Elk Management Strategy

Klamath National Forest

5/30/2007

Purpose and Scope of this Strategy

There has not been a comprehensive strategy developed for the management of elk habitat on the Klamath National Forest. An earlier document (KNF, 1995) recorded the status of the elk reintroduction program and some efforts to improve isolated habitat conditions. That effort focused principally on habitats in the Elk Creek watershed (Happy Camp Ranger District) and the South Fork Salmon River watershed (Salmon River Ranger District) and catalogued locations of project activities cooperatively completed with the Rocky Mountain Elk Foundation.

The purpose of this strategy is to assess existing habitat conditions and provide guidance for restoring critical components and overall suitability of elk habitat. The strategy assumes that the current habitat quality may restrict population size, negatively affect animal condition, reproduction and survival, encourage elk to depredate on private property, and jeopardize public safety along roadways. There is limited research on mortality among local elk herds, but a study from the redwood region herd listed habitat quality (malnutrition) followed by poaching and motor vehicles as the leading causes of mortality (Harper et. al. 1967)

This strategy uses available modeling tools to analyze existing seasonal elk habitat quantity, quality, condition, location, and interspersion to identify factors that may negatively affect elk herds. Identified habitat factors will be evaluated to determine if they can be modified to reduce their negative affect on elk. Habitat modifications will be modeled to determine locations where their application may have the greatest potential positive effect on elk habitats.

It is recognized that habitat management alone is only one factor involving the management of elk. Many other factors, such as disease, predation, sport hunting and sex ratios have major affects on herd success. This document addresses only the habitat management components of a successful elk management strategy. Sport hunting is under the jurisdiction of the California Department of Fish and Game and is beyond the scope of this document.

Elk Taxonomy and Evolution

Advancements in genetics have shed light in recent years on the origins and lineages of North American elk. The main center of elk evolution occurred in northern India, where the ancestral Red Deer *(Cervus elaphus)* still occupies most of Eurasia and the Orient (Polziehn and Strobeck 1998). The North American subspecies, Rocky Mountain elk *(C. e. nelsoni),* descended from the Red Deer of Siberia nearly 250,000 years ago, crossing into North America during the periodic emergence of the Bering Straits land bridge between 10-40,000 years ago (Kywayama and Ozawa 2000). These heavily maned and complexly antlered immigrants became the evolutionary parent stock of three extant and two extinct "new world" races of North American elk.

Locations where historical specimens of Rocky Mountain Elk have been recovered have mapped the probable expansion of these highly mobile ungulates as they populated western North America (McCullough 1969). Emigrating from central North America, elk entered the Pacific Coast region through southern Oregon and northern California where they evolved into the unique sub-species of Roosevelt Elk (*C. e. roosevelti),* a large and dark-coated subspecies whose populations thrive from northern California to British Columbia. Elk entering the more arid habitats of California's central valley became a distinctly smaller race known as the Tule Elk (*C. e. nannodes),* a light-coated subspecies nearly extirpated in the late 19th century by competition from Spanish livestock, over-hunting, and urbanization (McCullough 1969).

Elk in Northern California

Roosevelt Elk

The Roosevelt Elk is the largest subspecies of North American elk. Large males can reach more than 900 pounds while females are considerably smaller weighing up to 600 pounds (Bryant and Maser 1982). The species has a noticeably dark body color that appears reddish-brown in summer, lightening in winter to a creamy coloration on bulls and a grayish-brown hue on cows. "Roosevelt elk have a more massive, rigged [sic] antlers that are often shorter than in other subspecies, but antlers may be flattened or even form a crown-like structure of three or four points at the terminus" (Franklin et al. 1975).

Large herds of Roosevelt elk once roamed across much of Northern California. There were at least two kinds of populations: one, which centered from the Siskiyou Mountains to Mt. Shasta, was migratory, moving from high mountain meadows in the summer to river valleys in the winter. The other population used the coastal lowlands of the redwood region. Their existence is documented by numerous place names and in anthropological accounts of tribes such as the Shasta, Karuk, Hupa, Chilula, Chimariko and Yurok (Bright 1978). These tribes all hunted elk, using various methods such as stalking, driving, and snaring (Toweil and Thomas, 2002). Modern human developments now occupy most of their historic range, which effectively fragments many local populations (Harper et al. 1967). Hunting for meat and hides during the gold rushes of the mid 1800's is considered the major factor in the extermination of Roosevelt elk in the southern portion of their range (Harper et al. 1967). In settled areas, consumption of crops and destruction of fences led to further campaigns of extermination (Toweil and Thomas, 2002). Landscapes once shaped by Indian burning have changed dramatically over the last 150 years (Huntsinger and McCaffrey 1995). By setting back vegetative succession and reducing overstories, these traditional burning practices created favorable elk habitat conditions (Higgins 1986). By the mid 1800s, traditional burning practices of Northern California Indian tribes had virtually ceased. Many areas once managed for oak woodlands and grasslands now have dense canopies of Douglas-fir and other conifers (de Rijke 2001). By the 1870's, Siskiyou County had lost its last elk (Doney et. al. 1916).

Rocky Mountain Elk

The Rocky Mountain Elk is the most plentiful of North America subspecies because of its adaptive nature and variable diet as well as successful reintroductions or repatriation to historical habitats (NRCS 1999). Once considered plains animals, Rocky Mountain Elk are now mountain inhabitants within much of their present range.

Mature male Rocky Mountain Elk may weigh up to 800 pounds, while adult females typically weigh less than 600 pounds. The species is distinguished by displaying a light brown body color with darker coloration within the head, neck and legs (Murie 1957).

The existence of Rocky Mountain Elk in northeastern California (Figure 1) has been documented in historical specimens, ethnographic studies of local Native Americans, accounts from early explorers to this region, and recent genetic studies.

While traveling in the Goose Lake Valley on the historic Lassen trail in 1849, a member of J. Goldsborough Bruff's party fell victim to the indigenous Achumawi Indians of Modoc County, a tribe known as the "terror of emigrants" due to their unique method of digging pits to kill their prey or enemies:

