears will often move great distances in search of alternative food sources.

Seasonal food resources could be a limiting factor on black bear populations in the ranch area.

Conservation Practices and Management Options

Avoid operation of open garbage disposal pits and use of garbage containers that are not bear proof to discourage bears from seeking food around residences and causing conflicts with humans.

Mountain Lion



Distribution and Population Status

Mountain lions have the widest distribution of any mammal in the New World, ranging throughout much of North and South America. They once were distributed over the entire continental United States. Populations mostly have been extirpated in the East and significant areas in the West as well. This big cat is still common in many parts of Wyoming, although it is less common on the eastern plains. However, robust populations are currently found in the Black Hills of northeastern Wyoming, the pinyon-juniper country of southwestern Wyoming, and all major mountain ranges throughout the state. They do occur on the Elk Mountain Ranch and fresh mountain lion sign was observed near Lost Meadow during field surveys.

Mountain lions are considered a game species in Wyoming. The Wyoming Game and Fish Commission regulates hunting seasons and bag limits.

Life History

Mountain lions are solitary carnivores exhibiting a polygynous breeding strategy where dominant males typically breed with females that reside within their home range. Resident males aggressively defend their territories against male intruders, whereas females allow more overlap, but express mutual avoidance. Size of female home ranges tend to be large enough to provide

sufficient prey for themselves and their young (20-40 square miles), while male home ranges tend to be larger (60-120 square miles), overlapping several females, apparently to maximize their reproductive success. Young females commonly remain in their natal range upon reaching independence, but males typically disperse from their natal ranges.

Mountain lions have no set-breeding season. Female mountain lions reach sexual maturity at about two and one half years of age. Females may come into heat at any time of the year. They are polyestrous and will recycle about every two weeks until bred. Gestation lasts about 92 days. Litter size may range from 1-6 kittens, but 2 and 3 kittens are most common. The kittens usually stay with the mother for 1 to 2 years. The weeks following independence are particularly hard on young lions and this may be a period of high mortality until they become proficient at stalking and killing prey. It is likely that mortality in nearly grown and older lions is mostly man caused.

The wide-ranging, territorial nature of these cats causes them to be less than common throughout their occupied range. They may range up to 25 miles per day and are considered year-round residents in most forested ecosystems.

Habitat Needs

The mountain lion may be found in all forested and woodland habitats, but lower mountains and transition zones where deer, the mainstay of their diet, are more abundant and have higher densities. The only habitat and climatic limitations are vast areas with little hiding cover and severely cold winter temperatures of northern climates. Habitat quality depends largely on the density of preferred prey species and the ease with which they may be taken.

Rearing requirements: The extremely large cruising radius of these solitary cats provides them with opportunity for making contact with other individuals for breeding purposes.

Dense thickets, rocky canyons, rim rock, and slide areas are favored as rearing sites. Those sites offering some protection from the elements, such as caves and overhanging rock ledges, are most desirable.

Cover Requirements: Dense thickets and rocky canyons usually meet the minimum cover requirements for the mountain lion. Rim rock and trees are used to escape enemies, usually man and domestic dogs. Such habitats are in good supply on Elk Mountain.

Water: Mountain lions are known to exist in country with little or no water, suggesting that they can survive without free water. However they will drink water if available.

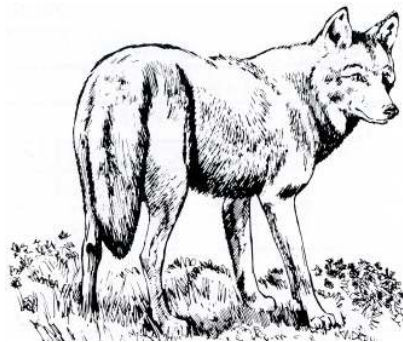
Food: Mountain lions are carnivorous, eating a great variety of mammals that range in size from rodents to horses. Studies show that deer are the most important diet item. Although lions will eat carrion, they show a definite preference for feeding on their own kills. Grass has also been found to be a standard part of their diet. The healthy deer herd on the ranch should supply an adequate food source for this big cat.

Conservation Practices and Management Options

- Mountain lions (particularly those that are old or in ill health) can become problems by attacking domestic livestock and pets. Removal of those animals may be the most effective remedy.
- Preserving the solitude on Elk Mountain by limiting new roads and access may be a key factor in maintaining the quality of mountain lion habitat.

Predators

Coyote



Distribution and Status

The coyote is North America's most abundant and widespread predator - approximately four million coyotes live across Alaska, Canada, the United States, Mexico and central America. About the size of a small German shepherd dog (20 to 40 pounds), they may live in small packs of three to ten animals. Most coyote packs are family units consisting of a mated pair and its current offspring and possibly a few of last year's offspring. In Wyoming, they are found throughout the state at all elevations.

The Wyoming Game and Fish Commission classifies them as a predator.

Life History

In coyote packs the *alpha* pair is typically the only members of the pack to breed in any given year. The other members of the pack are referred to as the *beta* coyotes. These *beta* coyotes often assist the *alpha* pair in raising their pups each spring. The *alpha* pair is the dominant pair, and the other members of the pack are subordinate to them. The female is in breeding condition for about five days, usually between January and March. Gestation takes about 63 days and litters average five or six young. Litter sizes may fluctuate by one or two depending on the abundance of rodents and the density of the coyote population in the area.

Natal dens are generally excavated in areas with heavy cover including shrub thickets, downed timber, steep banks, or rocky areas. Young may emerge from the den as early as the second or third week and are weaned at about six weeks of age. During this time social skills are learned during play with littermates. Dispersal, if it occurs, is usually at six to nine months of age, but may be slowed or halted if population densities are high. In a typical litter of coyote puppies, only about two will survive to the fall. Birds of prey such as eagles and owls often catch young pups and other large predators such as

mountain lions, wolves, wolverines, lynxes and bobcats will also prey upon coyote pups. Diseases, including distemper and canine hepatitis also claim coyote puppies.

Coyotes may live as long as 13 to 15 years, but such longevity is rare. Annual mortality is estimated as high as 40 to 70 percent in juveniles and about 35 to 40 percent in adults. The amount of mortality depends on location and the amount of human interaction.

These animals are truly opportunistic in their diet, although animal matter comprises roughly 90 percent of their diet. In much of the west, jackrabbits, cottontail rabbits and rodents make up the bulk of their diet. The bulk of coyote predation on game and livestock is targeted at young animals.

Coyotes may be active at any time of the day, although most activity occurs in the evening. Their home range for resident pairs may be as little as one square mile to as large as 12 square miles depending on habitat and available food sources. Coyotes may partially restrict populations of other small carnivores, including foxes, bobcats and possibly badgers, by direct predation or competition for food sources. Coyote populations to a large extent are self-regulated through variations in reproductive rates in relation to the size of the prey base.

Habitat Needs

Rearing requirements: Because coyotes use a wide variety of den sites, including natural cavities, dens dug by coyotes themselves and man made sites, denning sites is seldom an issue.

Feeding requirements: Since coyotes feed on almost anything available including voles, ground squirrels, carrion; also plants, frogs, lizards and insects, prairie basin, riparian and forested areas with an abundance of litter and down material meet the habitat needs for food sources.

Cover requirements: The species will use any natural and man made cover available for resting and escape.

Conservation Practices and Management Options

This species may use any habitat available. Consequently managing for sustained populations of coyote through the management of features in their habitats is not an issue.

- If predation becomes an issue, some population control measures may need to be taken.

Gray Wolf



Distribution and Status

Gray Wolves are large, powerful canids with long bushy tails and bushy ears. Adults may weigh up to 175 pounds and may reach a total body length of nearly 6 feet. They once ranged over much of North America except for the southeastern states and the desert southwest. Today the species is gone from the contiguous United States except for remnant populations in Minnesota, Wisconsin, Michigan, Idaho, Montana, and Washington and a reestablished population in northwestern Wyoming.

Gray wolves were reintroduced into Yellowstone National Park in 1995 as an experimental, non-essential population and have been occasionally observed in other parts of the state in recent years. As of 2001, there were an estimated 218 wolves in Yellowstone National Park and over 500 in Idaho. Both populations have long since met their recovery goals and the reintroduction experiment has been a resounding success.

Wyoming Game and Fish submitted a final Wolf Management Plan in 2003 to the US Fish and Wildlife Service aimed at delisting the species. That plan was rejected by the Service in 2004 and regulatory control of the species remains under federal jurisdiction.

Prior to 2003, the gray wolf was classified by Wyoming Statute (W.S.) 23-1-101(a)(viii) as a predatory animal. This classification was changed in the 2003 legislative session to a dual status, pending delisting by the USFWS, of “trophy game animal” or “predatory animal” depending on the area they occupy. The State of Wyoming will commit to maintaining 15 packs of wolves in the State including the National Parks and Parkway with 7 of these packs occupying areas outside the National Parks and Parkway.

Life History

Gray wolves usually live in family groups or packs of 2-8 individuals, though some packs contain 20 or more members. The average size of the eight packs

in Wyoming outside of Yellowstone National Park in 2001 was 8.7 wolves (range 2-12) and 13.3 wolves (range 2-37) inside Yellowstone National Park. A pack consists of at least two individuals of the opposite sex that breed and produce pups. Packs are territorial, frequenting areas of 20-200+ square miles. A dominance hierarchy exists within each pack. Generally, only the dominant male and female breed, though exceptions exist. Breeding occurs during February or March, and pups are born after a 63-day gestation period in April or May. Litter sizes in Wyoming have averaged approximately five pups from 1997-2001. Pups remain at a den site for about 6 weeks until they are weaned. The pack then moves to rendezvous sites (home sites) until the pups are old enough to hunt with the pack (September and October). Once pups begin hunting, these rendezvous sites are no longer used and packs range throughout their territory. Offspring remain within the pack or move out to become "lone wolves" as yearlings. These individuals are nomadic, some living in areas over 1,000 square miles in size. If a member of the opposite sex is encountered and suitable range exists, the pair may start a pack of their own. Wolves are sexually mature at 22 months of age.

Pack territories are defended against other wolves. Territory location is advertised to other wolves through scent marking and howling. Territory size appears related to prey density. Territory sizes of wolves recolonizing northwest Montana average 300-400 mi². Territories of wolves in the Greater Yellowstone Area are averaging 200 mi².

Prey species include deer, moose, beaver, and sometimes domestic livestock and pets. Generally, wolves target the easiest prey including the old, weak, sick or disabled individuals. Wolves are not normally detrimental to populations of prey species. However, some studies in Alaska with caribou and in northern Minnesota with deer indicate that wolves have eliminated or are limiting their prey in parts of their range.

Preferred Habitat

Gray wolves' habitat preferences appear to be more prey dependent than cover dependent. Gray wolves choose home territories with a variety of topographic features. Forests, open meadows, rocky ridges, and lakes or rivers all comprise a pack's territory. In the West, gray wolves have been known to follow the seasonal elevational movements of ungulate herds. In Minnesota, where territories encompass only subtle elevational changes, researchers observed no changes in territory use by gray wolves between summer and winter. In south-central Alaska, researchers found that gray wolves do not follow migrating moose or caribou outside of their pack territories. Gray wolves do, however, follow moose and caribous' elevational movements within pack territories.

Denning and Rearing Requirements

Gray wolves excavate natal dens in well-drained soils in meadows near water. They may use the same den for several years. In Minnesota researchers found

gray wolves denning in hollow logs up to 35 inches in diameter. Gray wolves also den under tree roots, rock outcrops, or even in beaver lodges. After 1 to 2 months, these natal dens are abandoned for an open area called a rendezvous site. Here the pups are guarded by a few adult pack members, while the rest of the pack hunts.

Conservation Practices and Management Options

Humans are the only significant predator of the gray wolf and have eradicated it from almost all of its former range worldwide.

Wolves need large areas, relatively free of human disturbance to maintain a viable population. At least 7,818 square miles is needed to maintain a viable population of 50 individuals. Fear of livestock depredation seems to be the single most important cause of opposition to gray wolf recovery. Also hunters worry that game will be less abundant if gray wolves were to recolonize their former ranges.

If a wolf is observed on the Elk Mountain Ranch, it will likely be a yearling pioneering out from one of the packs in the Greater Yellowstone Area. It is unlikely that the area contains enough remote habitat to support successful establishment of a new pack. However, it is likely that the southern portion of the ranch contains some transitory habitat suitable for wolves.

Swift Fox



Distribution and Status

The swift fox was once found in dry prairie habitat from the southern Canadian prairie to Texas, but the species began to decline early in this century. The present distribution is much reduced from the historical range and this species has become extirpated in Canada and much of the western United States. They are not presently abundant in any portion of their occupied range. In

Wyoming they are listed as a breeder or possible breeder over much of the eastern half of the state and in the extreme southwestern part of the state. The swift fox is smaller and more slender than the red fox, and lighter in color. The dorsal pelage ranges from yellowish to buffy gray, with the underfur tan and interspersed with multicolored guard hairs so that the overall dorsal color is fairly dark.

The Wyoming Game and Fish Commission has classified them as a predator.

Life History

Swift Foxes are characteristically nocturnal animals, although they are sometimes active during the daytime as well. They leave their dens at night to hunt and rarely move far from their dens. They rely on speed and nearness to their dens for safety. Foxes from many different family groups may hunt in the same territory, but not necessarily at the same time.

Excellent diggers, swift foxes excavate their own dens, which are typically located on flat areas or along slopes or ridges that afford good visual fields. Dens are typically located on sites dominated by blue grama or buffalo grass. The soil accumulated at the burrow entrance may be visible for several hundred yards. More than one den is used at a time. Dens used for whelping typically have three to six entrances; dens used by solitary foxes usually have only one or two entrances.

Mating begins from late December through February at which time these animals become highly vocal. Females come into heat only one time during the year. Both parents assist in rearing the young that are born in late March, April or early May following a gestation period of 51 days. Litter size ranges from one to eight, with four or five young the average. The altricial pups develop rapidly. Their eyes and ears are open by the end of the second week and they first come above ground at about four weeks of age. The young gradually learn their surroundings and will hunt with the adults as they get older. They typically disperse in September and October. Females may breed in their first year.

Their diet is composed mainly of small mammals such as kangaroo rats, jackrabbits, cottontails, and rodents, but they will also eat insects, small birds, lizards, amphibians, and fish.

Swift Foxes are not very suspicious of humans, so that they are easily trapped or poisoned. In areas where trappers are active or where poison is used to control predators, the foxes have been greatly reduced in number or entirely eliminated.

Habitat Needs

Swift Foxes typically live in the open desert or grasslands. They hunt in high, well-drained mesas, hilltops, along the borders of valleys, and sparsely vegetated hillsides and other well-drained areas. They have also adapted to cultivated and ranchlands. Such areas meet their breeding, feeding and cover requirements. The sagebrush community on the northern part of the ranch contains an extensive amount of suitable habitat for swift fox.

Conservation Practices and Management Options

Conversion of native prairie grasslands to farmland has reduced both the quantity and quality of habitat available to the swift fox over much of their range. This species is very vulnerable to shooting and trapping since it is not wary of humans, and poisons used to kill coyotes has been detrimental to swift fox.

- If trapping, shooting, poisoning or other control measures are used to control coyotes, care should be taken to avoid targeting swift fox.

Wolverine**Distribution and Status**

The wolverine is the largest terrestrial member of the mink and weasel family. Adults may weigh up to 70 pounds and reach a total length of 3 feet. Its appearance is somewhat bear-like, although movement and associated behavior are distinctly characteristic of the weasel. The wolverine has a circumpolar distribution that corresponds with the boreal zone of the northern hemisphere. The historical North American distribution of the wolverine included the northern part of the continent southward to the northernmost tier of the United States from Maine to Washington. It extended south along the

Sierra-Cascade axis through Oregon into the southern Sierra Nevada in California and along the Rocky Mountains into Arizona and New Mexico.

Present distribution of the wolverine in the western United States appears to constitute several peninsular extensions of Canadian populations. While reports of wolverine sightings persist in the Rocky Mountain States, only Idaho and Montana report populations of known extent. The Wyoming Atlas indicates that there is some evidence of breeding for this species in the northwestern $\frac{1}{4}$ of the state and Atlas block 26 (Carbon County).

The Wolverines is classified as a nongame species and has special protection status in Wyoming.

Life History

Wolverines are mostly nocturnal and active year round. They are typically solitary, with pairing occurring only during the brief mating season.

The mating system of the wolverine appears to be polygamous. Females are believed to have one mating cycle and, breed from May to August. Recent studies of captive animals show that females generally come into estrus from June to early August. Males show readiness for mating with elevated testosterone levels from early April through early July.

During the breeding season, males usually remain close to females, but females take the lead and initiate moves when pairs travel. Wolverines exhibit delayed implantation. Fertilized eggs remain in an undeveloped stage until implantation occurs, usually from November to March. Post-implantation following fertilization is about 30-50 days.

Parturition occurs from January through April, with most females giving birth before late March. Litter size averages 2-3 kits. Young are born fully furred with eyes closed and teeth not erupted. At birth their fur is white; they weigh an average of 3 ounces. Young are weaned at 9-10 weeks and begin to travel with mothers by late-May. Adult size is often reached by early winter although young may remain associated with their mother, siblings, and the resident male until reproductive maturity. Female wolverines attain sexual maturity at about 15 months but only 7% of 2-year-old females produced litters in a Yukon Territory study. Males appear to reach sexual maturity at about 2 years of age.

Data from Idaho suggest the male may participate in rearing of young. Studies have found that from parturition to physical maturation (at about 8 months of age), the female was the primary associate of young, while from physical maturity until about 14 months of age, juveniles associated primarily with the resident male.

Wolverines eat a variety of mammals, birds, eggs, fish and berries. They do attack large game animals, but most large game animals in their diet are carrion. Their winter diet is mostly carrion. Wolverines cache surplus food, marking the site with urine and scent.

Habitat Needs

Wolverines have large home ranges that frequently overlap. Researchers have reported mean annual home range size for male wolverines at 162 mi² to 275 mi² in Montana and Alaska and 36 mi² to 149 mi² for females in the same areas. Idaho wolverines displayed the largest spatial requirements with resident male home ranges averaging 587 mi².

Rearing requirements:

Data on wolverine denning habitats in North America are limited. The denning habitat used by 2 marked females and 1 unmarked female in Idaho was specific to subalpine talus habitats. Females selected den sites associated with large boulder talus (individual rock size greater than 2 meters diameter) in subalpine cirque basins above 8,100 feet elevation. Female wolverines in Idaho accessed natal dens by tunneling through snow into the natural chambers and passage-ways created by the talus. The depth of snow at the time of den use was not determined, but it most likely exceeded 6 feet.

The use of reproductive dens begins from early February to late March. In some cases, females may use multiple dens prior to kit weaning. Idaho wolverines abandoned natal dens as early as 10 March, moving kits through a series of maternal dens until weaning which occurred at 9-10 weeks of age.

Cover requirements:

Researchers have found 70% of wolverine use in medium to scattered density timber. Idaho research reported similar results, with montane coniferous forest types accounting for 70.2% of wolverine use. South central Alaska wolverines preferred spruce during winter and rocky areas during summer. Male wolverines in the Yukon preferred coniferous habitats in winter and avoided alpine talus in summer. Others found forest types were avoided by wolverines during summer in south-central Alaska. Preference for higher elevation habitats during summer may be related to the availability of prey or human avoidance while lower elevation forest types commonly associated with wild ungulates likely provide the highest carrion availability.

Vegetative characteristics appear less important to wolverine than physiographic structure of the habitat. Montane coniferous forests, suitable for winter foraging and summer kit rearing, may only be useful if connected with subalpine cirque habitats required for natal denning, security areas, and summer foraging. In addition, these habitats must be available during the proper season. Subalpine cirque areas, important for natal denning, may be made unavailable by winter recreational activities. Also, high road densities, timber sales, or housing developments on the fringes of subalpine habitats may

reduce the potential for winter foraging and kit rearing, and increase the probability of human-caused wolverine mortality.

Montana wolverines were reluctant to cross openings such as clear cuts or burned areas. Idaho wolverines commonly crossed natural openings and areas with sparse overstory such as burned areas, meadows, or open mountain-tops.

Conservation Practices and Management Options

Due to the rarity and large home range requirement of this animal, it is unlikely to be observed on the ranch.

Protection of natal denning habitat from human disturbance may be critical for the persistence of wolverine. The clear association between wolverine presence and refugia may be strongly linked to a lack of available natal denning habitat outside protected areas. Idaho wolverines selected specific natal and kit rearing habitat and responded negatively to human disturbance near these sites. Technological advances in over-snow vehicles and increased interest in winter recreation has likely displaced wolverines from potential denning habitat and will continue to threaten what may be a limited resource.

Refugia may be most important in providing availability and protection of reproductive denning habitat. Life history requirements of the wolverine are tied to the presence and stability of ecosystems lacking broad scale human influence. Dispersing wolverines in Idaho traveled over 77 mi² following routes across isolated subalpine habitat. Habitat alteration may isolate subpopulations, increasing their susceptibility to extinction processes.

It is possible that Elk Mountain could contain some portion of the habitat needs for a wolverine. If wolverine do occasionally utilize Elk Mountain, it is likely that they transition between there and the forested habitats on the Medicine Bow National Forest to the East.

Canada Lynx



Distribution and Population Status

Lynx are restricted to forested habitats from Alaska and Canada and their range extends south into the Cascade Range of Washington and Oregon and the Rocky Mountains of Colorado, Utah and Wyoming. These cats have always been extremely rare at the southern extremes of their range. Lynx breed in the northwest part of the state and have been observed in south central Wyoming.

During the past several years, the Colorado Division of Wildlife has undertaken a lynx reintroduction program and released 204 lynx into the mountains of southwestern Colorado. Of that total, 42 are confirmed dead. Currently, 36 lynx are being tracked by the Colorado Division of Wildlife. In Colorado, their distribution is primarily in mixed conifer and aspen forests above 9,300 feet elevation. In those habitats, lynx typically occur in areas where low topographic relief creates continuous forest communities of varying stand ages. Some of the lynx reintroduced into Colorado may travel north into the Elk Mountain area looking for suitable habitat.

The Canada Lynx is listed as a Federally Threatened Species. It is federally protected under the Endangered Species Act and is protected as a nongame species under Wyoming Game and Fish Department regulations.

Life History

Lynx breed from March through May in various parts of their range. The gestation period is about nine weeks. The single annual litter contains one to six (average, three) young. The female raises the litter, and the young disperse in the fall or the following spring. Females apparently can breed as yearlings, but breeding by such animals may be reduced or delayed if prey is scarce. Newborn kittens are blind, and the ears are closed. They are well haired, even including some indication of the ear tufts to come.

Lynx are primarily solitary and nocturnal. However they have been observed traveling together and hunting cooperatively. These animals hunt mostly on the ground, but can also climb. Lynx den or bed under ledges, trees, deadfalls, or occasionally in caves. In severe weather they may bed down in thick evergreen cover.

Lynx mortality is mostly due to loss of kittens during periods of low prey availability. Human caused mortality can also be a major factor in some parts of their range.

Habitat Requirements

Foraging Habitat: Early succession forests where snowshoe hares are plentiful are the habitats that lynx favor for hunting. Such forests may result from fires, timber harvests, or wind throw and disease. Studies have found that hares were more abundant in younger stands of lodgepole pine (< 20 years) than in any other forest type. Young conifer stands provide greater concealment from

predators, lighter snow pack, and warmer temperatures during winter than hardwood stands and such stands are critical to hare winter survival. The diversity of conifer stands on the ranch provide potential habitat for lynx.

Denning Habitat: For denning, females select dense, mature forest habitats that contain large woody debris, such as fallen trees or upturned stumps, to provide security and thermal cover for kittens. All of 16 dens observed in Colorado were in high elevation (10,226-11,765 feet) Englemann spruce/subalpine fir forests in areas of extensive downfall. Other important features of denning sites are minimal human disturbance, proximity to foraging habitats (early succession forests), and stands that are at least 2.5 acres in size. Travel corridors between den sites are important to permit females to move kittens to areas where prey is more abundant or to avoid disturbance.

Travel Cover: Lynx require cover for security and for stalking prey; they avoid large open areas. Travel cover allows for movement of lynx within their home ranges and provides access to denning sites and foraging habitats. In general, suitable travel cover consists of coniferous or deciduous vegetation at least 6 feet tall with a closed canopy that is close to foraging habitats.

Conservation Practices and Management Options

Lynx are closely associated with high elevation mixed conifer forests and the distribution of snowshoe hare in Wyoming. They have large home ranges and may travel 600 miles or more to meet their seasonal needs. If lynx utilize Elk Mountain, they may transition between there and the coniferous forest stands on the Medicine Bow National Forest to the East.

- High quality lynx habitat consists of a mosaic of early succession habitats with high hare densities, and late-succession stands with downed woody debris for thermal and security cover and for denning.
- Clear cuts greater than 300 yards wide may create barriers to lynx movements.
- Snowshoe hares may not move into cutting areas until 6-7 years after cutting.
- Thinning strategies for mixed conifer stands may be compatible with snowshoe hare and lynx habitat needs on the ranch.
- Small sized parcels (2.5-5 acres) of late-succession forest with downed woody debris appear to be adequate for den sites if they are connected with corridors of cover to permit females to move kittens.

Furbearers

Beaver



Distribution and Status

The beaver is North America's largest rodent. Adults can weigh 60 pounds or more and reach a length of four feet. They are found throughout North America except the Southwest and Mexico. Beaver occur throughout the state in suitable habitat which contain adequate supplies of water and food. They are considered a breeder in all atlas blocks. They depend upon aquatic and riparian ecosystems where sufficient water is available, or can be created by building a dam. Water must be of sufficient depth such that it will not freeze solid. In those situations where streams are too shallow to offer adequate protection for beaver, the availability of suitable dam sites near adequate food supplies largely determines beaver inhabitancy.

Studies have shown that three factors affect beaver occupancy of streams: stream gradient, valley width, and geological origin. Stream gradient is a major factor influencing dam site selection by beaver. Beaver prefer dam sites where stream gradients are less than 6 percent. Site selection decreases rapidly as gradients exceed 6 percent and terminates at gradients greater than 15 percent. Narrow valley bottoms limit the availability of food and, therefore, are not as favorable as wide valleys. In most cases, streams with low gradients also have wide valley floors. Geological factors influencing favorable dam sites include rocks and soils of granitic or glacial origin, whereas less suitable sites have rocks and soils of sedimentary origins. No currently active beaver colonies were documented on the ranch during field surveys. One old, inactive beaver pond was located along Rattlesnake Creek. Rattlesnake Creek appears to have the most suitable beaver habitat of all the available streams on the ranch.

Life History

Beaver usually live in family units consisting of the older mated pairs, young from the previous year, and young from the current season called kits. Young from the previous year are evicted from the family when they are about 22 months of age and they seek mates of their own and start a new colony.

Mating activity usually takes place in January and February under the ice cover. After a gestation period of 107 days, the young are born usually in May or June. The birthing process may take several days, and the litter size is usually three to five kits. Beaver kits are fully furred at birth, their eyes are open, and the incisor teeth are visible. Newborn beaver kits take to the water easily and may be swimming before they are a day old. However they are seldom seen before they are a month old. The kits are weaned within three months, but remain with the colony for up to two years.

Beavers usually do not range more than a few hundred yards from water while foraging. They have cardiogastric glands in the stomach and microflora which aid in the digestion of woody material. Beavers are mostly bark-eaters. They eat the bark of young twigs, and new growth of wood found between the outer bark and the wood of tree branches and trunks. During the summer months, much of their food may be herbaceous vegetation. As fall approaches the beaver begins to actively cut trees and shrubs for the colony's food cache. The quantity, quality and availability of this under-ice food supply will determine the condition and survival of the colony.

Habitat Needs

Rearing requirements: In beaver lodges or bank dens, the entrances to which must be under water, are essential to successful reproduction. Breeding, birthing, and early rearing of young take place inside these protected sites.

Feeding requirements: Beaver feed primarily on the bark of aspen, cottonwood, willow, and to a lesser extent, alder, birch and other species. Non-woody plants, such as sedges, rushes, cattails, and lush forbs, are also utilized in summer. Beaver in the Rocky Mountains have also been known to cut Engelmann spruce, junipers, lodgepole pine, and oak. But they are utilized primarily for dam building material. In the high elevation riparian ecosystem, aspen is the most palatable and preferred beaver food source. However, many beaver colonies subsist on willow where aspen is not present or has been eliminated. Both cottonwoods and willows are heavily utilized in the cottonwood riparian ecosystem.

Food requirements for a single beaver colony have been determined for the high elevation riparian ecosystem similar to the beaver habitat on the Elk Mountain Ranch. One colony requires four acres of aspen in a tall, closed stand with vigorous growth; six acres in medium height, light stand in good condition; or 8 acre in a low, open stand with slow growth. Similarly for willow, 12 acres in tall, closed stands; 18 acres in medium height stands with some openings; or 25 acres in low, open stands would be required.

Cover requirements: Streams, lakes and reservoirs with water depths greater than one foot offer escape cover, and lodges and bank dens provide escape, resting, and thermal cover for beaver.

Conservation Practices and Management Options

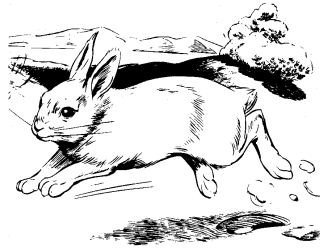
Beavers are natural watershed managers. The consequences of that management at times can be good and at other times can be quite damaging. Their structures slow spring runoff (hence reduce floods) and raise water tables, often with net benefits in forage available for livestock. Their ponds create habitat for fish and wildlife. On the debit side of the equation, their activities flood roads and plug ditches and culverts. These negative impacts must be managed through population control.

Conservation Practices and Management Options

- Once beaver have determined to claim a territory, they are very difficult to dissuade. If the activities of the beaver flood roads or damage property, some control measures may be needed.

Upland game

Snowshoe hare



Distribution and Status

The snowshoe hare are found in northern sections of the United States and most of Canada. They are also known as the varying hare because of their seasonal color changes. They are found in the montane and subalpine zones of the state and are the most common in elevations from 8,000-11,500 feet. One snowshoe hare was observed near Lost Meadow during field surveys.

The Wyoming Game and Fish Commission considers them common in the mountainous portions of the state and has a liberal hunting season on them.

Life History

During the breeding season, males fight frequently. In addition to territorial aggression, these hares show dominance interactions. Males are generally dominant in winter and females are dominant during the breeding season. Breeding starts in mid- to late April and typically is over by late August or early September. Females breed for the first time when they are one year old. Females have two or three litters per year of one to seven young. The abundance of winter food supply influences the timing of reproduction and the number of young produced each year. The gestation period is 37 to 40 days. Females breed again immediately after giving birth. The young are precocial and huddle together for the first few days. They are weaned at about one month and reach adult size by five months of age.

Adult survival averages 45 percent, with an estimated 15 percent survival in juveniles. Juveniles inhabiting more open, less favorable habitat have the highest mortality rate. A variety of predators including coyotes, bobcats, lynx, weasels, martens, golden eagles, hawks, great horned owls, and humans feed on snowshoe hares.

Snowshoe hares are mostly nocturnal and spend the day in scrapes called "forms" in concealed, protected areas such as a dense tangle of shrubs or young conifers. They do not venture much more than 100 yards into large clearings, consequently open areas do not provide habitat for them.

The summer pelage of this hare is rusty brownish to gray-brown above and white below. The tips of the ears are blackish, and frequently the animal shows striking, whitish gray stockings. During the fall the animals molt to a white winter pelage with only the tips of the ears remaining black. This pelage is shed in the spring. For a short time in spring and fall the animals are mottled brown and white.

Habitat Needs

Rearing requirements: This hare is not particular about its nesting sites; any shallow depression under a shrub, slash, or logs will suffice. Concealment seems to be the determining factor. Because the young are born in an advanced state of development, the nest is more of a birthplace than rearing quarters.

Feeding requirements: Grasses, sedges, and forbs seem to be preferred classes of forage for the snowshoe. When these are covered with snow, this species turns to bark, buds, and the more tender woody portions of aspen, alder, birch, and willows, and the bark and needles of conifers for its sustenance.

Shortage of winter food can be a limiting factor in snowshoe hare populations and is about the only factor that will induce them to migrate from their traditional home range.

Cover requirements: Snowshoes rest during daylight hours in unlined depressions in the soil, forest litter, or the snow (Forms). Forms are often under or adjacent to vegetative cover in summer and under logs, brush, or low hanging branches of conifers in winter. These hares rely heavily on their protective coloration to avoid detection.

Dense forest cover or dense willow and alder thickets are used by the snowshoe for escape cover. Seldom is this species found more than several hundred feet from such cover. When closely pursued, this hare sometimes takes refuge in burrows of other animals. Hollow logs are frequently used to escape falling snow or rain.

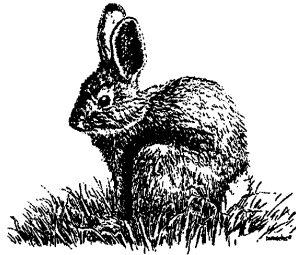
Conservation Practices and Management Options

This hare depends heavily on dense forest cover and brush. Consequently managing for sustained populations of snowshoe hares necessitates that these features be maintained in their habitats. Elk Mountain presently contains a good diversity of forest stands which should provide favorable habitat for snowshoe hare.

- In areas where timber is being cleared, consider constructing brush piles from the residual slash adjacent to drainages in those areas.

- Small patch cuts (2-5 acres) in conifer stands should improve habitat conditions for snowshoe hare over time.

Desert Cottontail



Distribution and Status

Three species of cottontails occur within Wyoming, the desert cottontail, which is found state wide at elevations below 7,000 feet; mountain cottontail, found in the mountains of the state; and the eastern cottontail, found in the extreme southeastern part of the state. Desert cottontail is the species found in Carbon County and on the Elk Mountain Ranch. They occupy habitats from 6,000 to 11,500 feet elevation. The best cottontail habitat consists of highly interspersed mixtures of grasses, forbs, shrubs, and escape cover. They are considered a small game species in Wyoming.

Life History

Cottontails breed from February to July and produce four litters per year. Gestation is 28 to 30 days. Young are blind, naked, and helpless at birth and are kept in a nest lined with fine grass and hair from the female's underside. The nest is usually in a thicket or dense stand of grass. The young grow rapidly and by the end of two to four weeks are ready to leave the nest and forage on their own. Juveniles from early litters may become reproductively active by late summer.

During warmer months, grasses and forbs are the mainstay of the diet. Sagebrush, rabbitbrush, and junipers are important winter food. Cottontails are somewhat crepuscular, often feeding early in the afternoon or from dawn to midmorning. They are active year round, but temperature, precipitation, and wind may cause them to seek shelter.

Drought and cold temperatures contribute to juvenile mortality. Most mortality occurs in fall and early winter. Predators include bobcats, coyotes, badgers, eagles, hawks, great horned owls, and humans.

Habitat Needs

Rearing requirements: Cottontail nests, consist of shallow depressions lined with grass and fur. They are usually placed near the edges of grassy areas and close to escape cover of taller cover types or in burrows, logs, rocks, or other suitable locations.

Feeding requirements: Cottontails, depend upon a diet comprised largely of seasonally palatable grasses and forbs. Twigs and inner bark of trees and shrubs are used in winter. Green vegetation is sought whenever it is available in all seasons. Young rabbits require a diet of legumes and other forbs to meet their high nutritional demand.

Cover requirements: Escape cover is extremely important to the survival of cottontails because they are a highly prized food item in the diet of many aerial and ground predators. Rock outcrops, down logs, brush and slash piles, dense shrubs, or other ground cover near feeding and resting areas is important.

Cottontails also need cover for protection from inclement weather, especially severe cold. While standing vegetation will often suffice, more substantial cover such as dense brush or slash piles, hollow logs, burrows of other animals, and undercut banks are preferable.

Conservation Practices and Management Options

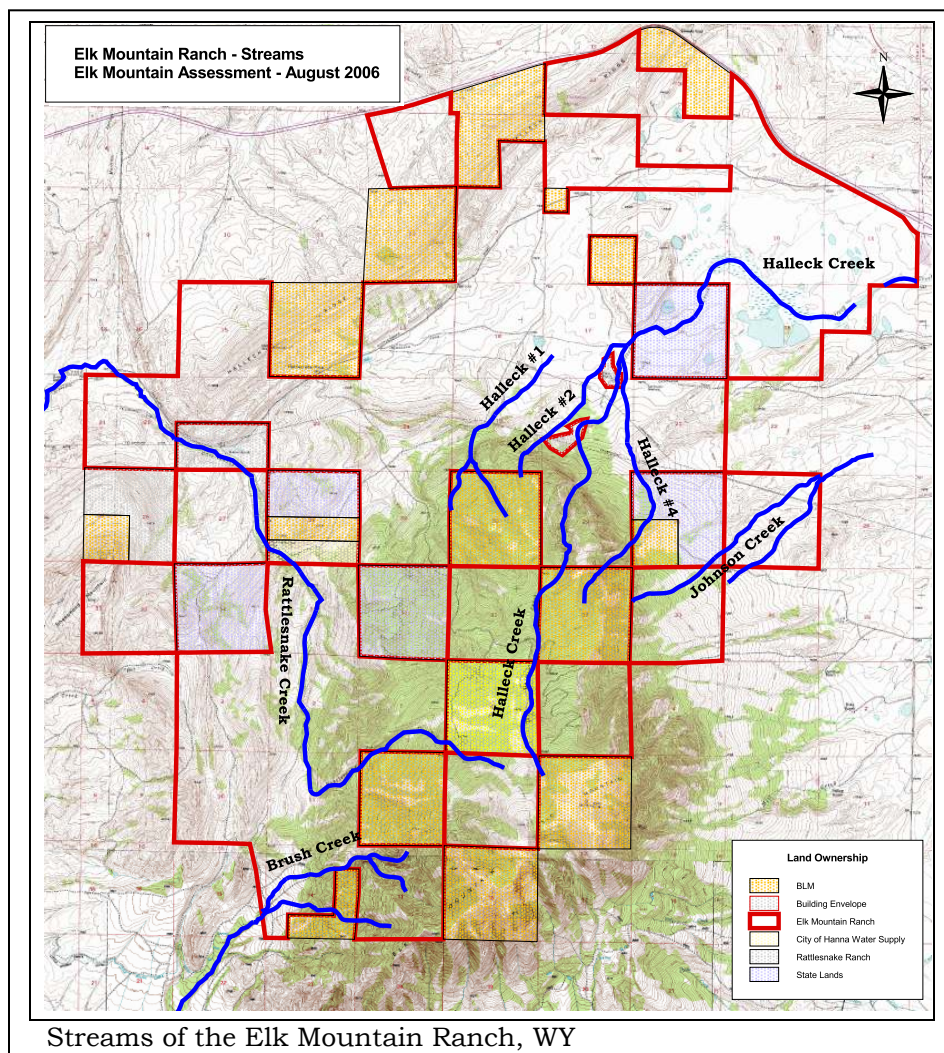
Mountain cottontails depend heavily on dense cover and brush. Consequently managing for sustained populations necessitates that these features be maintained in their habitats.

- In areas where timber is being cleared, consider constructing brush piles from the residual slash in those areas.
- Manage livestock to maintain patches of dense ground cover in areas managed for cottontails.

Fisheries

Note: There are photos, maps, tables and charts in the fisheries section labeled on a system only for the fisheries discussion and section.

Elk Mountain lies on the watershed divide between the Medicine Bow River and Pass Creek watersheds, two major tributaries of the North Platte River in south central Wyoming. Within the Elk Mountain Ranch there are four perennial streams and over 25 ponds and lakes. The headwaters of two major streams, Rattlesnake and Halleck Creeks, are found on the ranch. Two other lesser headwater streams, Brush Creek and Johnson Creek, also originate on the ranch. Rattlesnake Creek is one of the larger headwater tributaries in the Pass Creek watershed, and drains the entire western side of Elk Mountain. Brush Creek is a smaller tributary of Pass Creek, and drains the southwestern flank of Elk Mountain. Halleck Creek is a smaller headwater tributary of the Medicine Bow River, and drains the north and northeast flanks of Elk Mountain. Halleck Creek has four distinct headwater branches, which come together to form the main stem of the creek just below the headquarters of the ranch. Johnson Creek is a lesser tributary of Mill Creek, another of the many Medicine Bow River feeder streams, and drains a small portion of the eastern flank of Elk Mountain.



Historically the North Platte River drainage had no native salmonids (Hayden 1871). Native fish in the North Platte included several species of darter, sucker, dace and minnow. Population data on native fish range, assemblages and density has not been collected within streams on the Elk Mountain Ranch. Native amphibians also occur in the region, and include the Northern Leopard frog (*Rana pipiens*) and the boreal toad (*Bufo boreas boreas*).

Stocking efforts by private individuals and the Wyoming Dept. of Fish and Game and the Colorado Division of Wildlife over the last century have introduced several species of trout to the headwaters of the North Platte River. Many of these transplanted exotic salmonids have thrived in the cooler waters of the basin. The North Platte River, Medicine Bow River, and most of the watershed's headwater tributaries now support populations of brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*) and cutthroat trout (*Oncorhynchus clarki* sp.).

Low flow conditions are a serious limit to all of the streams on the Elk Mountain Ranch. Several reaches of Brush Creek, Johnson Creek and Rattlesnake Creek usually lose their surface flow over a segment in late summer and fall. The resulting fragmentation of aquatic habitat appears to result in all of the headwaters being fishless. No fish were observed in any of these reaches during the course of the assessment in August 2006.

Streams

Assessment Methods and Protocols

See the Water Resources section of this report for a reach map, discussion of reach identification and geomorphic characteristics of the streams.

Aquatic and Riparian Habitat Assessment Protocols

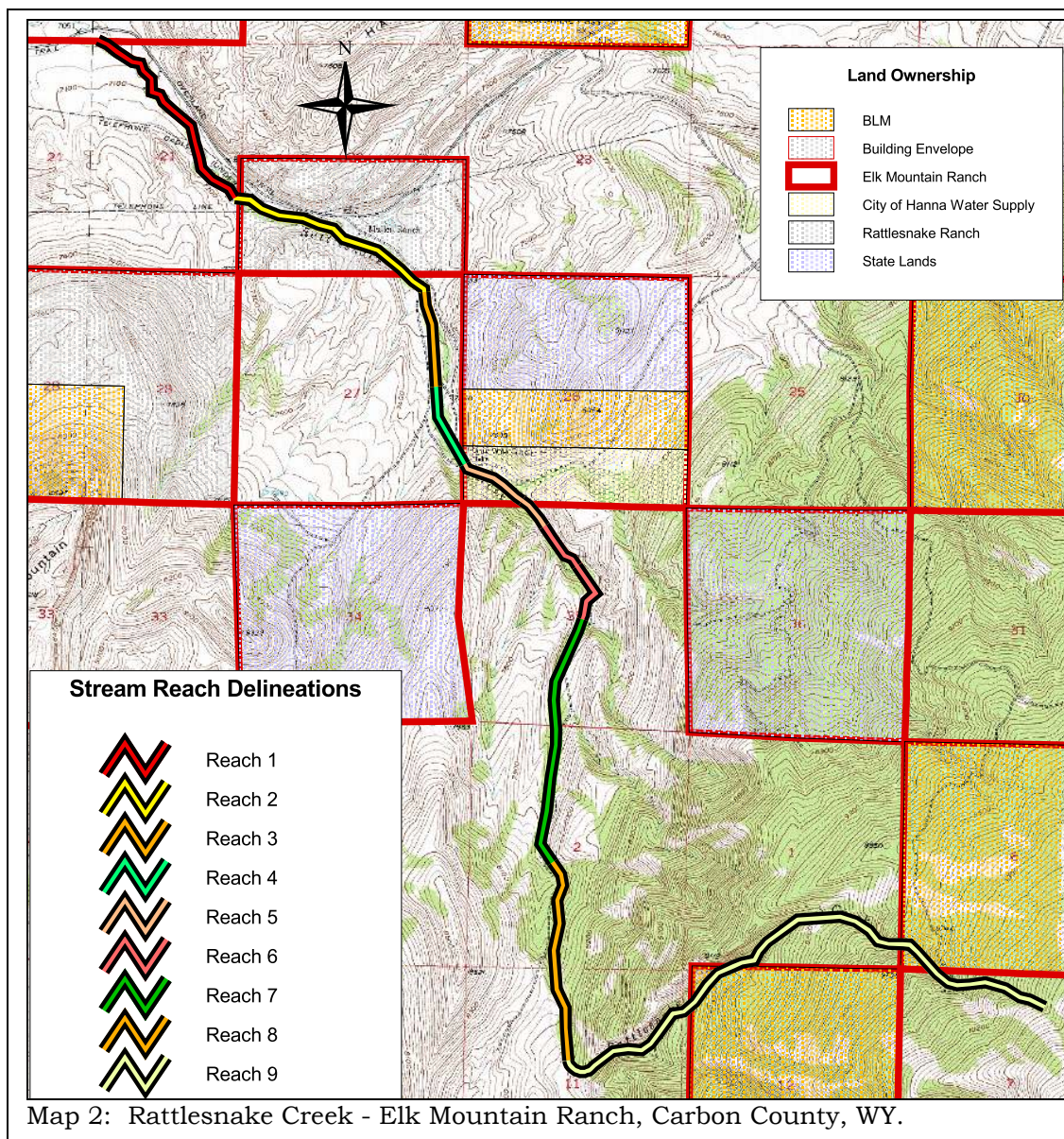
Each reach was assessed separately, in order to characterize existing habitat conditions and evaluate current management and restoration potential. A minimum rapid assessment was undertaken, which included an assessment of riparian condition using the BLM's Proper Functioning Condition (PFC) protocol (Pritchard, 1997). A copy of the PFC protocol is included in the appendix. A random sampling of maximum pool depth, residual pool depth (RPD), substrate composition/embeddedness, and stream bank condition was used to estimate the existing condition of the stream and potential for supporting a fishery. Stream reaches with a high potential for supporting fisheries were further analyzed using a basin-wide stream habitat survey protocol developed by the US Forest Service for smaller streams in the Rocky Mountain Region (Winters, 1997). This protocol is a modified basin-scale aquatic habitat inventory based on the Hankin & Reeves survey method. All meso-habitat types within a delineated reach are measured for multiple

attributes, include dimension, morphic form, bank condition and composition, substrate class, and cover for salmonids. The advantage of the Winters protocol is that it is a repeatable method, and therefore can be used to quantify changes in habitat resulting from management, habitat enhancement, or natural events. The Winters Protocol may be found in the appendix.

Rattlesnake Creek

Rattlesnake Creek begins near the west summit of Elk Mountain and flows to the southwest, down through a steep gorge for several hundred feet. Emerging from this gorge, the stream turns northwest and flows through a narrow valley between Sheep Head and the Elk Mountain massif, before exiting the ranch and eventually flowing to the west through a broad valley to its confluence with Pass Creek. Rattlesnake Creek reaches are displayed in Map 2.

A significant segment of Rattlesnake Creek downstream of the headwater gorge typically exhibits no surface flow during the late summer and fall. This seasonal barrier to migration and resulting fragmentation of aquatic habitat most likely severely limits the upper segment of Rattlesnake Creek to support a sustainable fishery. Downstream of the dry segment, a viable, self-sustaining brook trout fishery is present. Aquatic habitat conditions throughout this segment range from good in the upper wet reaches of the stream to poor in the lower reaches.



Reach 1:

This reach on Rattlesnake Creek is characterized by a broad valley bottom with dense willow and a few cottonwood trees. It is apparent that there has been considerable historic beaver activity within the reach, and at its full potential, this reach might consist of significant beaver pond complexes with little or no definable stream channel. There is evidence of significant past flooding occurring in the reach, particularly in the upstream segment, where there has been a severe down-cutting of the channel, and abandonment of the adjacent floodplain. Some mass-wasting of materials is occurring where the river has eroded away the steeper adjacent uplands.

Most of the channel throughout the reach is classified as Rosgen C5. In the upper portion of the reach, the channel type is a F5, with a new C5 channel beginning to form in the bottom of the F channel as the vertical banks recover a sustainable angle of repose and the stream adjusts to its new flood plain elevation. This channel type is typical of streams that have down-cut due to flooding or other event. In several areas throughout the reach, vertical instability is still an issue, with several severe head-cuts actively progressing up the stream channel (Photo 1). Stream bank condition is relatively poor in the reach, particularly in the areas near the active head-cuts. Noxious weeds, principally thistle, are present throughout the riparian zone.



Photo 1: Active head-cut on Rattlesnake Creek Reach 1

Water temperature in the reach was measured at 66° f., and pH was measured at 8.71. Aquatic habitat throughout the reach was found to be mostly stagnant glides choked with aquatic vegetation. Substrate composition was primarily fine sand and silt, with no suitable spawning areas for salmonids apparent. No fish were observed in the reach during this reconnaissance. It appears most likely that the reach is occupied by few, if any trout, but most likely supports native species such as Dace, Johnny Darters and White Suckers.

Management Recommendation:

The severe down-cutting occurring in this reach needs to be immediately addressed. The active head-cuts can be controlled through the installation of rock or large wood cross-vanes to control their migration upstream. If allowed to continue, this vertical instability will result in significant loss of adjacent riparian vegetation and wetlands as the stream abandons the existing floodplain for a new, lower elevation.

The reach currently has low potential as a quality cold water fishery. The reach can be managed to encourage robust willow growth and regeneration, with the expectation that beaver will return to the reach and create pond habitats that will support a viable cold-water fishery. Terrestrial noxious weeds are present throughout the riparian area and need to be appropriately treated.

Reach 2:

This reach is entirely located on the Rattlesnake Ranch, a private in-holding within the boundaries of the Elk Mountain Ranch, and was not assessed in detail for the purposes of this report. Reach 2 is primarily a Rosgen channel type C5, and appears to exhibit many of the same characteristics of Reach 1.

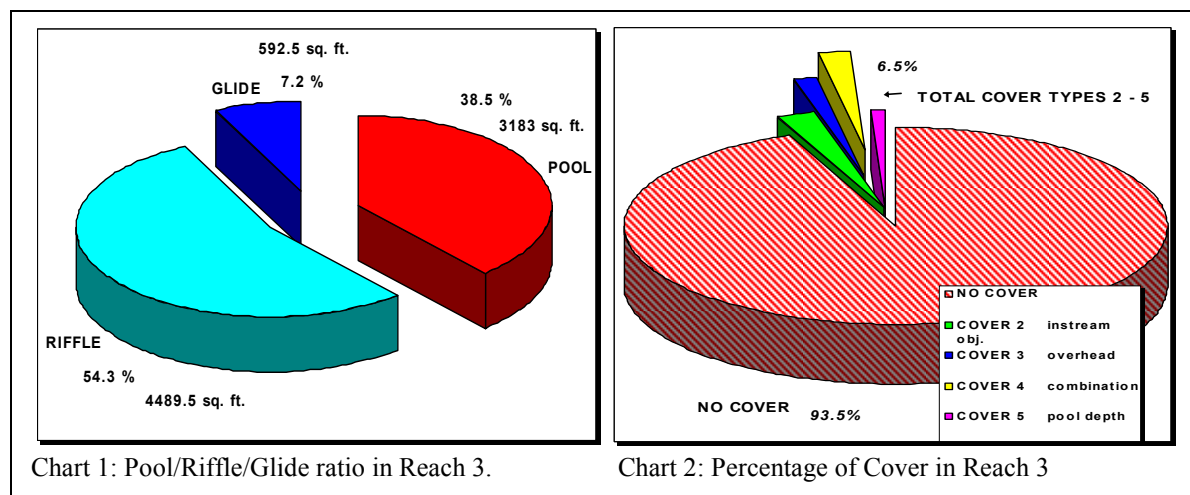
Reach 3:

Reach 3 extends from the Rattlesnake Ranch upstream to a road bridge that crosses the river and accesses the upland areas west of the creek on Sheephead Mountain. This reach is characterized by a relatively wide valley bottom and riparian corridor, with a sinuous, low gradient stream channel classified as a Rosgen C4. There is some evidence of past down-cutting due to flooding, and an old F channel is still apparent in the lower portion of the reach. The riparian zone in the reach exhibited good vigor with adequate willow regeneration, and was determined to be in properly functioning condition, although noxious weeds (Canada thistle) were present along the stream throughout the reach.

Water temperature in the reach was measured at 60° f., and pH was measured at 8.76. Stream flow was measured at the upstream boundary of the reach on August 1, 2006 using a Marsh-McBirney Flow-Mate 2000 flow meter, and was calculated to be 1.92 cubic feet per second (cfs). Some dense aquatic vegetation was present in a few of the pools, but is not nearly as severe as in Reach 1 downstream. Fish were observed throughout the reach, and most likely were brook trout. Habitat in the reach most likely also supports other native species such as Dace, Johnny Darters and White Suckers.

Initial reconnaissance indicated that Reach 3 exhibited a greater potential for a quality fishery than segments downstream, and appeared to be a good representation of habitat conditions in lower gradient C type channels found on Rattlesnake Creek. For these reasons, the reach was selected for more detailed analysis using the Winters BWSHI protocol to quantify aquatic habitat on a representative 1,000 foot long segment located near the upstream boundary. A summary of the BWSHI assessment is presented here. Detailed habitat metrics for the study segment can be found in the appendix.

A total of forty-two separate meso-habitats were identified in the study segment. These were composed of nineteen pools, twenty riffles, and three glide habitats (Chart 1). The average width of the stream was 8 feet, and the average depth was 0.5 feet. Channel substrate was predominately gravel, with some accumulations of cobble and a few boulders. Considerable sand and silt was present, filling the interstitial spaces between the gravels and cobble, resulting in poorer spawning habitat for salmonids. Adequate large wood was present in the study segment, with 73 individual pieces counted during the survey, and provided important velocity shelter and cover, but was not a significant contributor to habitat creation and scour. 14% of the left bank, and 19% of the right bank were categorized as vegetated but unstable, and the bank rock particle size (BRC) was less than 1/8 inch diameter throughout the reach. Smaller diameter BRC typically is more susceptible to erosion from higher flows, damage from hoof shear, and collapse due to lack of deeply rooted riparian vegetation. Nearly three hundred feet of active eroding banks were measured in the study segment, and appeared to be a significant source of fine sediment in the segment.



Pools in this segment were principally associated with scouring of the channel due to root-wad obstructions and the natural meander pattern of the river. Pool habitats comprised approximately 38% of the total wetted area of the study segment. The average depth of all of the pools measured was nearly 1 foot deep, with maximum pool depths ranging from 1.1 to 2.2 feet deep. Residual pool depth (RPD) is an important measurement of the potential over-wintering capacity of a pool, and was found to range from 0.6 to 1.9 feet, with an average of 1.1 feet throughout the reach. RPD was considered adequate to provide for over-wintering of salmonids and other native species in this reach.

Low gradient gravel riffles were the most dominant habitat type, in terms of both numbers and area, in the study segment, comprising more than 54% of the wetted area. These riffles were typically found in the transitional section of the channel between meander bends. The average depth of these riffles was 0.24 feet, and did not appear to be significant barriers to migration upstream or down. These riffles provide critical habitat for benthic macro-invertebrates as well as spawning habitat for salmonids and other native fish species.

Three glides were observed in the reach, and were associated with pools that had been filled with sediments from adjacent eroding banks or areas that had been disturbed by wildlife and/or cattle. Glide habitats accounted for only 7% of the total area of the study segment.

Cover is a critical habitat for salmonids and other aquatic species. Cover is important for providing protection from high water velocities and predators, and is typically the most limiting factor in headwater streams such as are found on the Elk Mountain Ranch. In the Reach 3 study segment, the quantity of suitable cover for salmonids was somewhat limited (Chart 2), accounting for approximately 6.5% of the total wetted area of the channel. In lower gradient C type channels with considerable pool scour, cover values of 10% - 15% would be expected in undisturbed streams. Cover was principally composed of in-channel object cover and overhead vegetation cover. Pool cover, another important metric for determining over-wintering capacity in the study segment, was very limited, accounting for less than 2.5% of the total wetted area of the pools and less than 1% of the total segment area.

Management Recommendation:

Aquatic habitat conditions in Reach 3 were found to be fair, with several limiting factors potentially affecting the sustainability of the trout fishery in the reach. Currently, the principal limiting factors to the fishery are the lack of over-wintering deep water habitat and limited cover in the reach. These problems are being compounded by actively eroding banks continuing to contribute sediment to the system and filling in the remaining deep water pockets. Additionally, sedimentation appears to be reducing the amount of suitable spawning habitat in the reach. Management in the reach may need to focus on treating the actively eroding banks, either through mechanical treatments such as toe-slope stabilization and re-vegetation, or through natural processes. In particular, the downstream portion of the reach near Rattlesnake Ranch has several steep banks that are slowly beginning to return to a sustainable angle of repose (Photo 2). Recovery of these banks may be accelerated by mechanically sloping back the banks, stabilizing the toe of the slope, and transplanting willow clumps. The riparian zone should continue to be managed to encourage willow regeneration and vigor. Rattlesnake Reach 3 appears to currently support a viable, self-sustaining population of brook trout, and therefore no supplemental stocking is recommended at this time.



Photo 2: Recovering bank in Reach 3.

Reach 4:

Reach 4 extends from the road bridge upstream to the Hanna Water Intake forebay. This reach exhibits the same characteristics as Reach 3, and was classified as a Rosgen C4 channel. The riparian zone in the reach exhibited good vigor with adequate willow regeneration, and was determined to be in properly functioning condition, although noxious weeds (Canada thistle) were present along the stream throughout the reach. Brook trout are most likely present throughout the reach, as they were observed both upstream and downstream of the segment. Habitat in the reach most likely also supports other native species such as dace, darters and suckers.

Management Recommendation:

Same as in Rattlesnake Creek Reach 3.

Reach 5 and Reach 6

Reach 5 extends from the Hanna Water Intake forebay upstream to the first road crossing. Reach 6 extends from the first road crossing upstream to the large spring on the east side of the stream. This spring is the primary source of late summer flows in Rattlesnake Creek, and the stream is virtually dry upstream of this point. Both

reaches exhibit similar morphological and habitat characteristics, and for the purposes of this assessment have been grouped together into one reach. Initial reconnaissance indicated that Reach 5 and 6 represent some of the best potential on the ranch for a quality fishery, and appeared to be a good representation of habitat conditions in higher gradient B type channels found in the higher elevation reaches of Rattlesnake Creek. For these reasons, the reach was selected for more detailed analysis using the Winters BWSHI protocol to quantify aquatic habitat on a representative 1,000 foot long segment located near the upstream boundary. A summary of the BWSHI assessment is presented here. Detailed habitat metrics for the study segment can be found in the appendix.

Rattlesnake Creek flows down through a relatively straight and narrow valley throughout this segment. The channel was classified as Rosgen B3, exhibiting less sinuosity than the C channels downstream, slightly greater gradient, and slightly more entrenchment of the channel. The adjacent riparian areas are not as broad as downstream, and are composed of aspen, alder, willow, and some larger mixed conifers. Riparian vegetation in the reach exhibited good vigor with adequate regeneration, and was determined to be in properly functioning condition, although noxious weeds (Canada thistle) were present along the stream throughout the reach. The road parallels the stream throughout Reach 5, and influences the stream in at least two areas. One of these areas is the road crossing at the boundary between Reach 5 and Reach 6 (Photo 3). This crossing is a low water ford, and is actively contributing sediment to Reach 5 immediately downstream. This crossing may also present a barrier to fish passage during extreme low flows, due to the wideness of the channel and lack of depth through the crossing.

Water temperature in the reach was measured at 50° f., and pH was measured at 8.58. Stream flow was measured at the upstream boundary of the reach on August 1, 2006 using a Marsh-McBirney Flow-Mate 2000 flow meter, and was calculated to be 2.24 cubic feet per second (cfs). Fish were observed throughout the reach, and most likely were brook trout. An electrofishing sample was collected by the Wyoming Fish and Game Dept. (WFGD) in July 1985, and found Brook trout present in the stream at densities of 1,560 individuals/acre with an

estimated biomass of 124 lbs/acre. Density and biomass estimates indicate that the population is viable and sustainable, but not robust. Other fish species found in the reach in 1985 included native species such as Creek Chub, Longnose Dace, and Longnose Sucker. The average length of brook trout sampled in the reach in 1985 was 5.5 inches, and no fish larger than this were observed during the 2006 assessment.

A total of thirty-six separate meso-habitats were identified in the study segment. These were composed of sixteen pools, seventeen riffles, and three glide habitats (Chart 3). The average width of the stream was 8.5 feet, and the average depth was

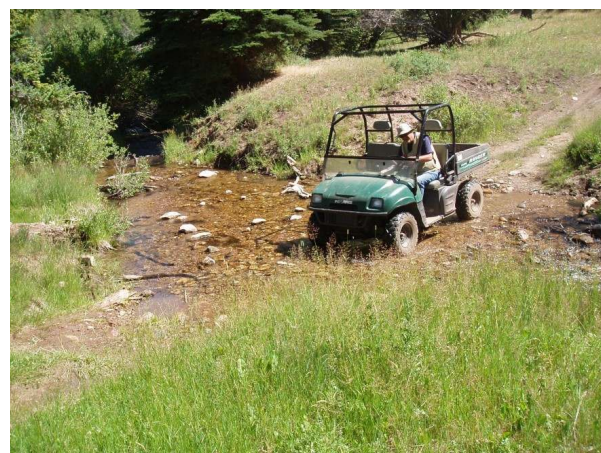
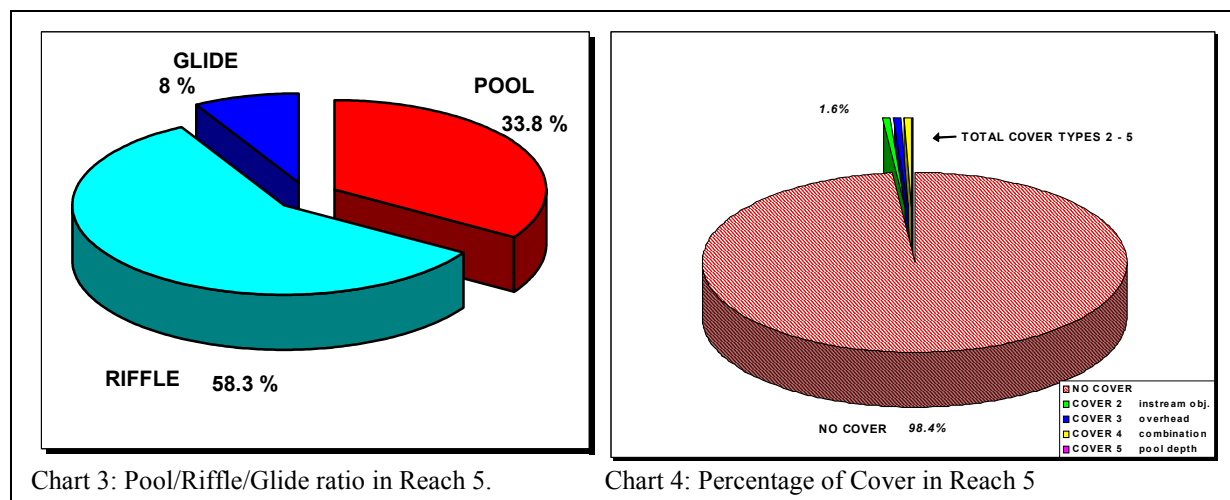


Photo 3: Road crossing at the top of Reach 3

0.4 feet. Channel substrate was predominately gravel, with considerable accumulations of cobble and a few boulders. Sand and silt was present in all habitat types, filling the interstitial spaces between the gravels and cobble, and was significant in depositional areas such as the bottom of pools and in the glides. Large wood was present but somewhat limited in the study segment, with 31 individual pieces counted during the survey. Large wood provided important velocity shelter and cover, and was a significant contributor to habitat creation and scour. Stream banks were mostly vegetated and stable throughout the reach, and the bank rock particle size (BRC) ranged from $<1/8$ " up 3". While not significantly armoring the banks, BRC was large enough to adequately strengthen banks with robust riparian vegetation. Two hundred and sixty-one feet of active eroding banks were measured in the study segment, and appeared to be a significant source of fine sediment in the segment. These actively eroding banks were primarily associated with the adjacent road and the road crossing.

Pools in this segment were principally associated with scouring of the channel due to root-wad obstructions, large wood and woody debris. A few of the pools were formed by boulders or the natural meander pattern of the river. Pool habitats comprised approximately 34% of the total wetted area of the study segment. The average depth of all of the pools measured was only 0.7 ft., with maximum pool depths ranging from 0.9 to 1.5 feet. Residual pool depth (RPD) was found to range from 0.4 to 1.1 feet, with an average of 0.6 feet throughout the reach. RPD in the reach was considered a significant limiting factor, and appeared to be barely adequate to provide for over-wintering of salmonids and other native species in this reach.



Low gradient gravel and cobble riffles were the most dominant habitat type, in terms of both numbers and area, in the study segment, comprising more than 58% of the wetted area. These riffles typically dominate B channel types, and depending on depth and substrate structure, may provide important holding and feeding habitats for trout, as well as critical habitat for benthic macro-invertebrates and other aquatic organisms. The average depth of these riffles was 0.25 feet in the study segment and there was only minimal ($<2\text{ft}^2$) holding cover. Riffles in the study segment did appear to provide adequate spawning habitat for salmonids and other native fish species.

Three glides were observed in the reach, and were associated with pools that had been filled with sediments from adjacent eroding banks and the road crossing. Glide habitats accounted for 8% of the total area of the study segment.

The quantity of suitable cover for salmonids in the Reach 5/6 study segment was very limited (Chart 4), accounting for less than 2% of the total wetted area of the channel. Less cover is expected in higher gradient B type channels, particularly those with larger stream channel substrates that armor the channel against pool scour. In undisturbed B channels, cover values of 5% - 8% would be expected. Cover was principally composed of overhead vegetation cover. Pool cover, another important metric for determining over-wintering capacity in the study segment, was virtually non-existent in the study segment.

Management Recommendation:

Aquatic habitat conditions in Reach 5 and 6 were found to be fair, with several limiting factors potentially affecting the sustainability of the trout fishery in the reach. Currently, the principal limiting factors to the fishery are the lack of over-wintering deep water habitat and limited cover in the reach. These problems are being compounded by actively eroding banks continuing to contribute sediment to the system and filling in the remaining deep water pockets. Reach 5 and 6, however, do present the best opportunities in the Rattlesnake Creek drainage for aquatic habitat manipulation and enhancement to dramatically improve the fishery.

A detailed habitat enhancement plan for the reaches should be developed with the primary goal of increasing pool depth and complexity, stabilizing the actively eroding banks, providing enhanced "pocket water" cover habitats in the riffles, and addressing the road/stream interactions in the reach. Recommended treatments would include improving scour in the pools using boulder and/or large wood cross vanes, large wood for toe slope stabilization of actively eroding or collapsing banks, installation of boulder micro-vortex pocket water structures in some of the riffles, and reconstruction of the old wooden bridge across Rattlesnake Creek at the crossing. The appendix contains schematic drawings and photographs of some of these treatment types. River restorations of this nature typically require the approval of an enhancement plan by the relevant State of Wyoming Aquatic Biologist as well as an authorization under Section 404 of the Federal Clean Water Act of 1972 from the US Army Corps of Engineers. These projects are usually considered to be relatively insignificant, and typically fall under the Corps' Nationwide Permitting authority for stream and wetland restoration (NWP27). An additional Section 401 certification from the State Dept. of Health may also be required, due to the proximity of the work to the Hanna Public Water Intake.

In addition to the stream enhancements recommended above, the large beaver pond upstream of the road crossing in Reach 6 (Photo 4) could be carefully enhanced to provide for additional pool habitat and over-wintering capacity in the



Photo 4: Rattlesnake Creek Beaver Pond

reach. This work would entail a certain greater risk than the stream enhancement project, due to the fragile nature of the old beaver dam forming the pond. If augmentation of this beaver pond is attempted, care must be taken not to disturb the dam face, and the pond should not be deepened to a level lower than the surrounding valley profile. I would recommend that enlargement be limited to removing the sedge mats that have formed along the upstream perimeter of the pond and transplanting these to the eroding banks downstream. Improvement of the in-flow channel and armoring the out-flow channel on the dam with large cobble will assure a good exchange of water in the pond and help minimize the algal blooms in late summer. Any dredged material from the pond would need to be completely removed from the site, and will require authorization under Section 404 of the Federal Clean Water Act of 1972 from the US Army Corps of Engineers. Additionally, this and the stream enhancement project would probably require consultation with the Conservation Easement holder (the Nature Conservancy) to ensure compliance with restrictions contained in that document.

In the interim, management in the reach may need to focus on treating the actively eroding banks, either through mechanical treatments such as toe-slope stabilization and re-vegetation, or through natural processes. The riparian zone should continue to be managed to encourage willow regeneration and vigor. Rattlesnake Reach 5 and 6 appear to currently support a viable, self-sustaining population of brook trout, and therefore no supplemental stocking is recommended until such time as the stream and pond enhancements can be undertaken. After these are complete, the landowner may choose to supplemental stock more brook trout or perhaps introduce brown trout in order to produce hybrid Tiger trout within the reach.

Reach 7 and Reach 8:

Reach 7 and 8 on Rattlesnake Creek were both dry during the 2006 assessment and were not analyzed for fisheries potential. Reach 7 was morphologically similar to Reach 5 and 6, exhibiting channel characteristics similar to a B channel type. Reach 8 consists of a significantly steeper and more confined valley type, with the channel exhibiting features more like an A channel. While these reaches may provide some limited temporal habitat during high flows, they are incapable of sustaining a fishery year round. Riparian areas in both of the reaches were relatively robust, consisting of aspen, alder, willow and some larger conifers. Reintroduction of beaver into Reach 7 might be desirable, in order to create ponds and raise the water table, possibly sustaining year round flows. The road parallels the dry stream channel throughout Reach 7, and crosses it at several points. Two of these crossings are negatively influencing the stream, and probably result in additional sedimentation downstream. Ideally, these low water crossings should be replaced with bridges. One crossing actually follows the creek channel (Photo 5) for more than one hundred feet, and in this case, the road will need to be relocated in order avoid the stream.



Photo 5: Road in stream channel - Reach 7

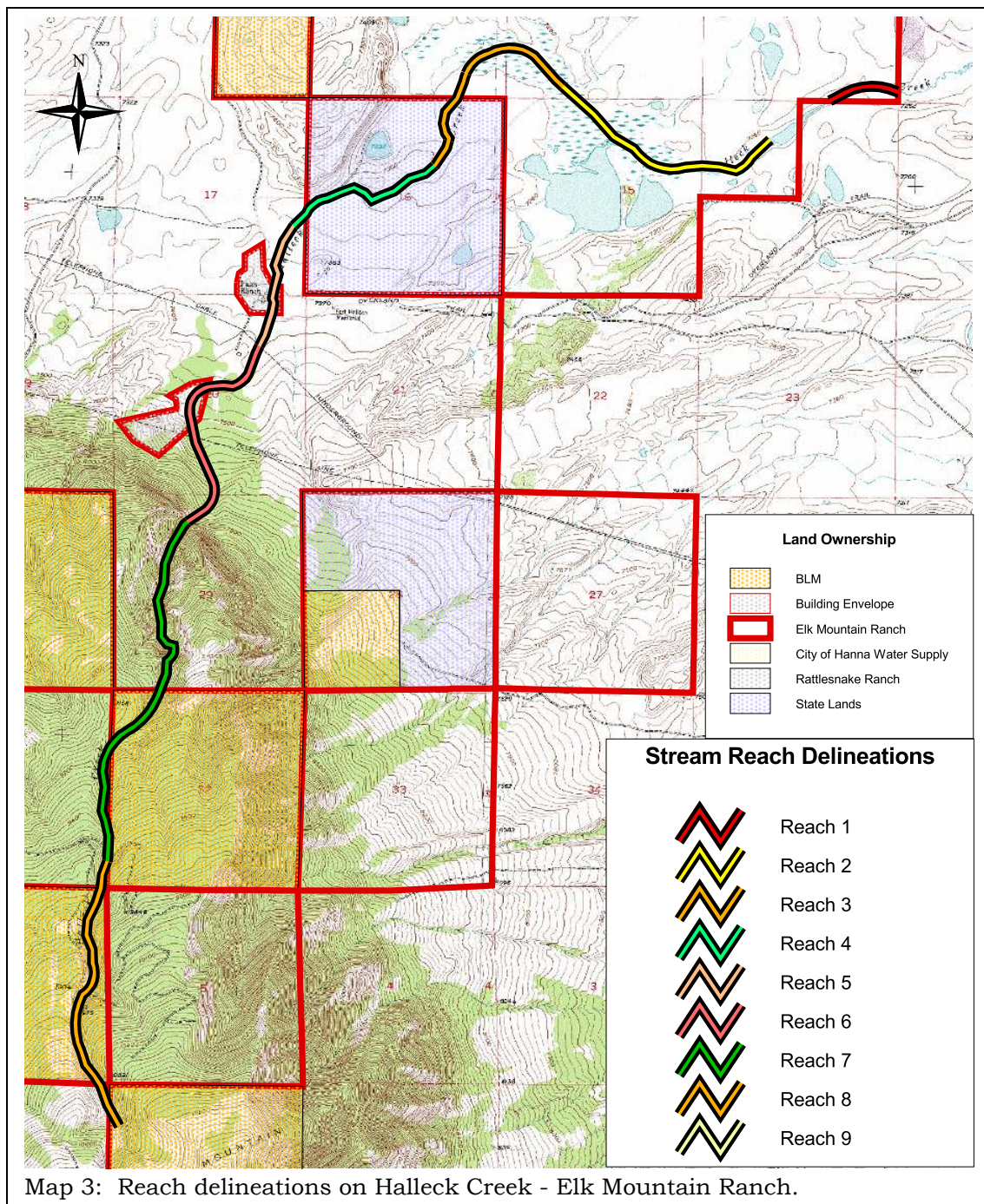
Reach 9:

Reach 9 on Rattlesnake Creek begins at the point where the stream enters a steep rocky canyon at approximately 8300 ft on the west flank of Elk Mountain, and continues upstream to the point where the creek becomes intermittent, somewhere near an elevation of 10,000 ft. The channel type throughout this reach is classified as Rosgen A2a, and is characterized by little sinuosity, steep gradient, and a deeply entrenched channel. The riparian buffer along the entire length of the reach is limited to the greenline immediately adjacent to the creek. Dominant riparian vegetation is alder and mixed conifer, with a few willows present. Some flow was present in the lower part of the reach, and was measured at 0.1cfs. Stream habitat in the reach is mostly a series of step pools, separated by steep cascades and rapids. These steep cascades may represent significant barriers to migration of aquatic species through the reach. Maximum pool depth was found to be poor in the reach, with most pools being less than 1.0ft deep. Average RPD was less than 0.5ft., and probably represents a significant limit to the over-wintering capacity of the stream throughout this segment. Stream substrate was dominated by boulder, with a significant infill cobble and sand. Substrates were packed tightly together and exhibited some embeddedness. Stream banks were mostly armored with 8" - 12" cobble, and appeared to be somewhat stressed due to high flows. No fish were observed in the reach, and are probably not present due to the the lack of habitat and potential barriers, and fragmentation caused by dry channel in Reach 7 and 8 below.

Halleck Creek

The main stem of Halleck Creek begins near the saddle between the main summit and the west summit of Elk Mountain and flows to the north, down through a steep gorge for several hundred feet. Emerging from this gorge, the stream flows across a broad alluvial fan and onto the pastures adjacent to the Elk Mountain Ranch headquarters. Two other perennial headwater tributaries, Halleck #2 and Halleck #4, drain sub-basins of the north flank of Elk Mountain west and east of the main stem, coming together with the main stem to form a single channel approximately 1/2 mile downstream of the Ranch headquarters. A forth perennial tributary, Halleck #1, drains a large portion of the northwest flank of Elk Mountain, but becomes intermittent before reaching the main stem of the creek. Below the confluence of the three headwater tributaries, the stream passes through open pasture land into a large wetland meadow on the northeast corner of the ranch. The stream was dry in the lower portion of this wetland meadow during the 2006 assessment. At the downstream boundary of the ranch, Halleck Creek flows into a man-made impoundment, Elk Mountain Reservoir, and then eventually joins Mill Creek, a major tributary of the Medicine Bow River.

A significant portion of Halleck Creek downstream of the headwater gorge is influenced by irrigation practices and water diversion. This seasonal dewatering and augmentation may result in negative effects due to variation of the natural hydrograph of the stream and fragmentation of aquatic habitat. Additionally, historic and current agricultural practices may be limiting the potential of the stream to sustain a viable aquatic ecosystem. Historic data



indicates that a self-sustaining brook trout fishery was once present on this stream, but current observations would indicate that this may no longer be the case. Aquatic habitat conditions throughout this watershed range from good in the upper wet reaches of the stream to extremely poor in a few of the lower reaches.

Halleck Creek was delineated into eight distinct reaches, based on valley type, channel morphology, perennial vs. intermittent flows, and administrative or physical boundaries. Reaches were numbered consecutively, from 1 to 8,

beginning at Elk Mountain Reservoir at the ranch boundary, and continuing upstream to the headwaters. The reach delineations depicted in Map 3.

Reach 1:

Halleck Creek Reach 1 extends from the east boundary of Section 11 in the northeast corner of Elk Mountain Ranch upstream to the private property boundary on the south boundary of Section 11. At the time of the 2006 assessment, the entire reach was inundated by water impounded by Elk Mountain Reservoir, on State lands downstream of the ranch. Fish populations in the reservoir are managed by the Wyoming Department of Fish and Game, and the reservoir is stocked for public fishing. The portion of Elk Mountain Reservoir extending upstream onto the Elk Mountain Ranch property was relatively shallow, with considerable aquatic vegetation present throughout the reach. Populations of sport fish species such as rainbow trout are assumed to be present in Reach 1 of Halleck Creek.

Management Recommendation:

None. Defer to the State for stocking of the reservoir.

Reach 2:

Halleck Creek Reach 2 extends from the Elk Mountain Ranch property boundary in Section 14 upstream to culvert where the primary access road to the ranch crosses Halleck Creek, approximately 1/2 mile north of Lake Waken Tanka. There was no surface flow in this reach during the 2006 assessment. The stream channel meanders through a large riparian/wetland meadow consisting of bull rush, carex/junkus and sedge throughout the reach. The riparian meadow appeared to be in properly functioning condition, even though the channel was dry. The channel type throughout this reach was classified as Rosgen E5. E Channels are highly desirable, and typically provide excellent habitat. These channels exhibit tortuous sinuosity, deep pools, undercut banks, and excellent cover for trout. Given the size of the adjacent riparian wetlands and the overall integrity of the stream channel, it was somewhat surprising to find the stream completely dry in this reach. Initial observations indicate that the ranch access road across the meadow at the upstream boundary of the reach may be adversely affecting the sponge-filter capacity of the wetland, effectively preventing subterranean flow downstream through the meadow (Photo 6). The road appears to have been recently re-constructed, using fill material to raise the level of the road approximately 6 - 8 feet above the surrounding wetlands. A single culvert, on the main channel of Halleck Creek drains the entire upstream wetland.



Photo 6: Wetland meadow in Halleck Reach 2, downstream of the ranch access road

Management Recommendation:

I recommend that water level monitoring wells be established in the wetland meadow upstream and downstream of the access road to determine if the road is negatively affecting the function of the wetland. These monitoring wells are easy to construct and install, and consist of a 3" or 4" diameter PVC pipe driven into the wetlands to a depth deeper than the surrounding water table - typically 5 -10 feet. A graduated wooden staff gauge is attached to the underside of the cap on the pipe, and is suspended in the well. A small amount of ground-up cork can then be dropped into the pipe. The cork will float on the water surface in the well, and stick to the wooden staff gauge, allowing a reading to be made when the staff gauge is removed from the well. A more elaborate, and expensive alternative may be to install a Sierra Scientific Corporation AQUA-ROD into the well. AQUA-RODs are automated water level logging devices that can measure stage at specified intervals, or when a pre-defined change in water surface level occurs. These units cost approximately \$1,000.00 each, and are capable of collecting up to 6,500 individual readings, including date, time, temperature, and water surface elevation.

In addition to monitoring the water table above and below the road, simple photo-points may be established to determine over time whether the vegetation in the wetland below is beginning to convert to drier, upland species. A gradual encroachment of upland plant species along the edges of the meadow may be a good indicator that the sponge-filter function of the wetland is being inhibited.

If water table and vegetation monitoring indicate the wetland downstream of the road is drying out, additional drainage will need to be installed in the fill material along the access road. This may be as simple as installing multiple culverts along the 1/3 mile length of the road through the wetland.

Reach3:

Halleck Creek Reach 3 extends from the culvert where the primary access road to the ranch crosses Halleck Creek upstream to culvert where the ranch headquarters access road crosses the stream. In the lower portion of the reach, the stream channel meanders through a large riparian/wetland meadow consisting of carex/junkus, sedge, and a few willow colonies. The upper segment of the reach is characterized by a narrower riparian zone, with less carex and greater concentrations of willow. For the most part, riparian areas in the reach appeared to be in properly functioning condition. The channel type throughout this reach was classified as Rosgen E5 (Photo 7). There was water present in the reach, however, the flow was somewhat stagnant. This was, in part, due to the dense aquatic vegetation found throughout the upper part of the reach. This vegetation may be due, in part, to excessive nutrients entering the stream from heavily used pastures immediately upstream.



Photo 7: E Channel and Robust Riparian

The stream channel width throughout the reach averaged 3 - 4 feet, with pool depths between 1.0 and 1.5 feet deep. Residual pool

depth (RPD) was estimated to be around 1/2 foot. The stream banks were in excellent condition, heavily vegetated with stable undercuts to support cover habitat for fish. No fish were seen in the reach, but native minnows and darters are may be present in the reach.

Management Recommendation:

Continue existing management for wetland health and vigor.

Reach 4:

Halleck Creek Reach 4 extends from the culvert where the ranch headquarters access road crosses the stream to the confluence with Halleck #2. This upstream boundary is adjacent to the BLM/private property line on the west side of Section 16. Halleck Creek throughout Reach 4 was found to be in extremely poor condition, primarily due to grazing, is most likely not capable of supporting a trout fishery. The stream through Reach 4 is characterized by a narrow riparian corridor consisting mostly of mature, decadent willow and upland grasses. There is little or no regeneration of riparian woody species apparent in the reach. The adjacent uplands in the reach appeared to be heavily grazed, and were contributing sediment directly to the stream. Riparian condition was found to be functioning at risk in the reach, with an apparent downward trend.

The stream channel throughout Reach 4 was classified as a Rosgen C5. Stream channel integrity was very poor, with pool/riffle habitats not readily distinguishable due to poor bank condition, over-widening of the stream channel, and sedimentation. Stream substrate consisted of a mix of sand and gravel, with significant silt accumulations filling the interstitial spaces. Stream banks were in very poor condition, with considerable damage from hoof shear in all areas not occupied by mature willow. Stream widths ranged from 3 feet wide in areas with willow, to over 8 feet wide in segments without adequate riparian vegetation. Stream bank particle size was mostly fine soils and rock fragments less than 1/8", providing little armoring of the banks.

Pool habitat was extremely limited in the reach, and within the few pools found, maximum depths did not exceed 1.0 ft. Residual pool depth was not present in any of the pools observed, due to significant infilling of sediment from adjacent eroding banks and upland sources. No fish were observed anywhere in the reach.

Management Recommendation:

Halleck Creek Reach 4 exhibits some of the poorest aquatic habitat and riparian conditions of any stream on the Elk Mountain Ranch. Habitat conditions are so poor in the reach that this segment is most likely a barrier to fish movements and migration through the reach. The adjacent pasture appears to be used as a frequent holding area for cattle. If the pasture will continue to be used for this purpose, a riparian exclosure might be considered to encourage new willow regeneration, re-establish riparian function, and allow the stream banks to heal and the stream to redefine the channel and pool/riffle habitat. A riparian exclosure could be constructed using either electric fencing or a permanent fence. A hardened watering site could be installed at a single point on the stream, using cobble to armor the stream bank, or an upland watering site may be considered.

Reach 5:

Halleck Creek Reach 5 extends the confluence with Halleck #2 upstream to the Ranch Headquarters (Palm Ranch). Halleck Creek throughout Reach 5 was found to be in similar condition to Reach 4, primarily due to grazing, is most likely not capable of supporting a trout fishery. Riparian conditions appeared to be similar to Reach 4, but a formal PFC assessment was not undertaken in the reach. Aquatic habitat and channel conditions were similar to Reach 4, and may limit the movement of fish throughout the reach. A riparian exclosure may need to also be considered in the reach to improve habitat and riparian condition.

Reach 6:

Halleck Creek Reach 6 extends from the Ranch Headquarters (Palm Ranch) upstream to a waterfall barrier at the obvious rock outcrop in the steep canyon above the ranch headquarters. Halleck Creek throughout Reach 6 flows through an alluvial fan at the base of the steep headwater canyon on the northern flank of Elk Mountain. There is evidence of considerable historic lateral migration of the channel across the alluvial plain in this reach, and old abandoned channels may be observed throughout the area. Near the center of the reach, there are a series of diversion points which feed irrigation ditches leading to the pastures below. These diversions present significant barriers to fish passage, and may dramatically alter the natural flow regime in the segment downstream, likely limiting the reach in terms of quality aquatic habitat and depth (Photo 8). Upstream of these diversions, extensive historic logging operations may have disturbed the stream channel in many locations, altering channel morphology and mobilizing stream substrates. An old logging road parallels the stream channel on the east bank from a point a few hundred feet upstream of the uppermost diversion point to the rocky waterfall at the upstream boundary of the reach. Large stumps (3-4' DBH) between this road and the stream lend evidence to extensive logging occurring down to the waters edge, and may partially explain the frequent lateral migration of the channel and generally poor pool habitat conditions observed in the reach. The waterfall at the top of the reach is an impenetrable barrier to fish migration upstream, and may account for no fish being observed in any of the reaches upstream on Elk Mountain.



Photo 8: Low flows on Reach 6 below ditch.

Although there is substantial evidence of historic disturbance in the reach, the current trend of riparian function and channel integrity appears to be recovering. Riparian conditions were found to be in properly functioning condition during the 2006 assessment. Riparian areas consisted primarily of aspen and alder, with robust willow

under-story. Riparian plant regeneration was evident, and disturbed banks appeared to be naturally re-vegetating.

The stream channel type throughout the reach was Rosgen B3, and was slightly entrenched, particularly in the upstream half of the reach. Stream substrate typically was composed of gravel and smaller cobbles, and appeared to be somewhat mobile in the upstream half. Stream banks were, for the most part, vegetated and stable, and the banks were mostly composed of particles 3" - 6" in diameter, providing some armoring from high flows. The width of the stream throughout the reach was typically 3 -4 feet, and considerable large wood was present in the channel, creating scour habitat and cover, as well as channel roughness and complexity. Pool habitats, however, were relatively infrequent and of poor quality throughout the reach. Maximum pool depth was rarely more than 1.0 foot, and residual pool depths did not exceed 0.6 foot. Over-wintering habitat was exceptionally limited in the reach.

An electro-fishing sample was collected by the Wyoming Fish and Game Dept. (WFGD) near the ranch headquarters in August 1984, and found Brook trout present in the stream at densities of 466 individuals/acre with an estimated biomass of 75 lbs/acre. Density and biomass estimates indicate that the population was marginally viable, but not robust. The 1984 sample data does not indicate any other fish species being present. The average length of brook trout sampled in the reach in 1985 was 5.7 inches. No fish were observed during the 2006 assessment, and brook trout may no longer occupy the stream, due to lack of over-wintering habitat in the reach, and poor habitat conditions at lower elevations in Reach 5 and Reach 4.

Management Recommendation:

Currently, the principal limiting factor to establishing a fishery in the reach is the lack of over-wintering deep water habitat and limited cover in the reach. Downstream of the irrigation diversions, water depletion further limits available habitat in summer months. Upstream of the diversions, the stream does present an opportunity for aquatic habitat enhancement and re-establishing a trout fishery. The old logging road on the east side of the stream in the upper half of the reach may allow for a small excavator to access the stream to improve existing pool habitats and create new ones. A detailed habitat enhancement plan for the reach would need to be developed with the goal of increasing pool depth and complexity, as well as providing enhanced "pocket water" cover habitats in the riffles. Recommended treatments would include improving scour in the pools by removing large cobble and boulder armoring the bottom of the channel. These excavated materials may be used to construct boulder cross vanes to focus flow and scour in the pools, installation of boulder micro-vortex pocket water structures in some of the riffles. At the same time, the diversion structures may be reconstructed as boulder cross vanes in order to eliminate aquatic organism migration barriers, reducing yearly maintenance needs and cost, and providing additional habitat for fish. Appendix II contains schematic drawings and photographs of some of these treatment types. River restorations of this nature typically require the approval of an enhancement plan by the relevant State of Wyoming Aquatic Biologist as well as an authorization under Section 404 of the Federal Clean Water Act of 1972 from the US Army Corps of Engineers. These projects are usually considered to be relatively insignificant, and typically fall under the Corps' Nationwide Permitting authority for stream and wetland restoration (NWP27).

Reach 7:

Halleck Creek Reach 7 extends from the waterfall barrier at the obvious rock outcrop in the steep canyon above the ranch headquarters upstream to the point where the road to the summit of Elk Mountain crosses Halleck creek, at approximately 9,600 feet elevation. The downstream half of Reach 7 flows through a steep canyon on the northern flank of Elk Mountain. The topology and geology of this canyon indicates the presence of numerous physical barriers to fish passage throughout this segment of the reach. Near the center of the reach, the gradient lessens considerably. Above the canyon, there is evidence of extensive historic logging operations on both public and private lands adjacent to the stream. The low water crossing at the upstream boundary of the reach was completely dry at the time of the 2006 assessment, and represents a significant barrier to passage of fish to flowing channels upstream and downstream of the ford.

The channel type in the lower half of the reach is classified as Rosgen A2a+, and is characterized by little sinuosity, steep gradient, and a deeply entrenched channel. The channel type changes to Rosgen B3a at the upper end of the steep canyon, and continues to exhibit this lower gradient channel morphology for approximately one mile, becoming steep again (A3) near the upstream boundary of the reach. The riparian buffer along the entire length of the reach is limited to the greenline immediately adjacent to the creek. Dominant riparian vegetation is alder and mixed conifer, and the reach riparian component was considered to be properly functioning. Stream flow was measured near the mid-point of the reach and was calculated to be 0.9 cfs. Water temperature in the reach was measured at 53° f., and pH was measured at 8.43.

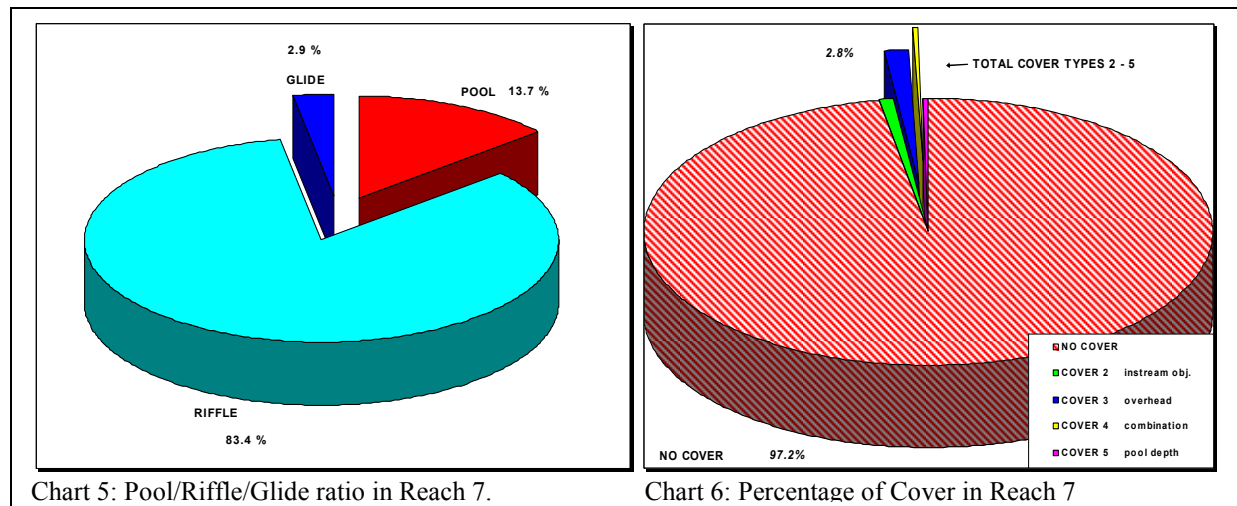
The B channel in Reach 7 appeared to be a good representation of habitat conditions found in the higher elevation reaches of Halleck Creek (Photo 9) and on first inspection, appeared likely to support a trout population. For this reason, the reach was selected for more detailed analysis. A representative 1,000 foot long segment located near the middle of the reach was surveyed using the Winters BWSHI protocol to quantify aquatic habitat. A summary of the BWSHI assessment is presented here. Detailed habitat metrics for the study segment can be found in the appendix.

A total of twenty-five separate meso-habitats were identified in the study segment. These were composed of twelve pools, eleven riffles, and two glide habitats (Chart 5). The average width of the stream was 7.6 feet, and the average depth was 0.5 feet. Channel substrate was predominately gravel, with



Photo 9: Halleck Creek Reach 7 - note the abundant large woody debris.

considerable accumulations of cobble and a few boulders. Sand and silt was present in all habitat types, filling the interstitial spaces between the gravels and cobble, and was significant in depositional areas such as the bottom of pools and in the glides. Large wood was abundant in the channel, with more than two hundred individual pieces counted during the survey. Large wood provided important velocity shelter and cover, and was the principal contributor to habitat creation and scour. Stream banks were generally vegetated and stable throughout the reach, and the bank rock particle size (BRC) ranged from <3" up 12" providing significant armoring of the banks. Only 5 feet of active eroding banks were measured in the study segment.



Pools were principally associated with damming of the channel due large wood and woody debris accumulations. A few of the pools were formed by the scour of water plunging over boulders or large wood in the river. Pool habitats comprised approximately 14% of the total wetted area of the study segment. The average depth of all of the pools measured was 0.75 ft., with maximum pool depths ranging from 0.8 to 1.7 feet. Residual pool depth (RPD) was found to range from 0 to 1.3 feet, with an average of 0.7 feet throughout the reach. RPD in the reach was considered a somewhat limiting factor, and may not provide adequate over-wintering habitat for salmonids at this elevation.

Low gradient cobble riffles were the most dominant habitat type, in terms of both numbers and area, in the study segment, comprising more than 83% of the wetted area. These riffles typically dominate B channel types, and depending on depth and substrate structure, may provide important holding and feeding habitats for trout, as well as critical habitat for benthic macro-invertebrates and other aquatic organisms. The average depth of these riffles was 0.25 feet in the study segment, however, there was holding cover in the form of pocket water (66ft²) present in many of these habitats. Riffles in the study segment did appear to provide adequate spawning habitat for trout.

The quantity of suitable cover in the Reach 7 study segment was somewhat limited (Chart 6), accounting for less than 3% of the total wetted area of the channel. Less cover is expected in higher gradient B type channels, particularly those with larger stream channel substrates that armor the channel against pool scour. Cover was

principally composed of overhead vegetation cover. Pool cover, an important metric for determining over-wintering capacity in the study segment, was present in the study segment, and accounted for approximately 2% of the wetted area of the pool habitats.

There is no historic record of fish stocking occurring on Halleck Creek upstream of the barrier at the bottom of Reach 7, and no fish were observed in either Reach 7 or Reach 8 during the 2006 assessment. It is most likely that these reaches have always been fishless due to the many barriers present in the lower segment of Reach 7.

Management Recommendation:

The habitat data collected in this segment in 2006 suggests that limits to over-wintering habitat may somewhat limit the viability of establishing a trout fishery in the reach. While it might be possible to establish brook trout or cutthroat in the higher elevations of Halleck Creek, there is a significant risk that these efforts could be fruitless without considerable enhancement to pool and pocket water habitats in the reach. At this time, it may be best if the upper reaches of Halleck Creek be left in a natural, fish-less condition.

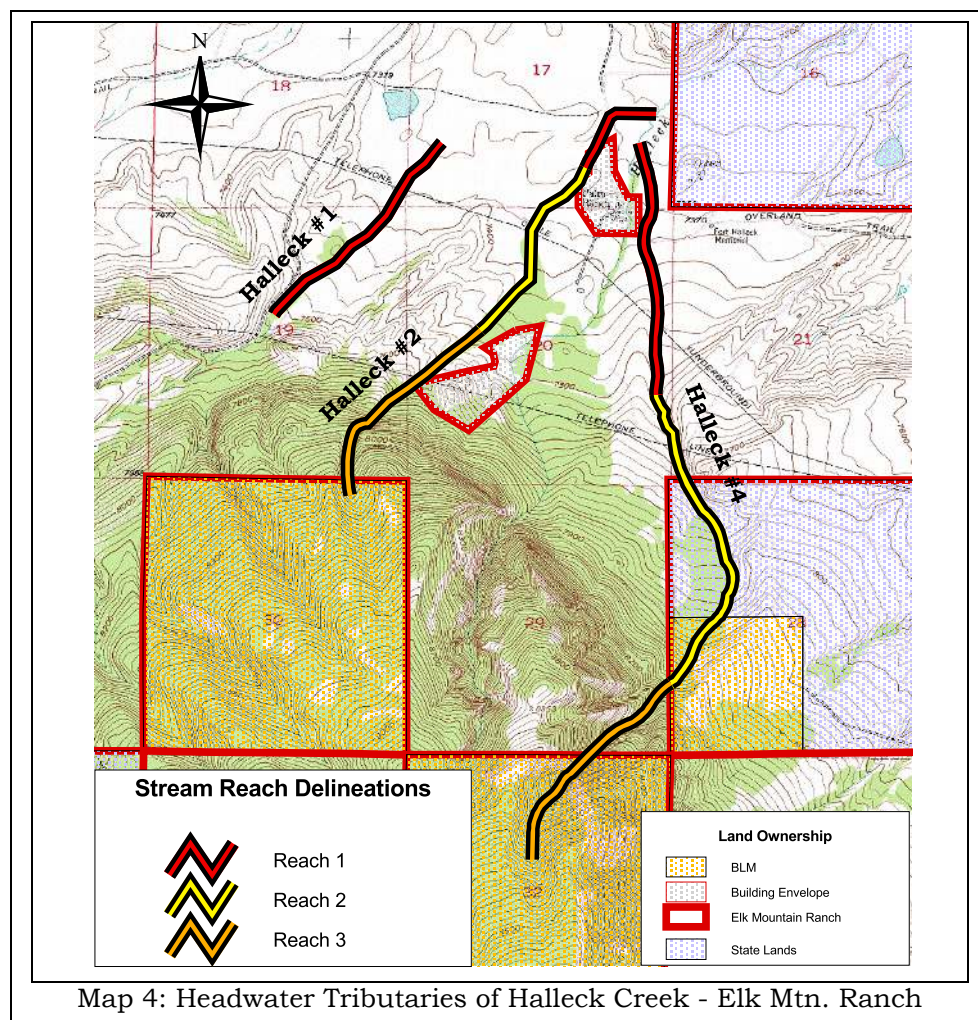
Reach 8:

Halleck Creek Reach 8 extends from the road crossing at approximately 9,600 feet elevation to the point where the channel is dry near the saddle between the main summit of Elk Mountain and the west peak. The channel type throughout the reach is classified as Rosgen A2a+, exhibiting a steep gradient, and a deeply entrenched channel. The riparian buffer along the entire length of the reach is limited to the green line immediately adjacent to the creek. Dominant riparian vegetation is alder and mixed conifer, with a few willows present. Stream flow was present in the lower part of the reach, and was measured at 0.7cfs. Stream habitat in the reach is mostly a series of step pools, separated by steep cascades and rapids. Maximum pool depth was found to be poor in the reach, averaging less than 1.0 ft deep. Average RPD was less than 0.5ft., and represents a significant limit to the over-wintering capacity of the stream throughout this segment. Stream substrate was dominated by boulder, with infill of cobble and gravel. Stream banks were mostly armored with 8" - 12" cobble, and appeared to be in good condition. The stream in this reach is most likely fishless, due to elevation and lack of over-wintering habitat.

Management Recommendation:

At this time, it is recommended that the upper reaches of Halleck Creek be left in a natural, fish-less condition.

Headwater Tributaries to Halleck Creek



Halleck #1 - Reach 1:

Halleck #1 Creek is the western most headwater tributary to the main stem of Halleck Creek, and drains three small sub-basins on the northwest flank of Elk Mountain. The stream flows to the north, parallel to the road to Rattlesnake Pass, and eventually dries up near the vicinity of Eagle Lake. There is no evidence of a channel connecting the main channel of Halleck Creek to the point where Halleck #1 becomes ephemeral. Reach 1 on Halleck #1 extends from the point where the stream dries up upstream to the road crossing the creek. The adjacent pastures are utilized for grazing, and the stream channel and riparian area are in generally poor condition similar to Halleck Reach 4. Riparian conditions were found to be functioning at risk in the reach, with an apparent downward trend. Riparian species consisted mostly of decadent willow and alder, with no apparent regeneration occurring along the stream. Upland grasses and numerous noxious weeds were observed to be encroaching on the stream banks. Channel integrity was poor, with numerous bare banks actively contributing sediment into the channel and in-filling pools (Photo 10). No fish were observed in the reach, and it is not likely that they are present, given the poor habitat condition and lack of connectivity with the main stem of Halleck Creek.

Management Recommendation:

Riparian fencing might be considered to encourage new willow regeneration, re-establish riparian function, and allow the stream banks to heal and the stream to redefine the channel and pool/riffle habitat. Either electric fencing or a permanent fence should be considered. Hardened watering sites may be installed at strategic points along the stream, using cobble to armor the stream bank, or an upland watering site could be considered.



Photo 10: Damaged banks on Halleck #1

Halleck #4 - Reach 1 and 2:

Halleck #4 Creek is the eastern most headwater tributary to the main stem of Halleck Creek, and drains a sub-basin on the northeast side of Elk Mountain. The stream flows to the north, past Crystal Spring, and joins the main stem of Halleck Creek near the upstream boundary of Halleck Creek Reach 4. . Reach 1 on Halleck #4 was dry during the 2006 reconnaissance. The adjacent pastures are utilized for grazing, and the stream channel and riparian area are in generally poor condition similar to Halleck Reach 4. Riparian conditions were found to be functioning at risk in the reach, with an no discernable trend. Riparian species consisted mostly of decadent willow, with no apparent regeneration occurring along the stream. Reach 2 did have detectable flow in the channel, but is probably too small to support a viable fishery. Riparian conditions in this reach were somewhat better than Reach 1, but were considered to be functioning at risk.

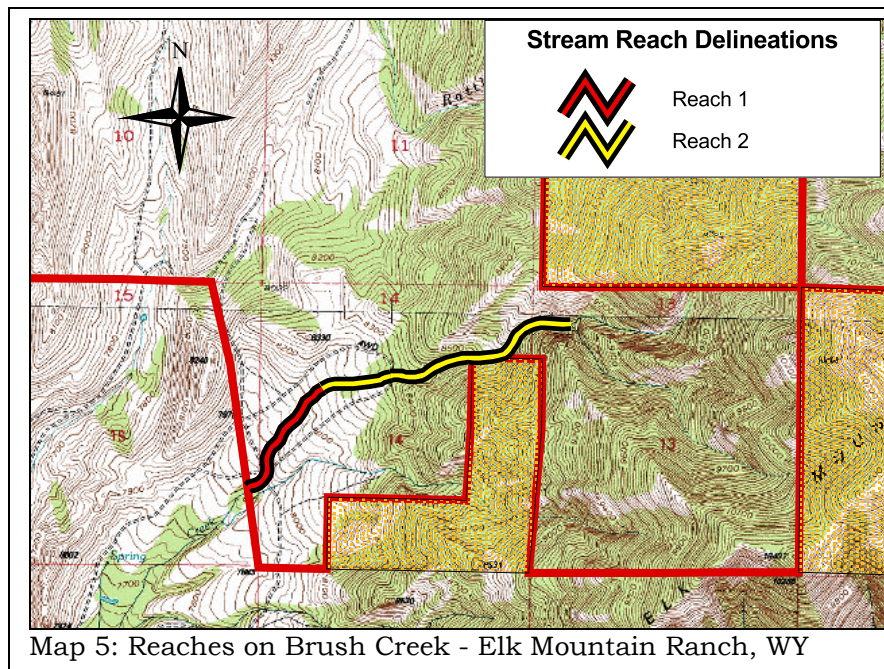
Management Recommendation:

Riparian fencing might be considered in Reach 1 to encourage new willow regeneration, re-establish riparian function, and allow the stream banks to heal. Either electric fencing or a permanent fence should be considered. Hardened watering sites may be installed at strategic points along the stream, using cobble to armor the stream bank, or an upland watering site could be considered.

Brush Creek

Brush Creek begins near the lower south summit of Elk Mountain and flows to the southwest, down through a steep gorge for more than one thousand feet. Emerging from this gorge, the stream flows across a large alluvial plain, exiting the ranch at an elevation of about 7,800 ft. The stream continues flowing to the south and west through a broad valley to a confluence with Pass Creek. Brush Creek exhibits no surface flow where it flows across the alluvial plain during the late summer and fall. This seasonal barrier to migration and resulting fragmentation of aquatic habitat most likely severely limits Brush Creek to support a sustainable fishery on the Elk Mountain Ranch. Several miles below the ranch, a viable, self-sustaining brook and rainbow trout fishery has been documented by the Wyoming Department of Fish and Game.

For the purposes of this assessment, Brush Creek was delineated into two reaches; Reach 1 being a dry channel, and Reach 2 having measurable flow (Map 5). At the time of the 2006 reconnaissance, detectable flow in the channel began at approximately the same elevation as the area on the east side of the stream known locally as "Secret Meadow". Initial observation of wet reach appeared to indicate that aquatic habitat might be severely limited. The reach does, however, hold some interest to the land owner as a potential aquatic resource; therefore, a more detailed assessment was warranted.



Reach 2

The channel type in the lower half of the reach is classified as Rosgen A3, exhibiting a relatively steep gradient, entrenched channel. The riparian buffer along the entire length of the reach is limited to the green line immediately adjacent to the creek. Dominant riparian vegetation is alder and mixed conifer, and the reach riparian component was considered to be properly functioning. Stream flow was measured to

be only 0.3 cfs. Water temperature in the reach was measured at 57° f., and pH was measured at 8.44.

A representative 1,000 foot long segment located near the downstream boundary of the reach was surveyed using the Winters BWSHI protocol to quantify aquatic habitat. The representative segment began at the fence crossing the stream upstream of the "Secret Meadow, and continued upstream, past a road/trail crossing, and into the steep canyon above. A summary of the BWSHI assessment is presented here. Detailed habitat metrics for the study segment can be found in the appendix.

A total of thirty-four separate meso-habitats were identified in the study segment. These were composed of sixteen pools, seventeen riffles, and one glide habitat (Chart 7). The average width of the stream was 6.5 feet, and the average depth was 0.4 feet. Channel substrate was predominately gravel and cobble, with considerable accumulations of boulders. Sand and silt was limited in all habitat types, and in-filling of depositional areas such as the bottom of pools was relatively insignificant. Large wood was present in the channel to a degree, with 45 individual pieces counted during the survey. Large wood provided important velocity shelter and cover, but was not the principal contributor to habitat creation and scour (Photo 11). Stream banks were generally vegetated and stable throughout the reach, and the bank rock particle size (BRC) consisted mostly of larger cobble providing good armoring of the banks. Two hundred and sixty feet of active eroding banks were measured in the study segment, and were primarily the result of erosion from high run-off flows.

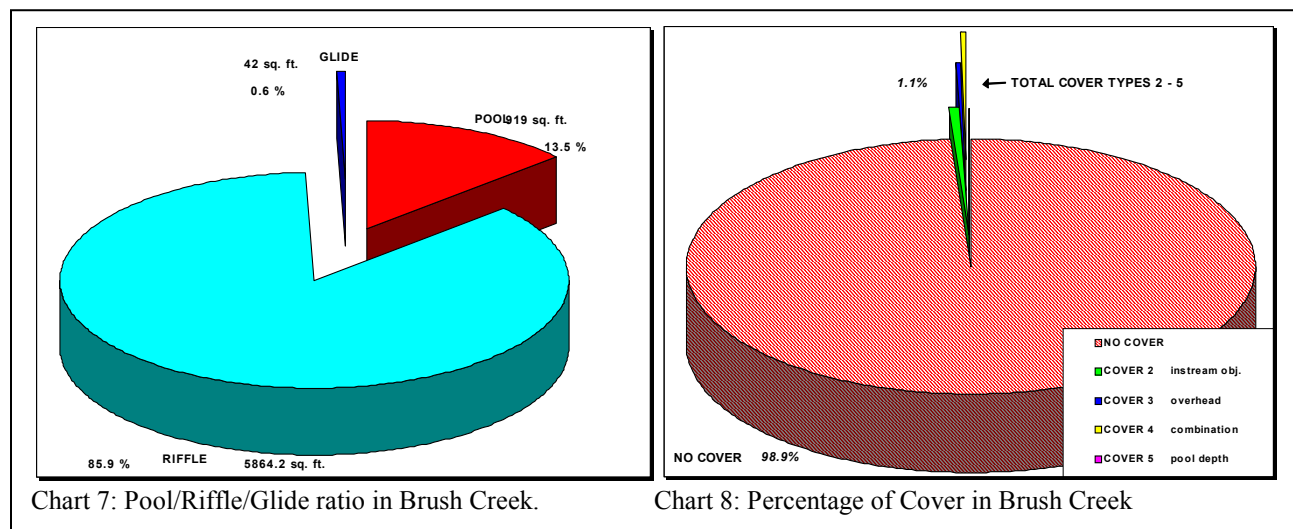
Pools were principally formed by water plunging over boulders or other large obstructions in the channel. Pool habitats comprised approximately 14% of the total wetted area of the study segment. The average depth of all of the pools measured was 0.64 ft., with maximum pool depths ranging from 0.7 to nearly 2 feet. Residual pool depth (RPD) was found to range from 0 to 1.7 feet, with an average of 0.8 feet throughout the reach. RPD and maximum pool depth, upon closer inspection, were found to be better than expected in the reach, and may provide adequate over-wintering habitat for brook trout at this elevation.

Cobble riffles, exhibiting higher gradient, pocket water micro-habitats, were the most dominant habitat type, in terms of both numbers and area, in the study segment, comprising nearly 86% of the wetted area. These riffles typically dominate A channel types, and depending on depth and substrate structure, may provide important holding and feeding habitats for trout, as well as critical habitat for benthic macro-invertebrates



Photo 11: Typical Riffle on Brush Creek.

and other aquatic organisms. The average depth of these riffles was 0.23 feet in the study segment, however, there was holding cover in the form of pocket water comprised 1.5% of the wetted perimeter of these habitats. Riffles in the study segment did appear to provide adequate spawning habitat for trout.



One glide was observed in the reach, and was due to the road/trail crossing and related disturbance to the stream banks. Glides are not typically encountered in A channels, unless they are due to some form of disturbance. Glide habitat accounted for less than 1% of the total wetted area of the reach.

The quantity of suitable cover in the Brush Creek study segment was very limited (Chart 8), accounting for only 1.1% of the total wetted area of the channel. Cover was principally composed of pocket water in-channel cover. Pool cover, an important metric for determining over-wintering capacity in the study segment, was present in the study segment, but accounted for only 1% of the wetted area of the pool habitats. It is interesting to note that the best pools in the study reach occurred in the upstream half of the segment, above the road/trail crossing, and it may be that cover estimates are slightly understated in the reach due to the inclusion of exceptionally poor habitat downstream of the crossing.

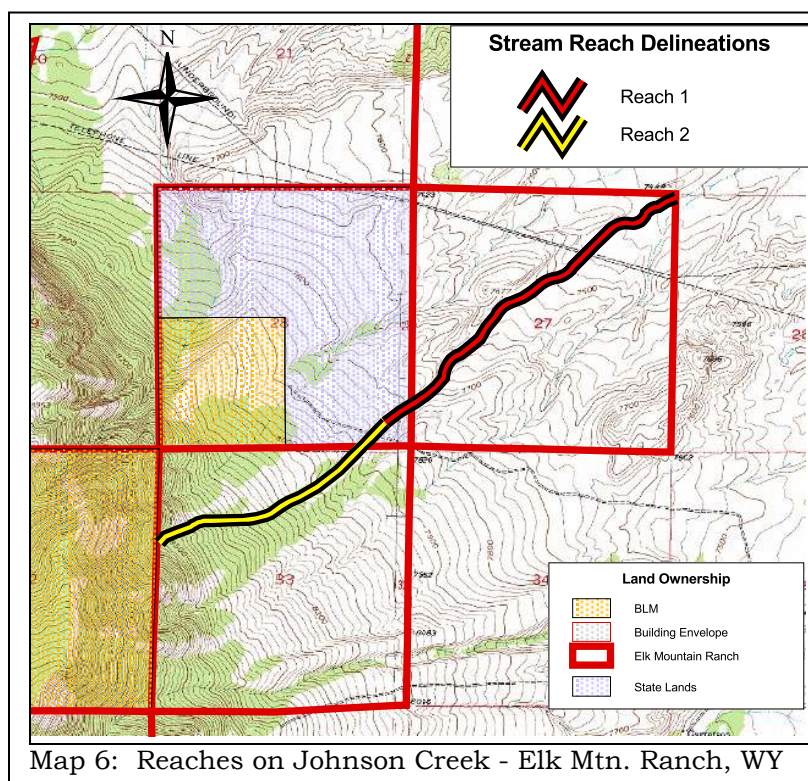
Management Recommendation:

The habitat data collected in this segment in 2006 suggests that there may be some feasibility in establishing a brook trout fishery in the reach upstream of the "Secret Meadow" through supplemental stocking. It may be desirable to enhance pool and pocket water habitats in the reach before attempting to stock the reach. Improvements could include removing armor (cobble) from the bottom of existing pools to enhance scour, improve RPD, and deepen these habitats. This work could be done by hand, possibly negating the need for a 404 authorization. Additionally, trees could be cross-felled into the channel to create log and woody debris dam habitats. This large wood would also add roughness to the channel, and help dissipate energy from high flows during spring snow melt.

Johnson Creek

Johnson Creek drains the northern most portion of the steep eastern rampart of Elk Mountain. Emerging from a gorge at about 8,000 foot elevation, the stream flows across a large alluvial plain and pasture land on the east side of Elk Mountain Ranch. During the 2006 reconnaissance, there was detectable flow in Johnson Creek. The stream becomes intermittent, and then ephemeral before exiting the property at approximately 7,400 foot elevation. Johnson Creek is a headwater tributary of Mill Creek, a major tributary of the Medicine Bow River. The lack of a definable channel downstream of the ranch would indicate that Johnson Creek only very infrequently flows into Mill Creek. This seasonal barrier to migration and resulting fragmentation of aquatic habitat severely limits Johnson Creek to support a sustainable trout fishery on the Elk Mountain Ranch. No electro-fishing data has been collected on Johnson Creek, however, several very small fish (2" - 3") were observed during this assessment in Reach 1. These were most likely native dace or darters that migrated into the reach during at some time when the stream flowed into Mill Creek.

For the purposes of this assessment, Johnson Creek was delineated into two reaches; Reach 1 consisting of the lower gradient channel meandering through the pastures near the eastern boundary of the ranch, and Reach 2, consisting of the steeper channels extending up to the source of the stream. At the time of the 2006 reconnaissance, the central portion of the stream on the ranch, including the upper part of Reach 1 and the lower part of Reach 2 was effectively without detectable flow.



Reach 1:

In the lower portion of the reach, the stream is relatively straight, and flows through grazed pasture lands. The riparian zone is characterized by a relatively narrow riparian zone comprised mostly of older, more mature willow and alder. Riparian areas in the reach appeared to be functioning at risk, particularly in the lower portion of the reach. The channel type throughout this reach was classified as Rosgen B4, with a G4 channel near the upstream boundary of the reach. There was water present

in the reach, but not at the upstream or downstream boundary. Flow in the middle of the reach was measured with a Marsh-McBirney Flow-Mate 2000 water meter and were calculated to be only 4/100ths of a cubic foot per second. This measured flow is the equivalent of only about 20 gallons per minute.

The stream channel width throughout the reach averaged 3 - 4 feet, with maximum pool depths averaging 1.2 ft. Residual pool depth (RPD) was estimated to be 0.6 foot. The stream banks were found to be in fair condition, with some evidence of trampling and hoof shear along banks that did not support dense willow vegetation. The stream channel and adjacent riparian areas exhibited worsening conditions the further downstream in the reach that we progressed.

Management Recommendation:

Ranch managers have indicated a desire to develop water resources for irrigation and agricultural use at a point near the ranch boundary in Reach 1. If a stock pond is developed at this site, the pond may serve a secondary use of recreational fishing if habitat requirements of depth and water exchange are incorporated into the pond design. However, before any trout species are introduced into this watershed, a population sample should be conducted in order to determine the species of fish currently present in Reach 1.

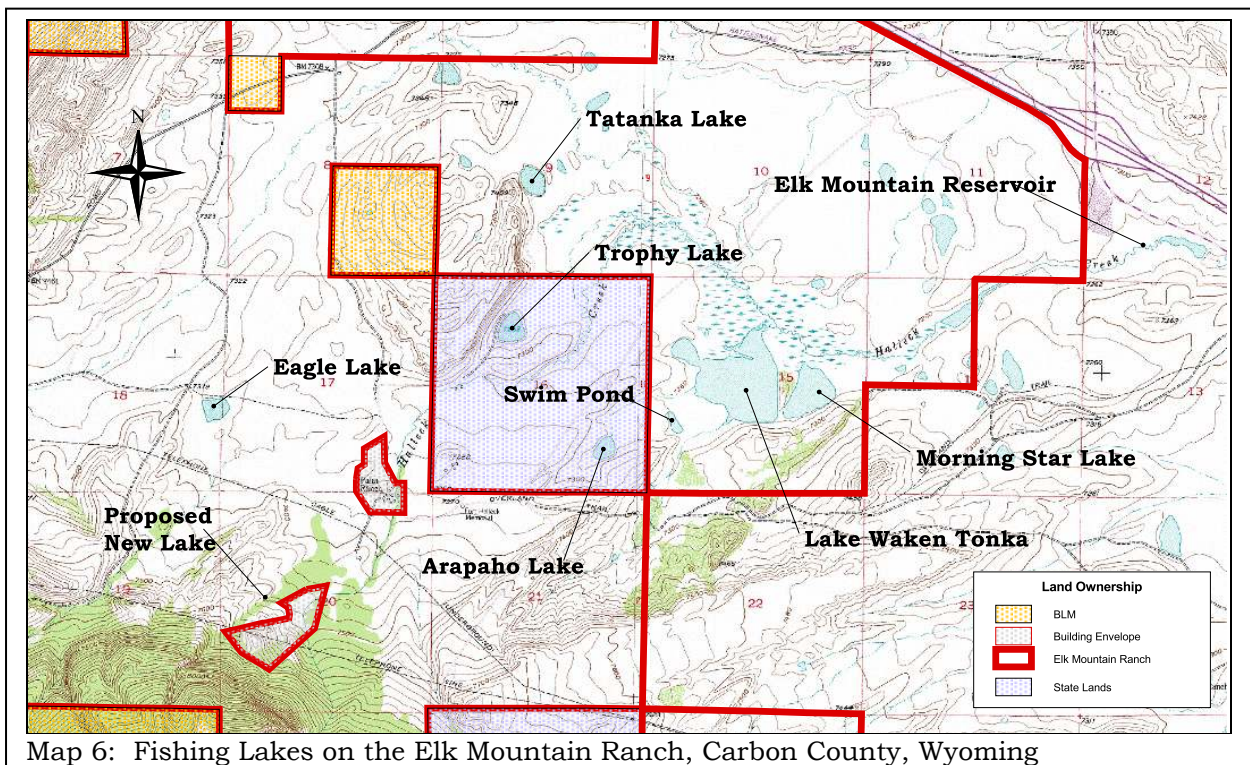
Reach 2:

Johnson Creek in Reach 2 exhibits most of the typical characteristics of a first order headwater tributary in the North Platte River basin. The riparian zone is very narrow, and consists of mixed conifers, aspen and alder, and is in generally robust condition. The channel is a Rosgen A3, with dominant cobble substrate composition and exhibiting a high gradient, step-pool and cascade pool/riffle meso-habitat component. The stream averages only 2 - 3 feet in width in this reach, and flows are extremely limited. Stream banks are, for the most part, very stable, and are well armored with cobble and robust riparian vegetation. Pool habitat, however, is exceedingly limited in the reach. Maximum pool depths were found to be less than 0.5 feet, and RPD was less than 0.3 feet. The lack of over-wintering habitat in the reach, and the migration barrier created by the dry segment separating Reach 2 from Reach 1, likely result in this reach being fishless.

Lakes and Ponds

There are twenty-five lakes and stock ponds found on the Elk Mountain Ranch. Of these water bodies, seven are managed uses including recreational fishing. The remaining stock ponds are used exclusively for livestock watering, and frequently completely dry up in late summer and fall. All of the lakes and stock ponds are within the Halleck Creek watershed on the north side of the ranch, at elevations below 7,300 ft.

Freshwater lake, or lentic, habitat is composed of a littoral zone that is euphotic and hence may be heavily populated by aquatic plants. Deep water, or profundal zones, are aphotic, and therefore do not support the photosynthesis necessary for plant development. These profundal habitats create important thermal refugia in the summer months, and may provide for critical over-wintering capacity during severe winter months. The benthos (bottom) of many lakes consists of oxygen-demanding organic detritus and is thus anaerobic. Benthic life such as bacteria and midge larvae, however, thrive and utilize the organics as food. Over time, lakes change physically and chemically. Aging in lakes involves a progression of changes from deep, nutrient-poor oligotrophic water bodies eventually evolving into shallow, richly organic eutrophic lakes. As lakes become more eutrophic, higher temperature and other water quality issues begin to affect the lake's capacity to support cold water species such as trout. With greater nutrient loads and temperature, undesirable aquatic plants, such as algae, floating and submerged weeds may become established. Proliferation of aquatic vegetation can lead to loss of



suitable habitat for forage species and juvenile trout, higher pH, and temporal crashes of critical dissolved oxygen in the water as dead plants decay and consume the available oxygen in the system.

The seven "fishing" lakes on the property range from 1 to over 90 surface acres. Most of the lakes are located off of the main channel of Halleck Creek and its headwater tributaries, and are fed by underground springs. All of these lakes are surrounded for the most part by relatively dry prairie with no woody vegetation to provide solar shading in the summer months. All of the lakes, with the exception of the recently constructed "Swim Pond", exhibit characteristics consistent with older, shallower eutrophic lentic systems, with limited profundal zones, significant aquatic vegetation, and relatively high temperatures.

Five of the lakes were excavator dredged in 2003, creating deep water trenches and islands along the edges of the water bodies. Dredging operations that use the spoils to construct islands within the high water mark of a water body generally require an individual permit under Section 404 of the Federal Clean Water Act of 1972, and the permitting process is regulated by the U.S. Army Corps of Engineers. The dredging of lakes on Elk Mountain Ranch in 2003 was apparently undertaken without a 404 authorization, which may make future applications somewhat more difficult.

Assessment Methods

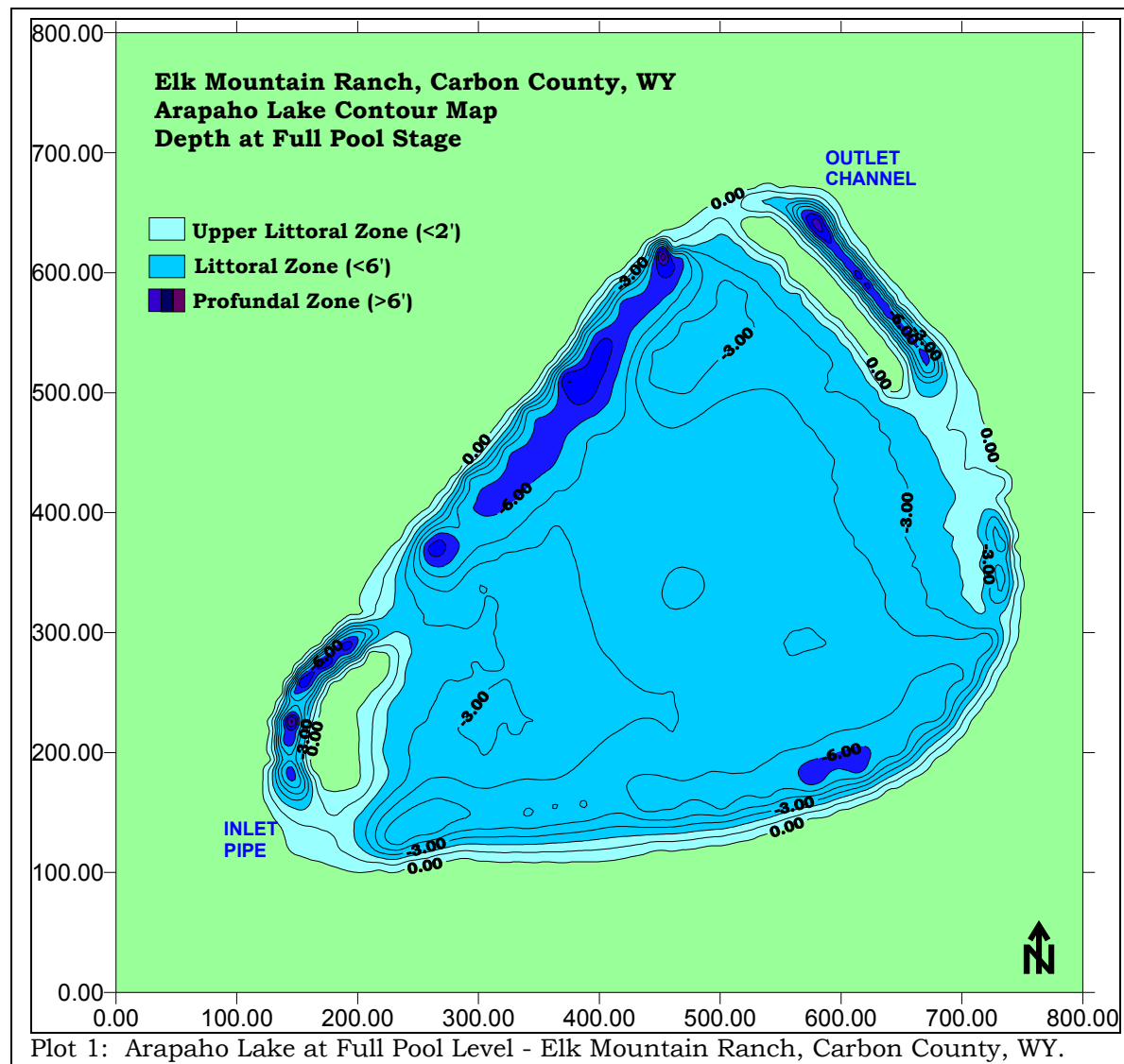
Each of the seven "fishing" lakes was assessed for surface area, volume, bathymetric profile, aquatic vegetation, aquatic life and water quality. Lake perimeters and surface area were mapped using a GPS receiver. Bathymetric profiles were mapped by boat, using a sonar depth finder linked to a GPS receiver. A minimum of 25 individual depth/latitude/longitude readings per surface acre were used to create the profile. The boundary between littoral and profundal regions of the lakes was estimated using a Secchi disk to determine the limit of light penetration in the lake. Perimeter and depth data were run through Surfer 16 surface modeling software to create a three dimensional profile of the lake bottom surface. Calculations of volume, littoral and profundal habitat were made from the interpolated bottom surface profile. State of Wyoming Stocking Permits, where available, were used to determine fish population assemblages. Otherwise, direct observation was used to estimate presence or absence of fish in the lakes. Aquatic vegetation density was estimated on site, and species were identified using an aquatic weed key. Water chemistry was analyzed using a LaMotte lake sampling kit and a YSI pH/Temperature meter calibrated to neutral 7.0 with an upper and lower range of 4.0 and 10.0. Dissolved oxygen (DO) samples were taken from the deeper water in the lake using a LaMotte deep water sampler. DO samples were processed on site, using the Winkler method.

Lake Assessments

Arapaho Lake

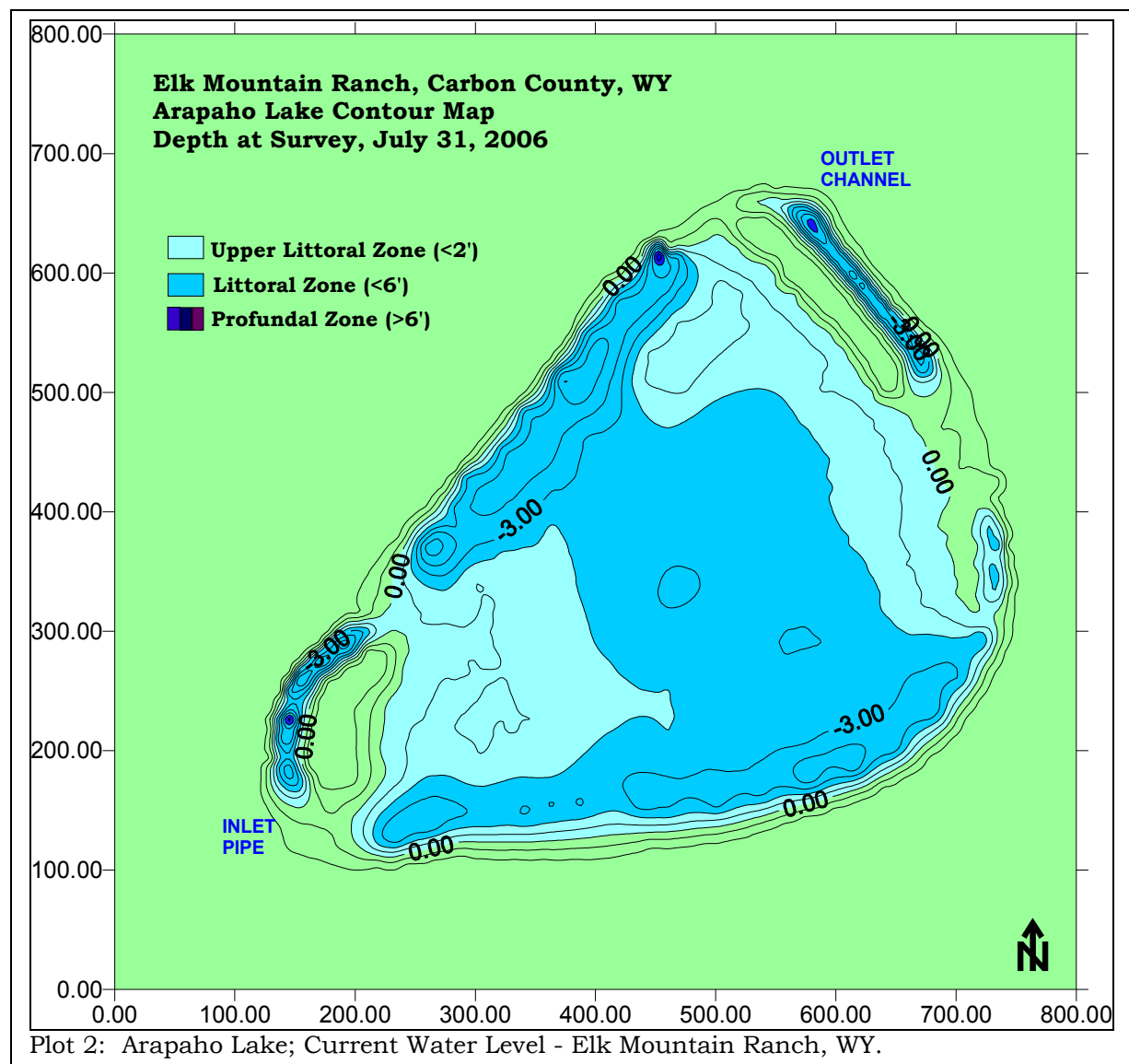
Arapaho Lake is roughly triangular in shape, and when full consists of 5.4 surface acres. The volume of the lake at full pool level is 19.2 acre/feet. The lake is spring fed, from a developed spring on the south side of the lake. A 3 inch pipe extends into the lake and was delivering water near capacity at the time of the 2006 reconnaissance. Flow through the pipe was estimated to be between 3 -5 gallons per second. The lake outlet, on the northeast side of the lake, flows into a channel leading to the swim pond reservoir, approximately 500 feet to the northeast. The outlet and channel between the lakes was dry in August 2006.

The lake is composed mostly of shallower, littoral areas (94%), and appears to be somewhat eutrophic. The upper littoral zone, exhibiting depths of less than 2 feet, account for nearly 20% of the area of the lake (Plot 1). The lake has historically been managed as a cold water trout fishery, and records indicate that the lake was most recently stocked in 2003 with fingerling brown, brook and rainbow trout, as well as catchable cutthroat, brook and rainbow trout.



Trenches on the west, north and east sides of Arapaho Lake were excavator dredged in 2002, creating deep water, profundal habitat. Two islands were constructed from dredged spoils; at the inlet and outlet of the lake. The dredged trenches were typically 15 to 20 feet wide, and depths are typically 12 feet below the full-pool level of the lake. Evaporative loss appears to be an issue in the lake, and at the time of this assessment, the lake was less than half full.

A bathymetric profile and water quality analysis of the current condition of the lake was conducted on July 30, 2006. The lake was found to cover 4.5 surface acres, and the volume of water in the lake was estimated to be 9.5 acre/feet. Deep water profundal zones (<6 ft) were extremely limited in the lake, accounting for only 100ft² of the area of the lake, occurring only in a few areas in the dredged trenches. Littoral areas dominate the rest of the lake, with very shallow upper littoral areas comprising more than 42% of the surface area (Plot 2).



Nuisance terrestrial and aquatic noxious weeds are a severe problem in the lake and on surrounding shorelines. Disturbed areas from dredging activities and the constructed islands are severely infested with Canada thistle. All littoral areas of the lake are choked with common watermilfoil, severely limiting these areas for utilization by fish. Only the dredged areas exhibit open water pelagic habitat.

A dissolved oxygen sample was taken from the deepest area in the lake, along the dredged northwest shore approximately halfway between the inlet and outlet. D.O. was measured at 8.4 parts per million (ppm), and did not appear to be a limiting factor in the lake. Water temperature was very high for a cold water fishery, with surface sample temperatures measuring 78 F. Measurements of water pH appeared to indicate a potential limiting factor to the fishery, and were found to be 9.5, at the upper limit of tolerance for salmonids. A pH sample taken at the inlet pipe measured 8.0, more than one hundred times less basic than the water in the lake. High pH in the lake may result from a combination of alkaloid soils in the area, higher summer temperatures, severely limited water exchange, and profuse aquatic vegetation in the lake.

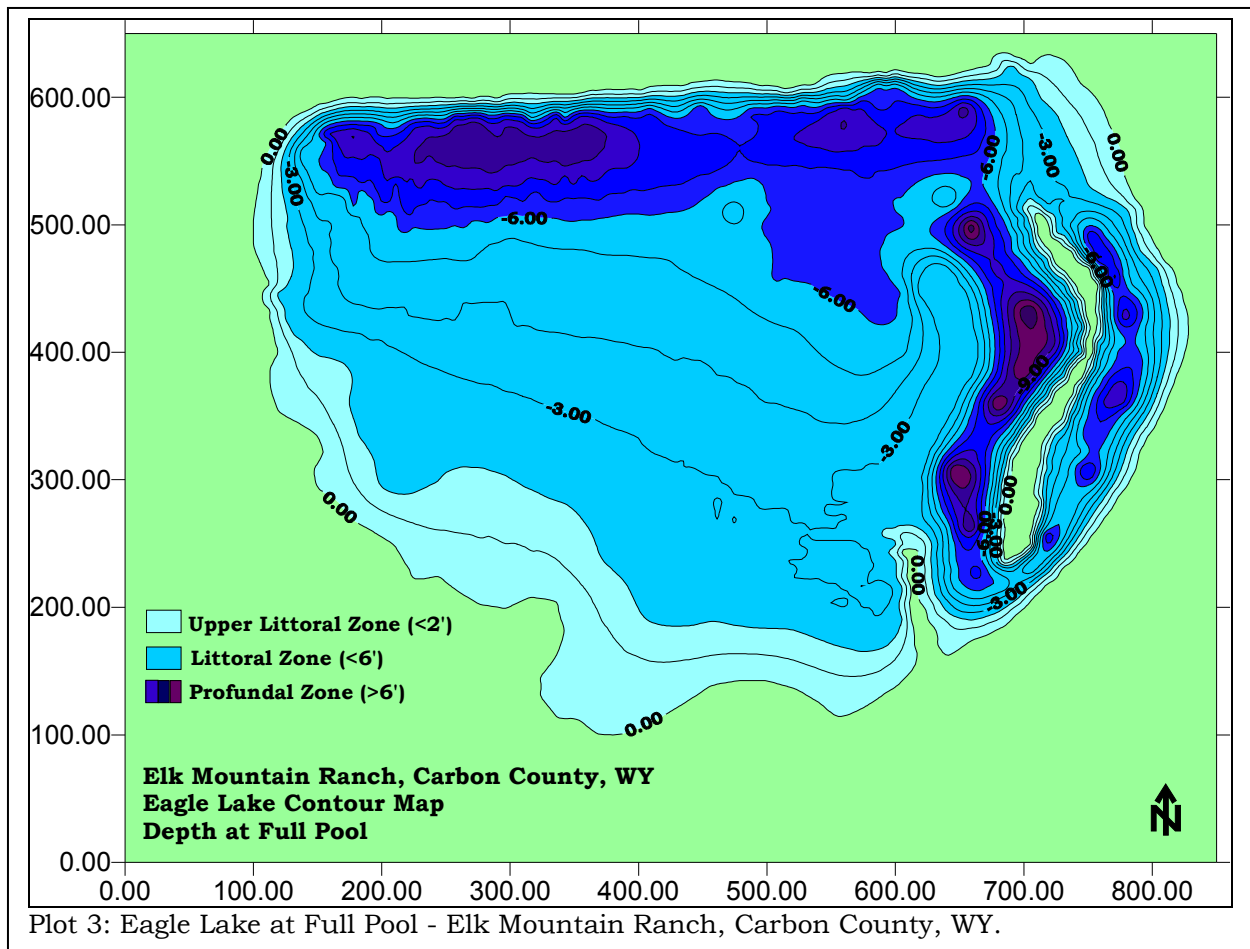
Several species of trout, including several larger specimens, were observed in the lake, exclusively in the dredged trenches. These fish appeared to be healthy, but did exhibit some signs of stress, most likely due to water quality issues in the lake. No smaller fish, minnows, or young-of-the-year (YOY) were found, nor were any amphibians or other wetland obligate species seen during the survey.

Eagle Lake

Eagle Lake is roughly rectangular in shape, and when full consists of 6.8 surface acres. The volume of the lake at full pool level is 25 acre/feet. The lake is spring fed, from a developed spring on the south side of the lake. This spring was providing water to the reservoir at the time of the 2006 reconnaissance. A bull rush / cattail wetland forms the south shore of the lake, providing good habitat for waterfowl and amphibians. The lake is man-made, consisting of an earthen dam forming the north shore of the lake. The dam face facing the lake is severely eroded in several areas, and is in considerable need of maintenance. The lake outlet consists of a culvert and head-gate, on the west side the dam. The outflow flows into a wetland immediately below the lake, and has no definable channel. The outlet was dry in August 2006.

The lake has historically been managed as a cold water trout fishery, and records indicate that the lake was most recently stocked in 2003 with fingerling brown, brook and rainbow trout, as well as catchable cutthroat, brook and rainbow trout. At full pool, Eagle Lake exhibits a good ratio of deep water profundal habitat to shallower littoral habitat. The littoral area comprises approximately 77% of the lake at full pool (Plot 3), with very shallow upper littoral areas of less than 2 foot depth occupying 42% of the footprint of the lake. Eagle Lake appears to be somewhat eutrophic, but less so than other lakes on the Elk Mountain Ranch.

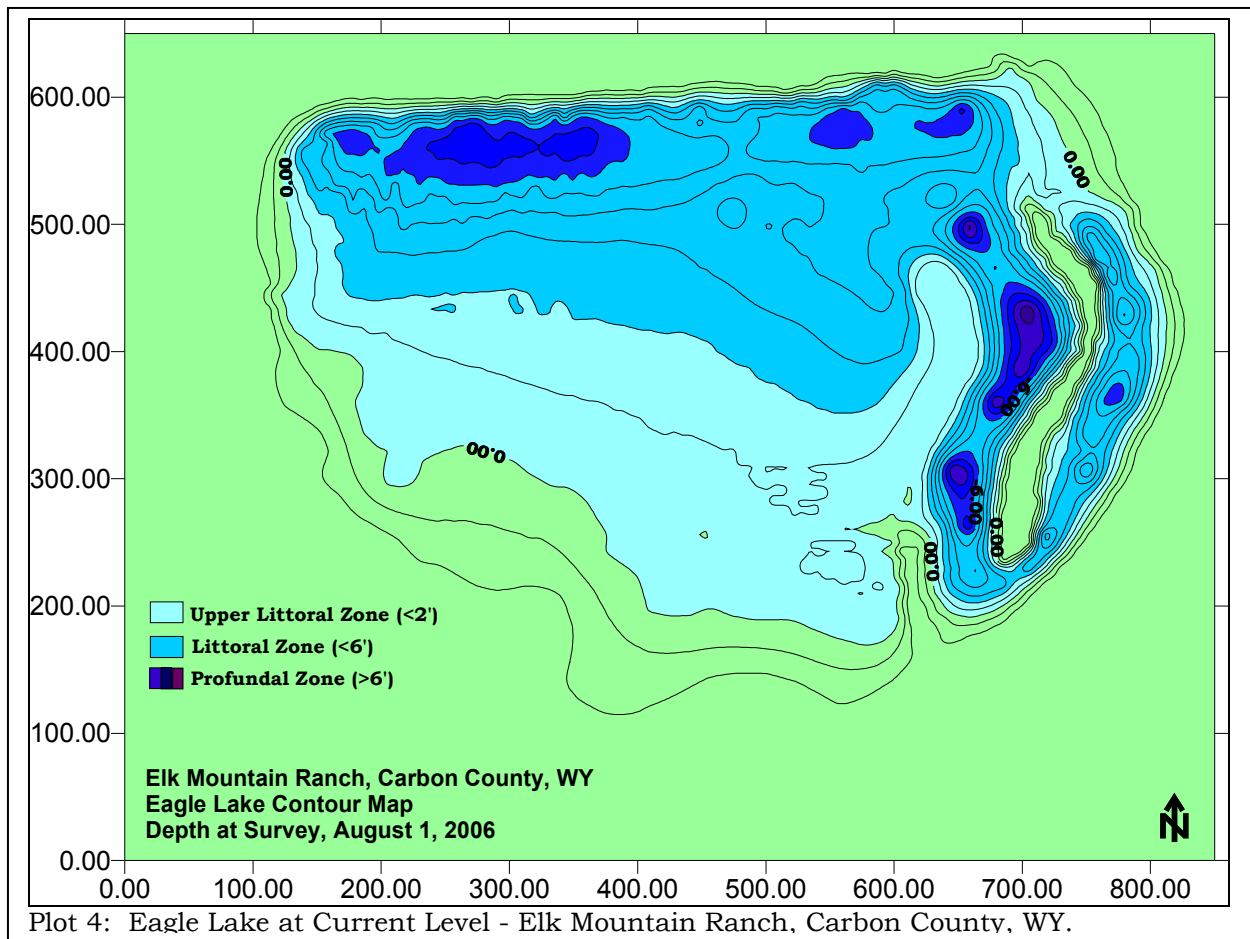
Trenches on the eastern half of Eagle Lake were excavator dredged in 2002, creating new deep water, profundal habitat in this area and increasing the overall volume of the lake. Wyoming State Engineer's records indicate that the original volume of the lake was only 11.4 acre/feet. A large island was constructed from dredged spoils from two deep trenches aligned in a north-south axis along the eastern side of the lake.



This island is extremely unstable, and is rapidly eroding due to wind and wave action, filling the previously dredged areas. A large spoils pile is also perched along the eastern shore of the lake, and is also eroding back into the lake, but at a slower rate than the island. The dredged trenches are typically 15 to 20 feet wide, and depths are typically 12 feet below the full-pool level of the lake. Evaporative loss appears to be an issue in the lake, and at the time of this assessment, the lake was approximately half full by volume.

A bathymetric profile and water quality analysis of the current condition of the lake was conducted on July 31, 2006. The lake was found to cover 5 surface acres (Plot 4), and the volume of water in the lake was estimated to be 13 acre/feet. Deep water profundal zones (<6 ft) accounted for approximately 7% or 0.34 acres, and were found along the face of the dam and in the dredged trenches along the eastern portion of the lake. Littoral areas dominate the rest of the lake, with very shallow upper littoral areas comprising more than 50% of the surface area.

Nuisance terrestrial and aquatic noxious weeds are a severe problem in the lake and on surrounding shorelines. Disturbed areas from dredging activities and the constructed islands are severely infested with Canada thistle. Additionally, the earthen dam is completely covered with weeds, whose roots may affect the stability of this structure. Most of the littoral areas of the lake are choked with Common watermilfoil, severely limiting these areas for utilization by fish. In particular, a well



established weed bed exists in the center of the lake, and is so dense that the propeller on our boat seized when crossing the bed. Only the dredged areas exhibit open water pelagic habitat.

Water quality in Eagle Lake was found to be less limiting than in the other lakes on the Elk Mountain Ranch. A dissolved oxygen sample was taken from the deepest area in the lake, along the dredged trench west of the constructed island. D.O. was measured at 8.0 parts per million (ppm), and did not appear to be a limiting factor in the lake. Water temperature was slightly high for a cold water fishery, with surface sample temperatures measuring 71 F. There appeared to be adequate profundal habitat to provide thermal refugia for trout during summer diurnal peaks in water temperature. Measurements of water pH were the lowest of any lake sampled on the ranch, and was found to be 8.26, within the optimal range for salmonids.

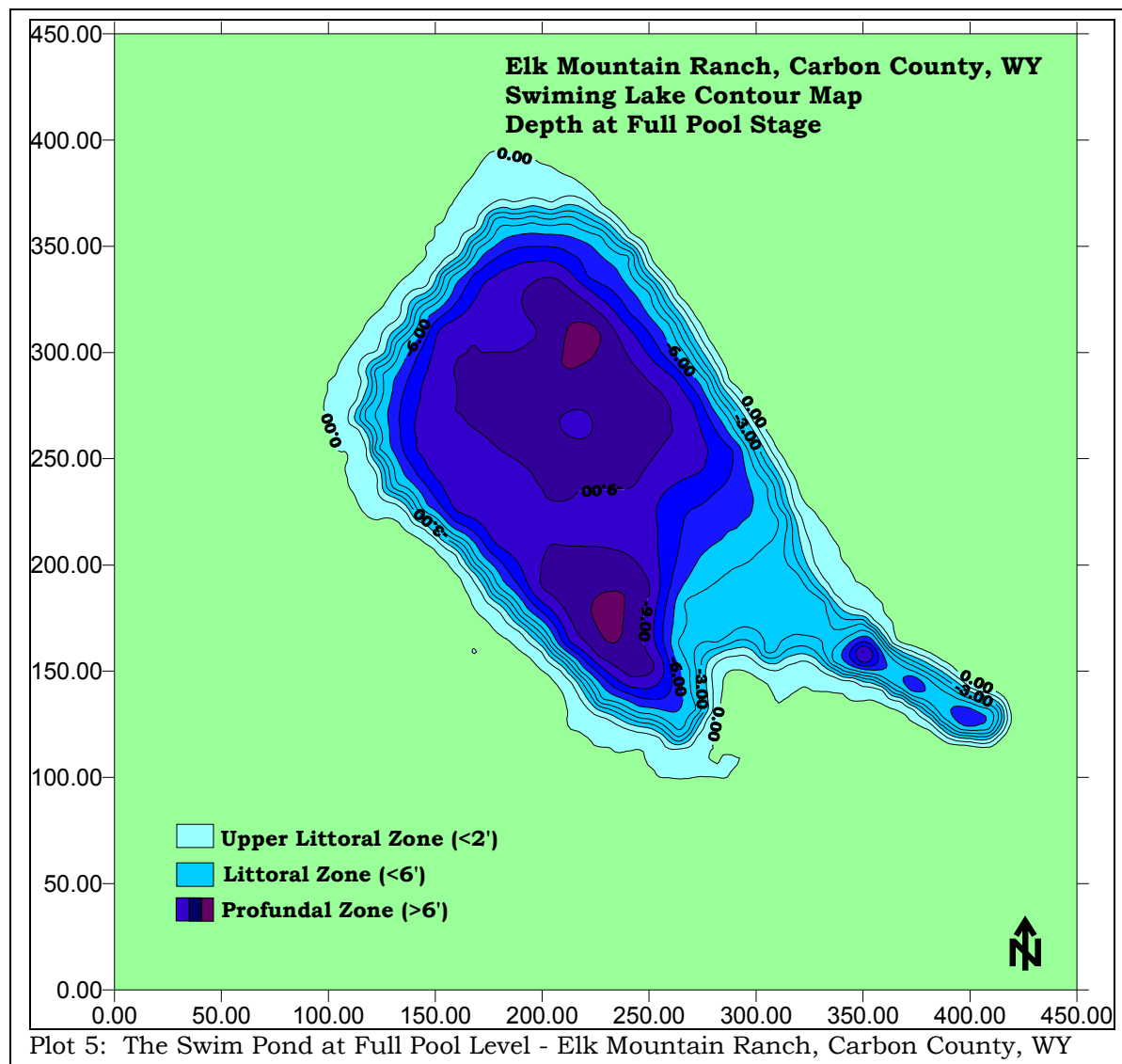
Several trout, including several larger specimens, were observed rising to the surface on the lake. No smaller fish, minnows, or young-of-the-year (YOY) were found, nor were any amphibians or other wetland obligate species seen during the survey.

Swim Pond

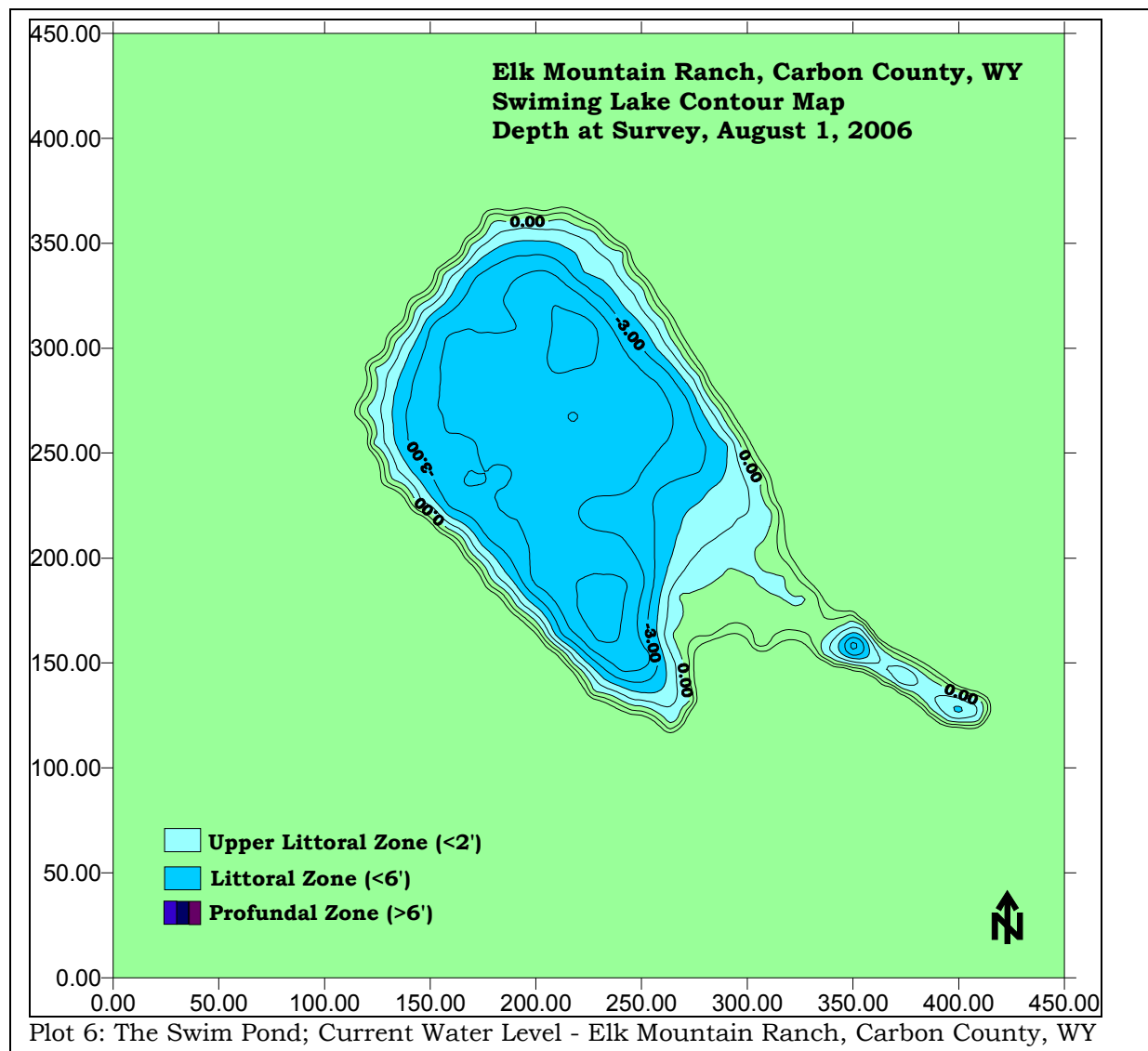
The Swim Pond is found downstream of Arapaho Lake, and is roughly elliptical in shape, with a tight bight of shoreline extending southeast. Swim pond is a constructed stock pond, consisting of an earthen dam forming the northeast shore of

the water body. The dam face facing the pond is in good condition, and deep rooted vegetation is limited on the dam face. The pond outlet consists of a combination bottom release culvert head-gate and an overflow surface release pipe on the north edge of the dam. The outflow flows into a wetland immediately below the lake, and has no definable channel. The outlet was dry in August 2006. At full pool level, the lake consists of 1 surface acre. The volume of the lake at full pool level is nearly 6 acre/feet. The pond is fed from a channel connecting the lake to Arapaho Lake.

At full pool, the Swim Pond exhibits an even mix of deep water profundal habitat to shallower littoral areas (Plot 5). The littoral zone comprises approximately 50% of the pond at full pool, with very shallow upper littoral areas of less than 2 foot depth occupying 20% of the footprint. Swim Pond appears to be somewhat oligotrophic, the only water body on the Elk Mountain Ranch exhibiting this characteristic. The pond appears to be recently constructed, and has no historic record to indicate stocking has ever occurred. Most likely the pond has been incidentally stocked by periodic movements of trout from Arapaho Lake immediately upstream. At full pool level, the pond probably provides good habitat complexity, water quality and thermal refugia for trout.



Evaporative loss is an issue in the pond, as is the case in the other lakes on the ranch, and at the time of this assessment, the pond was less than half full. A bathymetric profile and water quality analysis of the current condition of the lake was conducted on the morning of July 31, 2006. The lake was found to cover 0.6 surface acres, and the volume of water in the lake was estimated to be 2.0 acre/feet. Deep water profundal zones (<6 ft) were no longer present in the lake (Plot 6). Shallow upper littoral areas of less than 2 feet accounted for approximately one third of the total surface area of the pond.



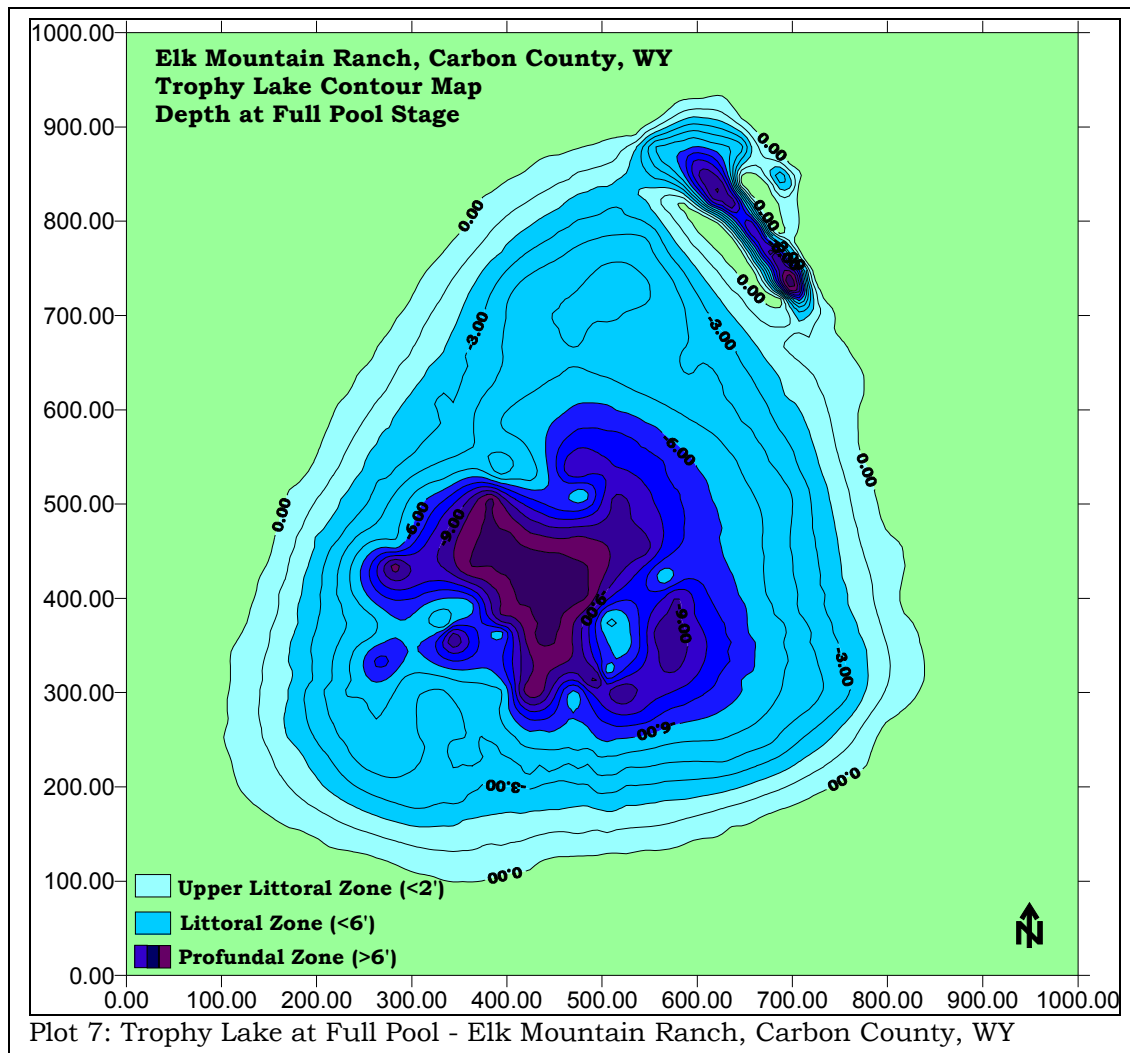
Nuisance terrestrial noxious weeds were present along the southeast shoreline of the pond where dredged spoils had been discarded. The pond has not yet been colonized by watermilfoil, and open water pelagic habitat was relatively abundant in the center of the lake.

A dissolved oxygen sample was taken from the deepest area in the pond within the western quadrant, approximately halfway between the inlet and outlet. D.O. was

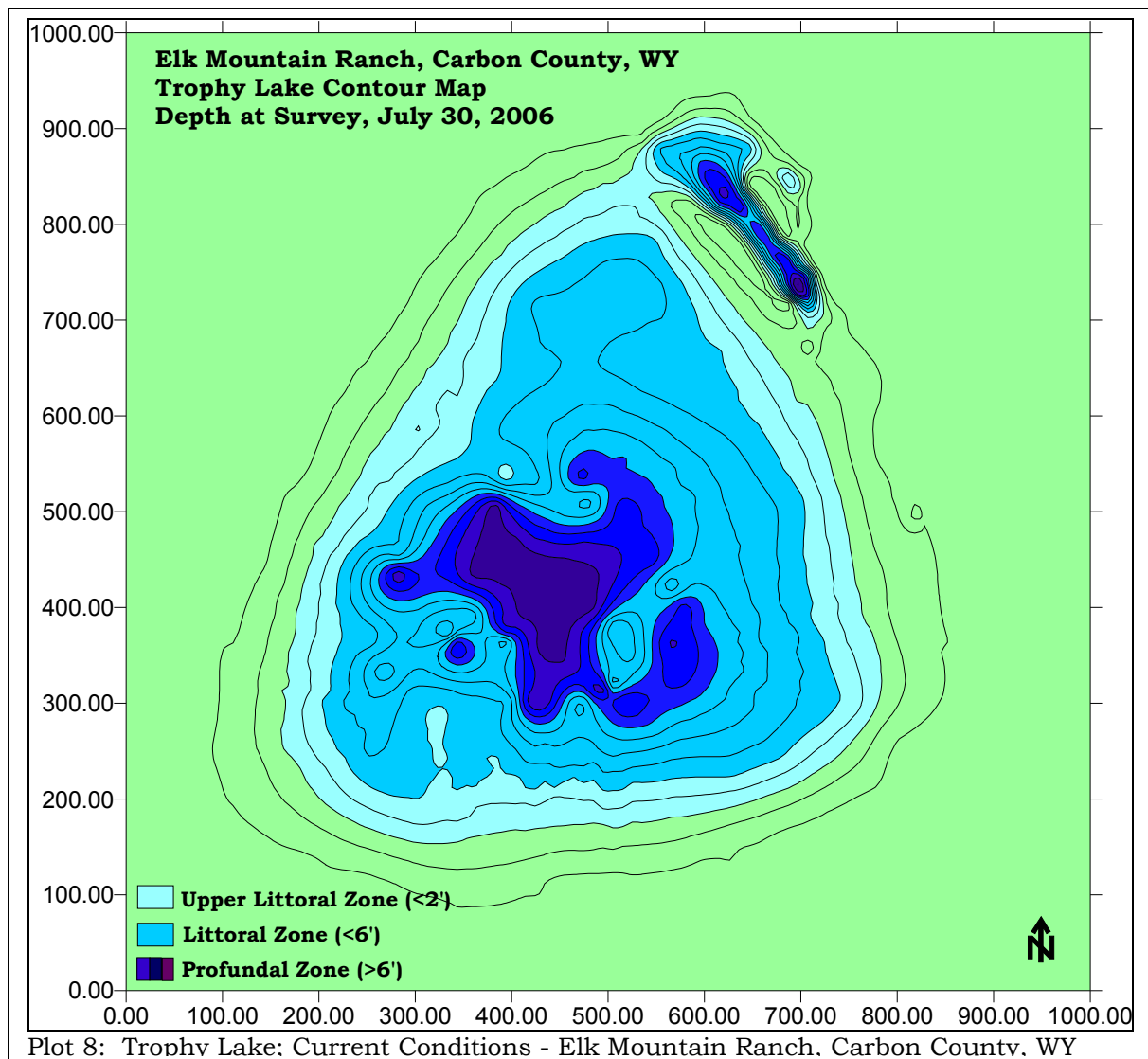
found to be somewhat limited, and was measured at 6.6 parts per million (ppm). Water temperature was slightly high for a cold water fishery, with surface sample temperatures measuring 71 F. Measurements of water pH were comparable to Arapaho Lake, and appeared to indicate a potential limiting factor to the fishery. Measured pH was found to be 9.42; near the upper limit of tolerance for salmonids. Poor water exchange may be the most limiting factor creating water quality problems in this pond.

Trophy Lake:

Trophy Lake is roughly elliptical in shape, and when full consists of 10 surface acres (Plot 7). The volume of the lake at full pool level is 40 acre/feet. The lake is spring fed with no apparent inlet. The lake is protected from the wind by a large ridge on the west side of the lake, and the lake shoreline is mostly well vegetated with riparian sedges and grasses. Some evidence of shoreline erosion due to wind and wave action is present on the northeast shore of the lake, and along the constructed island near the outlet. The outlet is uncontrolled, and drains into a wetland meadow north of the lake. The outlet was dry during the 2006 reconnaissance.



The lake has historically been managed as a "trophy-class" cold water trout fishery, and records indicate that the lake was most recently stocked in 2003 with catchable cutthroat, brook and rainbow trout. Several large brown trout were observed in the lake during the reconnaissance, indicating the presence of this species as well. A dead white sucker was observed in shallow water in the northeast quadrant of the lake, and small fry observed in the shallow areas along the south shoreline may be emerging white sucker fry. At full pool, Trophy Lake exhibits an excellent ratio of profundal deep water habitat to shallower littoral areas. The littoral zone comprises approximately 76% of the lake at full pool, with very shallow upper littoral areas of less than 2 foot depth occupying 28% of the total area of the lake. Trophy Lake appears to be somewhat eutrophic, which is not surprising given the percentage of shallow to deep water area and somewhat limited water exchange that occurs during the summer months.



Two trenches on the north side of Trophy Lake were excavator dredged in 2002, creating additional deep water habitat. Two islands were constructed from dredged spoils; near the outlet of the lake. The dredged trenches were typically 15 to 20 feet

wide, and depths are typically 12 feet below the full-pool level of the lake. Evaporative loss appears to be an issue in the lake, and at the time of this assessment, the lake was approximately 2/3 full.

A bathymetric profile and water quality analysis of the current condition of the lake was conducted on July 30, 2006. The lake was found to cover slightly more than 7 surface acres (Plot 8), and the volume of water in the lake was estimated to be 24.6 acre/feet. Deep water profundal zones (<6 ft) accounted for approximately 16% or 1.2 acres, and were found in the dredged trenches along the north quadrant and in the naturally deeper center of the lake. Littoral areas dominate the rest of the lake, with very shallow upper littoral areas comprising 31% of the surface area.

Nuisance terrestrial and aquatic noxious weeds are a severe problem in the lake and on surrounding shorelines. Disturbed areas from dredging activities and the constructed islands are severely infested with Canada thistle. All littoral areas of the lake are choked with Common watermilfoil, severely limiting these areas for utilization by fish. More disturbing, however, is the presence of Eurasian Watermilfoil in the lake. Eurasian Watermilfoil is a particularly aggressive species and is very difficult to control. Once established, this noxious weed may be difficult to eradicate, and can easily spread to other water bodies through vectors such as mud on boats, waders and animals. Only the deepest areas of the lake exhibit any open water, pelagic habitat. Some minor accumulations of filamentous algae were present along the shoreline, but were insignificant compared to the density of submerged vegetation in the middle of the lake.

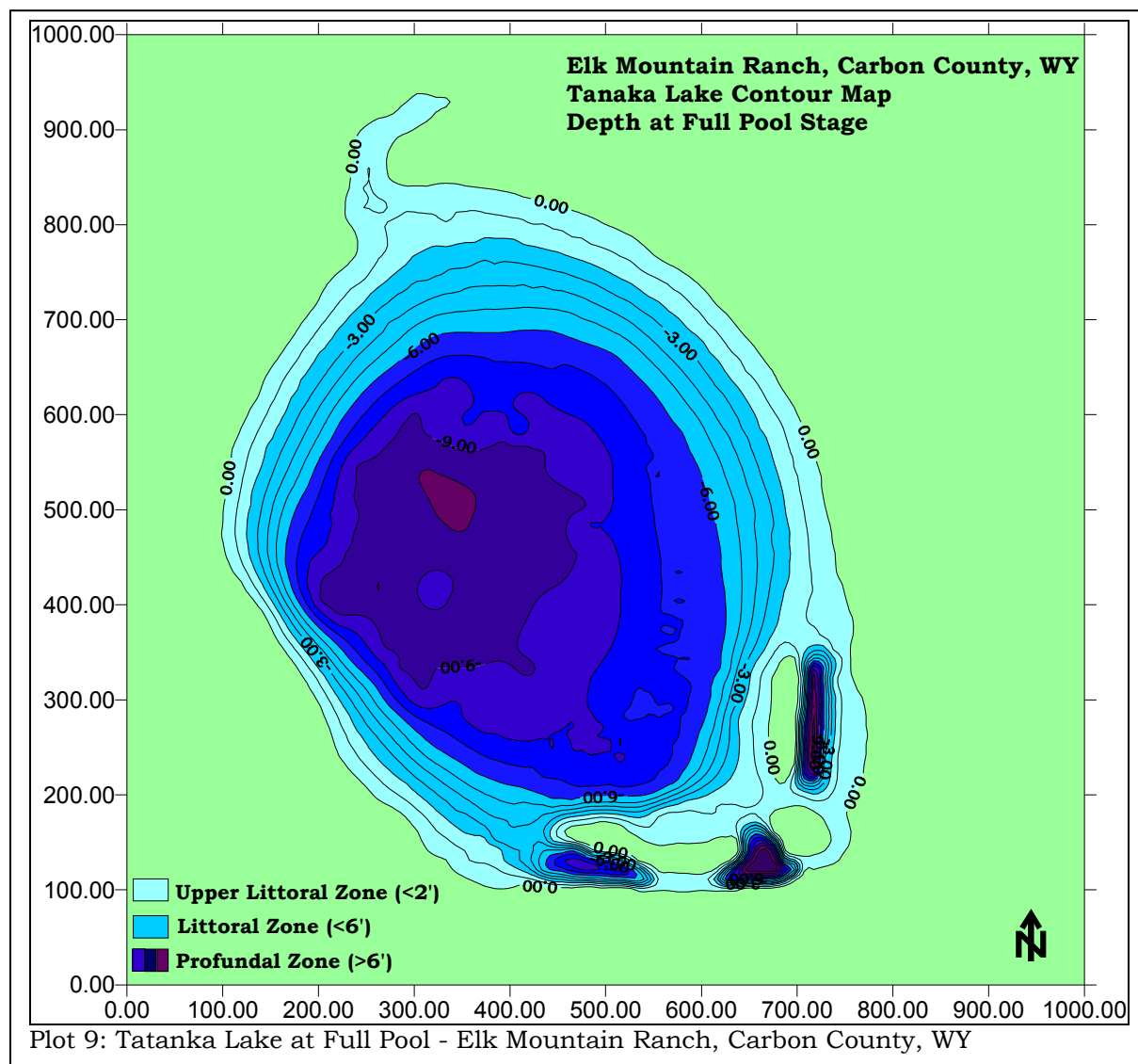
A Secchi disk sounding was taken at the deepest point in the lake, and indicated that the aphotic zone likely occurs below approximately 2 meters, or six feet in the lake. A dissolved oxygen sample was taken from the deepest area, near the center of the lake. D.O. was found to be somewhat limited, and was measured at 6.5 parts per million (ppm). Water temperature was slightly higher than optimal for a cold water fishery, with surface sample temperatures measuring 68 F. There appeared to be adequate profundal habitat to provide thermal refugia for trout during summer diurnal peaks in water temperature. Measured pH was found to be 9.5; near the upper limit of tolerance for salmonids. Poor water exchange likely is the limiting factor creating water quality problems in this pond. High pH in the lake may result from a combination of alkaloid soils in the area, higher summer temperatures, and profuse aquatic vegetation in the lake.

Several trout, including several larger specimens, were observed in the lake, rising to the surface in open waters near the dredged trenches and swimming along shorelines that were less obstructed with aquatic vegetation. These fish appeared to exhibit considerable stress, most likely due to water quality issues in the lake. Smaller fish, including emerging young-of-the-year (YOY) were seen along the edges of the lake, several Northern Leopard frogs were seen leaping into the lake during the walk around the lake perimeter.

Tatanka Lake

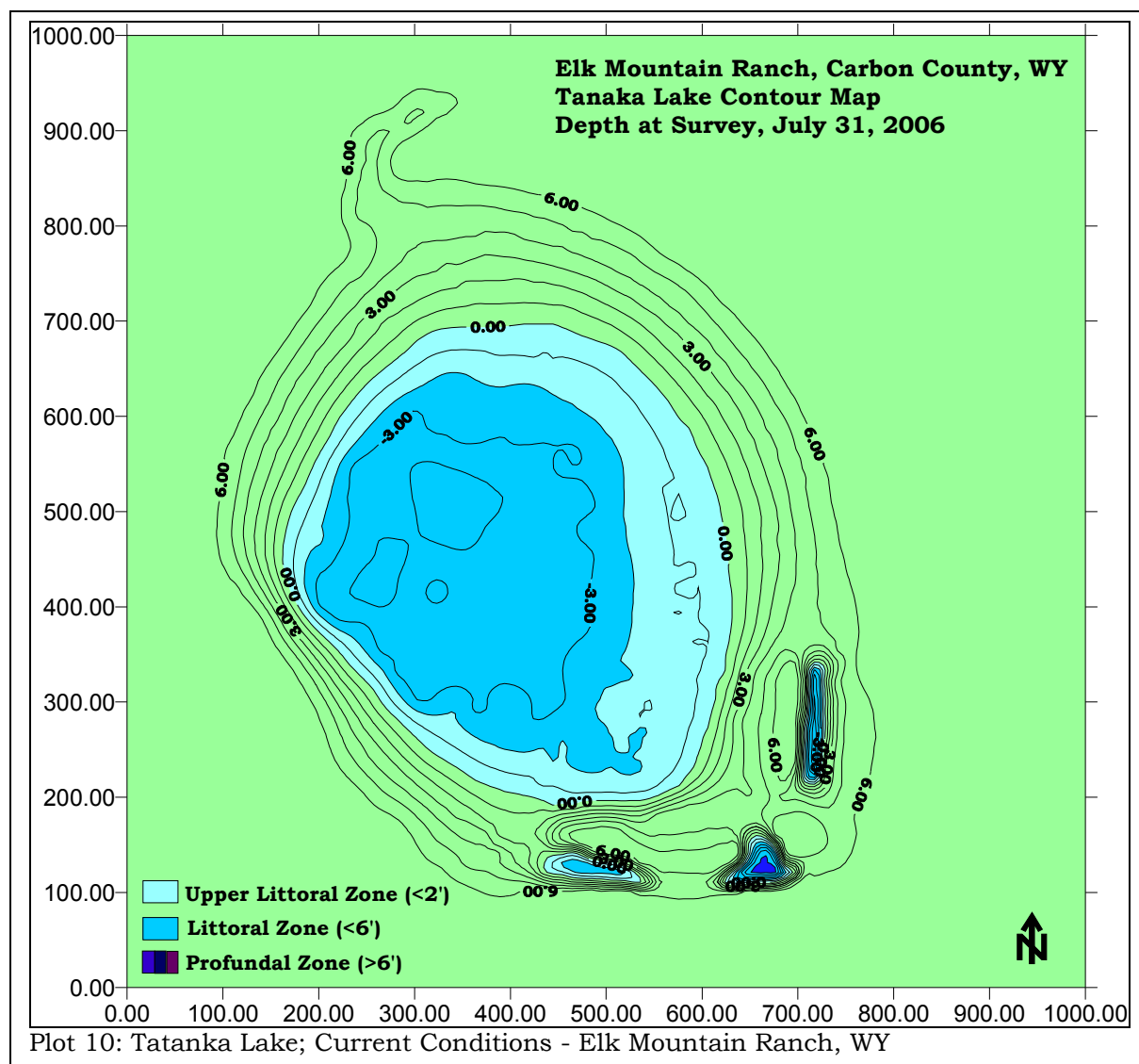
Tatanka Lake lies approximately one mile north of Trophy Lake, near the terminus of the ridge on the west that provides a wind break for the lakes. Tatanka Lake is roughly elliptical in shape, and when full consists of 8.5 surface acres (Plot 9). The volume of the lake at full pool is actually slightly greater than Trophy Lake, and was calculated to be 44 acre/feet. Tatanka Lake is spring fed with no apparent inlet. The leeward northeast and east shorelines are in poor condition, due to erosion from wind and wave action on the lake. The outlet is uncontrolled, and drains into a wetland meadow north of the lake. The outlet was dry during the 2006 reconnaissance.

Similar to Trophy Lake, Tatanka Lake at full pool elevation exhibits an excellent ratio of profundal deep water habitat to shallower littoral areas. The littoral zone comprises approximately 53% of the lake at full pool, with very shallow upper littoral areas of less than 2 foot depth occupying 25% of the total area of the lake. Similar to other larger lower elevation lakes on the ranch, Tatanka Lake appears to be somewhat eutrophic, providing good productivity of phytoplankton, macrophytes and other



primary producers. At full pool level, the pond probably provides good habitat complexity, water quality and thermal refugia for trout.

Two trenches and one deep water hole on the southeast quadrant of Tatanka Lake were excavator dredged in 2002, creating additional deep water habitat. Three islands were constructed from dredged spoils; along the south and east shoreline. The dredged trenches were typically 15 to 20 feet wide, and the deep water hole is roughly triangular in shape. Two of the excavated areas are exceptionally deep, being at least 12 feet below the full-pool level of the lake. Summer evaporative loss is an issue in the pond, as is the case in the other lakes on the ranch, and at the time of this assessment, the pond was less than 1/4 of its full pool volume.



A bathymetric profile and water quality analysis of the current condition of the lake was conducted on the morning of July 30, 2006. The lake was found to cover 4.3 surface acres (Plot 10), and the volume of water in the lake was estimated to be slightly less than 10 acre/feet. Deep water profundal zones (>6 ft) were extremely

limited in the lake, accounting for only 120ft² of the area of the lake. Dredged deep water habitats on the southeast and south quadrant held water, but were disconnected from the rest of the water body. Littoral areas dominate the rest of the lake, with very shallow upper littoral areas comprising more than 42% of the surface area.

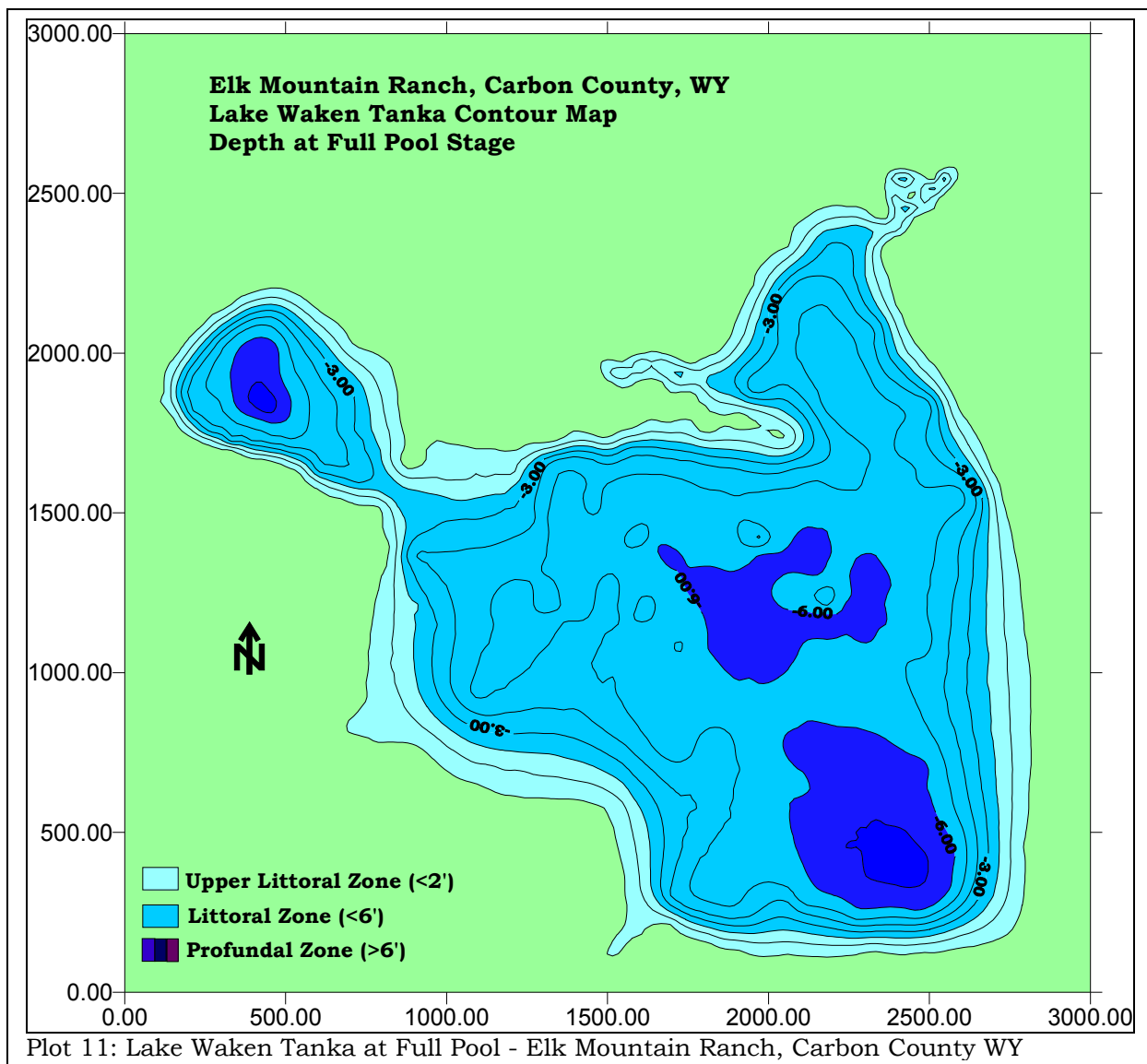
Nuisance terrestrial noxious weeds were present along the spoils piles on the southeast and south shoreline of the lake. Common watermilfoil is present in the lake, but not at the density observed in Trophy and other lakes on the ranch. Open water pelagic habitat was available in limited areas near the center of the lake. Some minor accumulations of filamentous algae were present along the shoreline.

A dissolved oxygen sample was taken from the deepest area, near the center of the lake. D.O. was found to be acceptable, and was measured at 8.9 parts per million (ppm). Water temperature was slightly higher than optimal for a cold water fishery, with surface sample temperatures measuring 72 F. There appeared to be adequate profundal habitat to provide thermal refugia for trout during summer diurnal peaks in water temperature. Measured pH was found to be 9.0; slightly better than in other lower elevation lakes on the ranch, and reasonably below the upper limit of tolerance for salmonids.

Smaller fish, including emerging young-of-the-year (YOY) were seen in one of the isolated dreaded trenches, and one dead white sucker was found in the shallows on the east side of the lake. Several Northern Leopard frogs were seen leaping into the lake during the walk around the lake perimeter. Although no trout were observed, and no stocking records exist, anecdotal evidence indicates that the lake was stocked at some point and was managed as a cold water trout fishery. At full pool level the lake could continue to provide exceptional habitat complexity and quality to support a trout population.

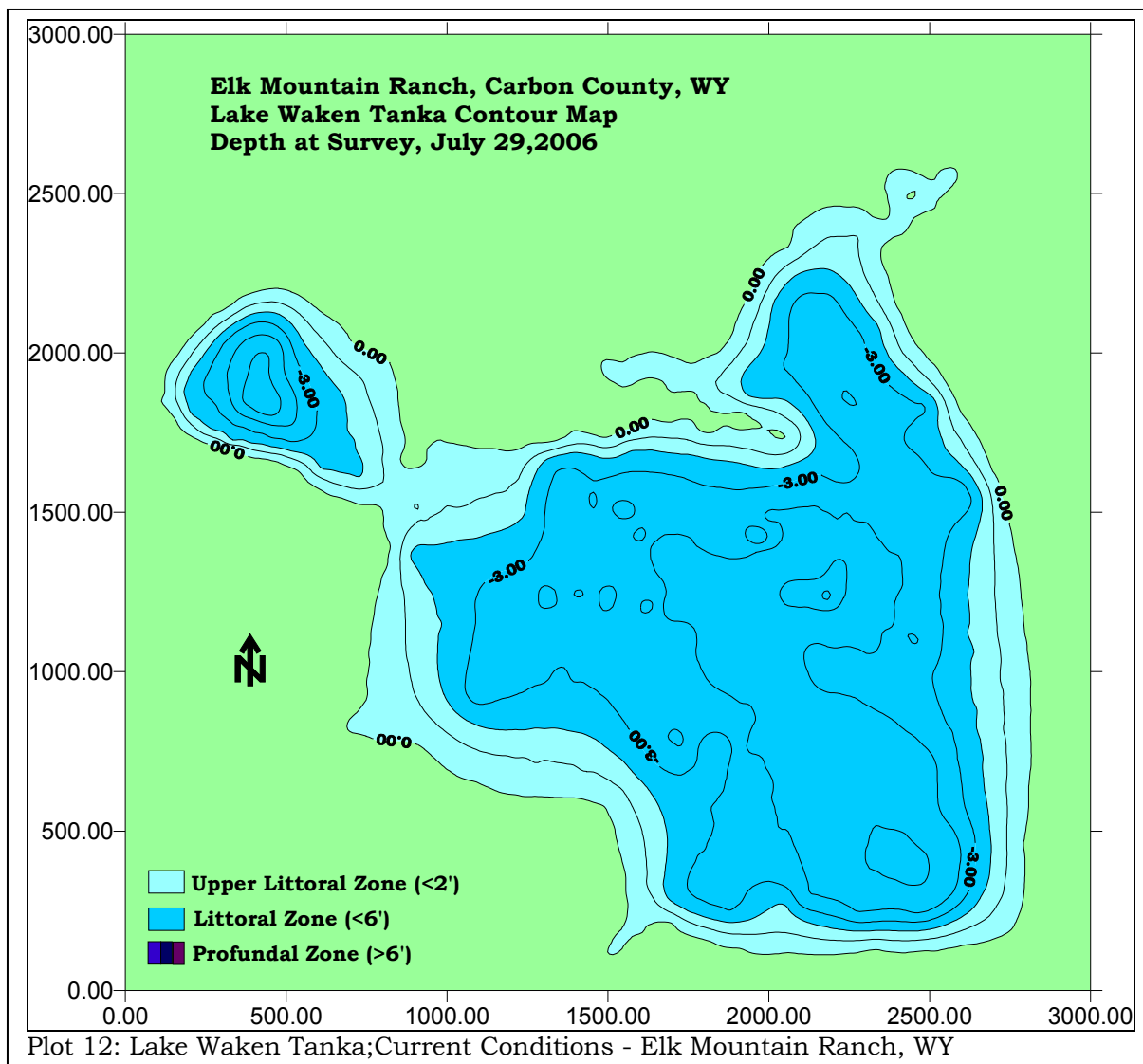
Lake Waken Tanka

Waken Tanka Lake is the largest lake found of the Elk Mountain Ranch. While the lake was probably a natural low depression, it has been substantially enlarged by an earthen berm constructed along the east shore. The lake consists of a large pool, with a much smaller pool connected by a shallow channel on the northwest. The lake when full consists of 90 surface acres (Plot 11). The volume of the lake at full pool level is estimated to be 320 acre/feet. Extensive wetlands consisting of bull rush and carex form the north shore of the lake, providing good habitat for waterfowl and amphibians. The lake is fed directly from Halleck Creek and its adjacent wetlands, and also from Bones Draw on the southwest side of the lake. The leeward east and south shore of the lake are severely eroding due to wind and wave action on the lake. Sediment from erosion occurring on the east shoreline extends over three hundred feet out into the main pool of the lake. The lake outlet, on the southeast side of the lake, flows into a channel leading to Morning Star Lake, immediately downstream to the east. Both of the inlets and the outlet were dry in August 2006, and the lake level was down approximately 1.5 feet. Due to the large surface area and relatively shallow depth, evaporative loss appears to be a significant issue in the lake.



The lake is composed mostly of shallower, littoral areas (80%), and appears to be very eutrophic. The upper littoral zone, exhibiting depths of less than 2 feet, account for nearly 20% of the area of the lake. The lake has historically been managed as a cold water trout fishery, and records indicate that the lake was most recently stocked in 2003 with fingerling brown, brook and rainbow trout, as well as catchable cutthroat, brook and rainbow trout.

A bathymetric profile and water quality analysis of the current condition of the lake was conducted on July 29, 2006. The lake was found to cover 81 surface acres, and the volume of water in the lake was estimated to be 210 acre/feet. No deep water profundal zones (<6 ft) were observed in the lake (Plot 12). Upper littoral areas less than 2 feet deep comprised 34% of the surface area.



Nuisance terrestrial and aquatic noxious weeds are a severe problem in the lake and on surrounding shorelines. Canada thistle is present throughout all of the shoreline, including the bull-rush wetlands along the north side of the lake. The larger pool in the lake is completely choked with submerged aquatic weeds, severely limiting these areas for utilization by fish. Common watermilfoil is the most abundant species of aquatic vegetation present. Filamentous algae were present in all of the upper littoral area along the southwest shoreline of the larger pool. The smaller pool is slightly less choked with weeds, but is still severely affected. Weed infestation in the pond was so severe that the outboard motor on the survey boat could not be used.

Due to an equipment failure, a dissolved oxygen sample was not taken from the deepest area in the lake. Water temperature was found to exceed the lethal limit for a cold water fishery, with surface sample temperatures measuring 81 F. Measurements of water pH appeared to indicate a severe limiting factor to the fishery, and were found to be 10.22. This measurement was considered beyond the upper limit of tolerance for salmonids. High pH in the lake is likely the result of a combination of alkaloid soils in

the area, predominance of very shallow water, high summer water temperature due to solar heating, and profuse aquatic vegetation in the lake.

No trout or other large fish were observed on the lake at any time during the 2006 recon-naissance. Interviews with ranch personnel revealed that no one can recall the last time a trout was caught from this lake. Many smaller minnows and emergent fry were observed along the shorelines of the lake, and may be native sucker, darter or dace. Amphibians were abundant along the northern shoreline. Over one hundred Northern Leopard frogs were observed during a walk around the perimeter of the lake. The lake appears to provide outstanding habitat for waterfowl and other wetland obligate species. Numerous species of waterfowl, including a great blue heron, were observed on the lake.



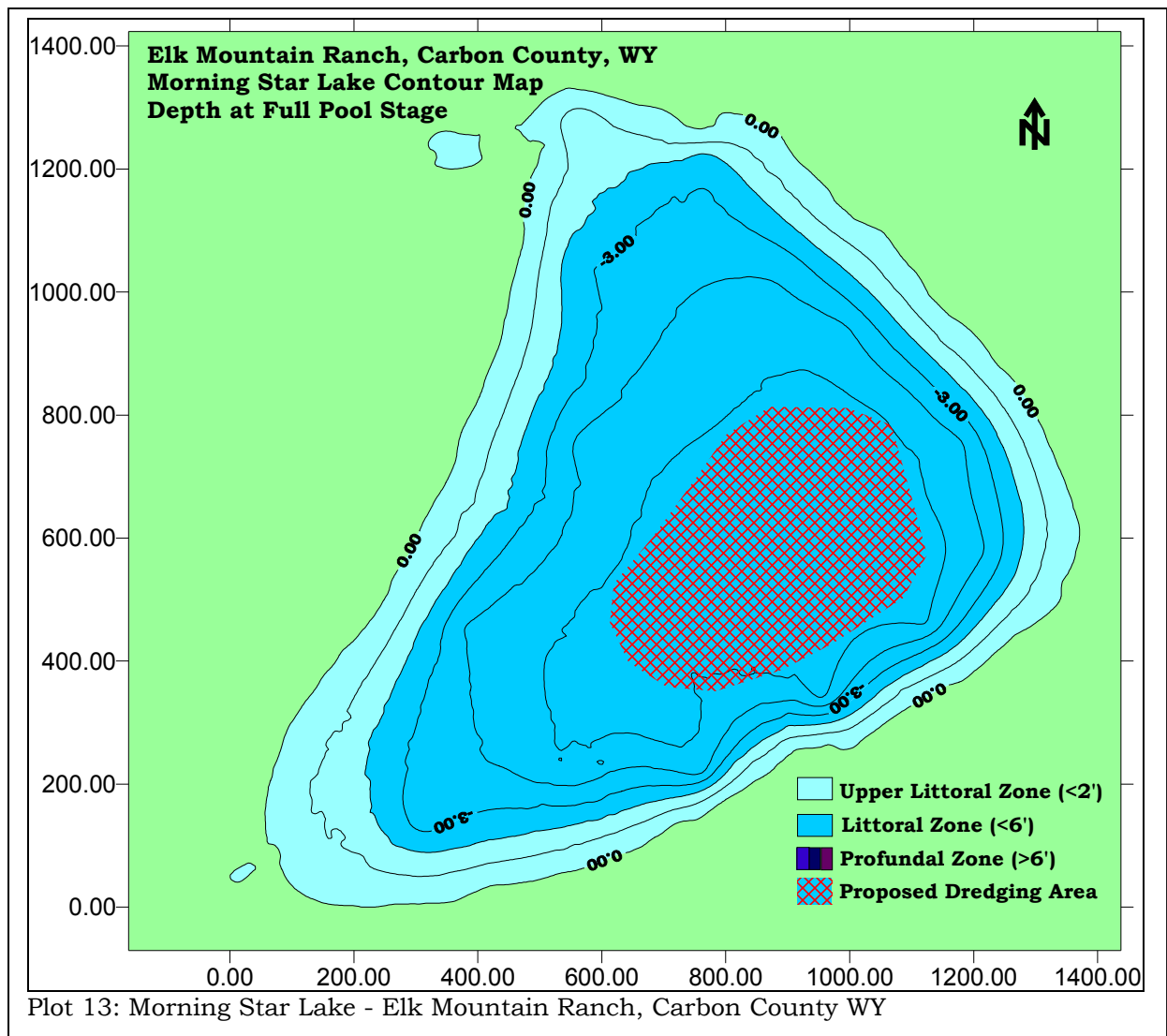
Photo 11: Northern Leopard Frog.

Morning Star Lake

Morning Star Lake is the second largest lake found of the Elk Mountain Ranch, but was dry during the 2006 assessment. The lake is roughly triangular in shape, and when full consists of 24 surface acres. The volume of the lake at full pool level is 75 acre/feet. The lake is fed from overflow from Lake Waken Tanka. Extensive wetlands form the north shore and outlet of the lake, providing good habitat for waterfowl and amphibians. The leeward south and east shore of the lake appear to be eroding due to wind and wave action on the lake. A hardened and fenced watering site has been constructed on the south east corner of the lake.

The lake appears to have been managed as a stock watering resource, and no records exist to indicate that the lake was ever stocked. Incidental migration of stocked fish may have occurred at some time. A bathymetric profile and water quality analysis of the current condition of the lake was conducted on July 31, 2006. At full pool, Morning Star Lake exhibits poor depth and habitat complexity. The lake consists entirely of littoral zone habitats at full pool, with very shallow upper littoral areas of less than 2 foot depth occupying one third of the area of the lake. It is doubtful that the lake provides suitable over-wintering habitat, and may be susceptible to periodic winter kill conditions.

Evaporative loss most likely is an issue in the lake, as it is with the other lakes on the ranch. Water quality in Morning Star Lake is probably directly linked to Lake Waken Tanka. Without supplemental water input from Halleck Creek or developed wells or springs, water quality in the lake could probably not support a viable trout population. Water temperatures can reasonably be expected to reach lethal levels for salmonids during summer months due to a lack of profundal habitat and other thermal refugia. Nuisance terrestrial noxious weeds are present along the lake shoreline. The eastern shoreline is severely infested with Canada thistle. Upon re-filling of the lake, aquatic



nuisance species such as Common watermilfoil can be expected to rapidly colonize the lake from infested areas upstream in Lake Waken Tanka.

Re-filling of Morning Star Lake should be postponed until the aquatic weed infestation has been addressed in Lake Waken Tanka. Additionally, serious consideration should be given to dredging the southeast quadrant of the lake before any attempt is made to re-fill. Dredging of the lake would be relatively easy in its current dry condition, requiring only excavators and several articulated six-wheel 20 side or end dump trucks. Creation of profundal zones 10 - 12 foot deep in 15%-25% of the lake area may dramatically improve cool water habitat conditions and water quality, and could allow the lake to support a population of trout. Approximately 25,000 to 35,000 cubic yards of material may need to be removed to create the necessary deep water habitats. A permit from the Army Corps of Engineers, authorization from the Wyoming State Engineers Office, and consultation with the Wyoming Department of Fish and Game will be required to undertake this work. Additionally, any dredged spoils from the lake bottom will need to be removed from the high water line of the lake and disposed of in accordance with the Conservation Easement held by the Nature Conservancy.

Management Recommendations

Without a doubt, the noxious aquatic weed infestation in all of the "fishing" lakes on the Elk Mountain Ranch is the single greatest aquatic resource management challenge facing the new owner of the ranch. These weeds have severely reduced available habitat for existing fish in these ponds, have altered the water quality, and may result in significant fish-kills from lack of oxygen in several of the lakes as the vegetation dies off in the fall and begins to decay in the bottom of these lakes. The weed infestation is severe in all of the lakes except "Swim Pond" and Morning Star (which is dry). Eurasian Watermilfoil is present in Trophy Lake, and is a particularly aggressive species that is very difficult to control. Once established, Eurasian Watermilfoil may be difficult to eradicate, and can easily spread to other water bodies. Until such time as it is controlled, it would be advisable to quarantine Trophy Lake. The quarantine should include a ban on boat use and contact with the water (waders, boots, etc.)

Mechanical removal is a preferred method of removing submerged weeds, since it does not require the application of herbicides and other potentially hazardous chemicals to the lentic environment, and poses the least risk to resident aquatic life. Unfortunately, the infestation of weeds in the lakes on the Elk Mountain Ranch has become so severe that mechanical treatments may be nearly impossible. Several years of periodic chemical treatments, using granular or liquid herbicides containing either 2,4-dichlorophenoxyacetic acid, dipotassium endothall, or diquat; combined with light absorbing water colorants such as AquaShade, may be necessary to bring the weeds under control. Copper based herbicides should not be used, due to the risk to remaining resident trout populations in the lakes. Chemical applications should be done in the spring, as soon as the plants begin to emerge from the benthos. These herbicides are restricted in Wyoming, and a local, Wyoming certified aquatic herbicide applicator should be contracted to develop a weed control strategy for the ranch and apply the herbicides to the lakes. The terrestrial weeds along the shorelines also need to be brought under control, and it may be advantageous to hire a single contractor to do both the terrestrial and aquatic weed control work.

In the short term, the lakes should be monitored this fall for indications of dissolved oxygen problems developing due to decaying vegetation. Signs to look for include fish quickly swimming back and forth along the shore of the lake while "piping", or gasping. Preventive action can include installing wind driven aerators. Several were observed near some of the lakes, but did not look to be in functional condition. In a worse-case scenario, a motor boat may be used to "churn-up" the surface of the lake and introduce additional oxygen into the system. Additional stocking of trout should not take place on the affected lakes until such time as the aquatic nuisance weeds are brought under control.

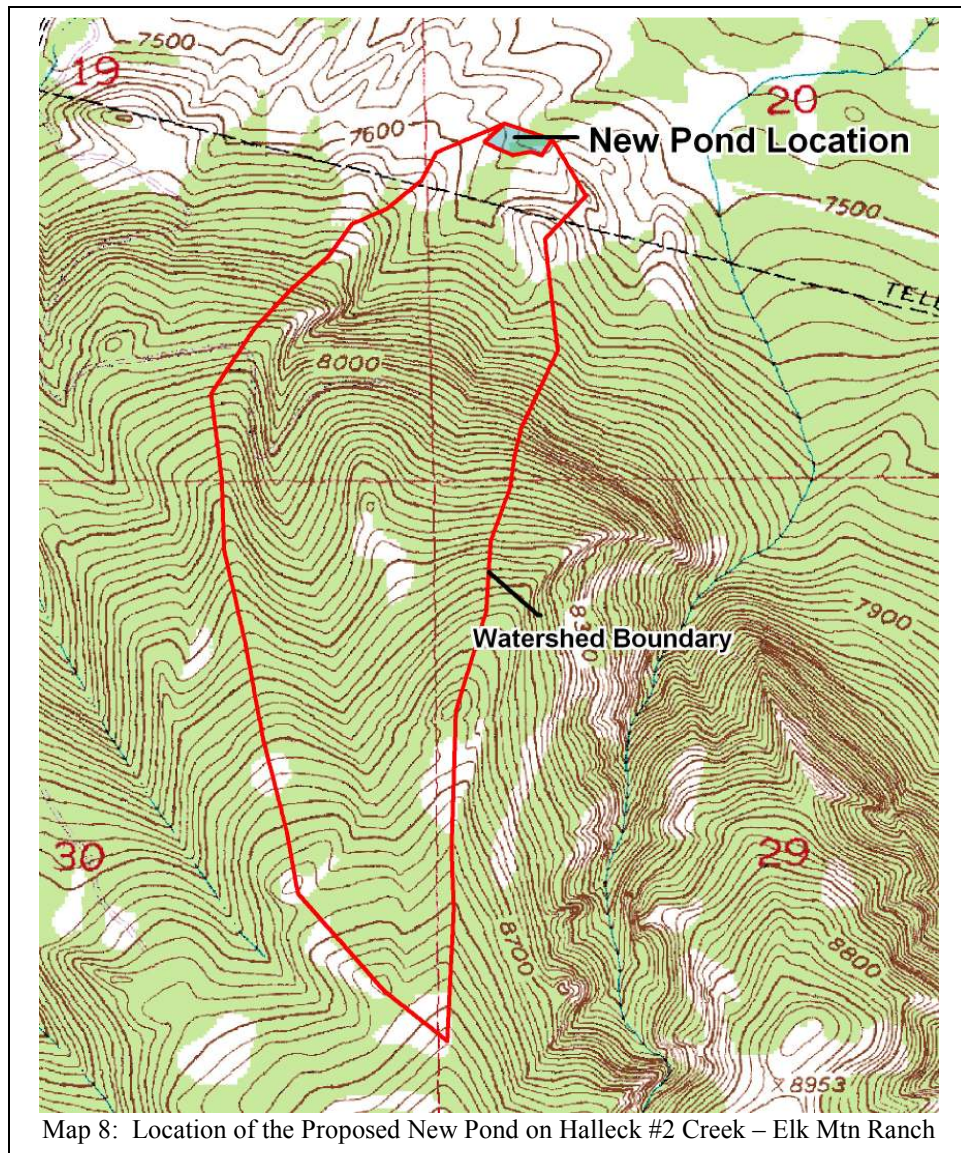
Water depletion and evaporative loss is the next most significant limit to the fishing lakes on the ranch. All of the lakes, except Waken Tanka and Morning Star, exhibit an acceptable ratio of deep/shallow habitat at full-pool, but all were habitat limited at the water levels observed in August 2006. It may be useful to investigate the possibility of further developing springs or drilling supplemental wells nearby to augment water in the lakes in the summer months. Additional water exchange should improve overall water quality and reduce daytime temperatures in the lakes. Any augmentation plan will require authorization and permitting from the State of Wyoming Engineers Office, and additional water rights may need to be acquired.

All of the lakes exhibit some level of shoreline erosion due to wind and wave action along the leeward shores. In many instances, this shoreline erosion is further filling in important lake habitat and should be stabilized. Root-wad revetments are useful for hardening of the shoreline to protect from erosive wave action. Root-wads could be obtained locally from harvest areas planned on the ranch. The root-wad, with approximately 10-15 feet of the tree bole, is embedded into the shoreline. Mats of carex, rushes, sedge and willow can be harvested from adjacent riparian wetland areas and transplanted behind and on top of the root-wad revetments to create a natural looking and well armored shoreline.

Although a limited dredging effort was undertaken by the previous owner, several of the lakes appear to be nearing the end of their useful life as cold water fisheries. Lake Waken Tanka, has likely already past this point, and may best be managed for waterfowl nesting, amphibian and native minnow habitat. If it is going to be managed as a trout fishery, Morning Star Lake will need to be excavated before it is refilled. Otherwise, it should be managed under the same strategy as Lake Waken Tanka for waterfowl and other aquatic/riparian obligate species. At some point, it will likely become necessary to drain and excavate Eagle, Arapaho, Tatanka and Trophy Lake. If this work is considered, dredging efforts should focus on creating contiguous profundal zones of at least 12 foot depth near the center of the lakes instead of along trenches near the shoreline. Proper permits should be applied for, and all dredged materials will need to be completely removed from the lake and disposed of in a manner consistent with the conservation easement.

New Pond (feasibility)

At the request of the landowner, several sites were examined along Halleck#2 Creek downstream of the new home site for possible construction of a new lake. This area is somewhat limited for construction of a lake, due to being located on an alluvial plain with steeper gradients and unconsolidated soils. We did find one location, immediately downstream of the road to the home site, where it may be possible to construct a small 1.5 acre pond. A site location of the lake is shown in the topographic map (Map 8).



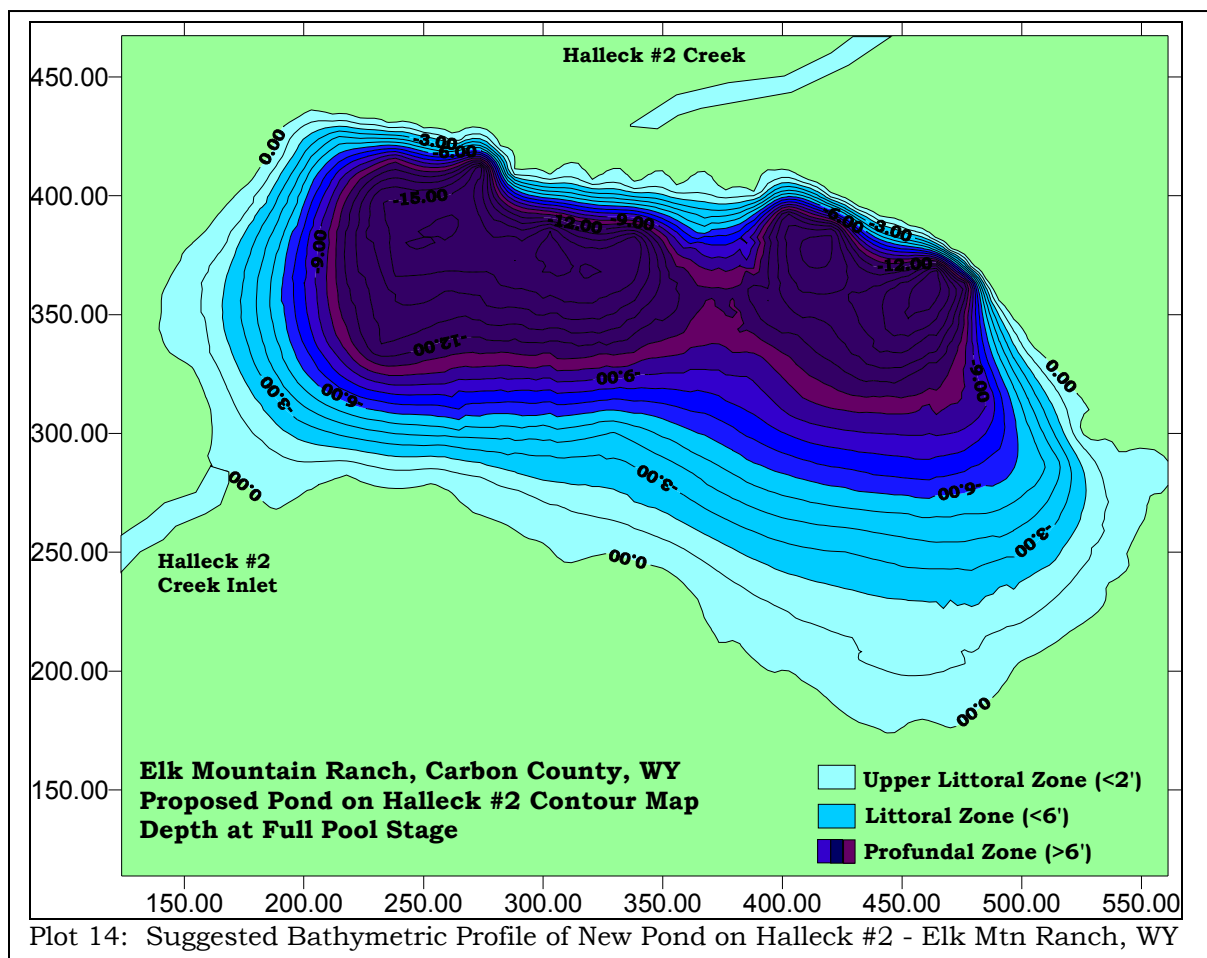
A preliminary plan and bathymetric profile of the proposed lake can be found on Plot 14. This site has an advantage of being located immediately downstream of an existing adjudicated diversion point, possibly simplifying the permitting and authorization process with the Wyoming State Engineers Office.

A pond constructed at this site would be a maximum of 16 feet deep, with approximately 33% of the water body comprising deep water profundal habitat. Of the remaining littoral habitat, 27% will consist of shallow upper littoral zones suitable for juveniles and forage species. The volume of this pond is estimated to be approximately 7 acre/feet. Adequate streamflow was observed in October, 2005 and August, 2006 (normally low flow months) to ensure a fresh-water environment for fisheries.

The watershed upstream of the proposed location is approximately 225 acres, with elevations ranging from 7,550 feet to about 8,900 feet. The mean annual precipitation for the watershed is estimated at 14 to 15 inches, with an average annual snowfall of about 85 inches (estimates extrapolated from the Elk Mountain weather station, continuous data from 1951-1980, 7,265 feet elevation). In general, the watershed is in good condition with primarily forested cover. However, because of shallow soils and steep slopes, surface run-off from high intensity precipitation events can be substantial and, because it will be an "on-line" pond, an adequate emergency spillway needs to be constructed. For design purposes, a 25-year, 24 hour precipitation is 2.4 inches and a 50-year, 24 hour precipitation is 3 inches (NOAA Atlas II, Volume II, Wyoming).

A pond in this location will likely require an engineered clay core, earthen dam constructed to a height of 25 - 30 feet. The length of the dam is estimated to be 250 feet. The dam would probably require a substantial spillway, given that it is located on-channel on Halleck #2 Creek, and for the most part will operate as a "run-of-the-river" reservoir. We recommend that both a bottom and top release be considered, in order to fully utilize management options for maintaining good water quality for the fishery.

The location of the proposed new pond is based solely on observed topology of the landscape and morphology of the stream channel. Additional feasibility studies will need to be undertaken before construction can commence. A soil and geotechnical analysis may be crucial to determine the feasibility of the dam location, and whether the pond could hold water without substantial supplemental lining of the benthic region. Construction of the pond will require approval from the State Engineer's office and a 404 permit from the US Army Corps of Engineers.



Future Management

This plan should be updated within 10 to 15 years. If what has been done is working and the objectives are the same the management should be continued.

IV. APPENDICES

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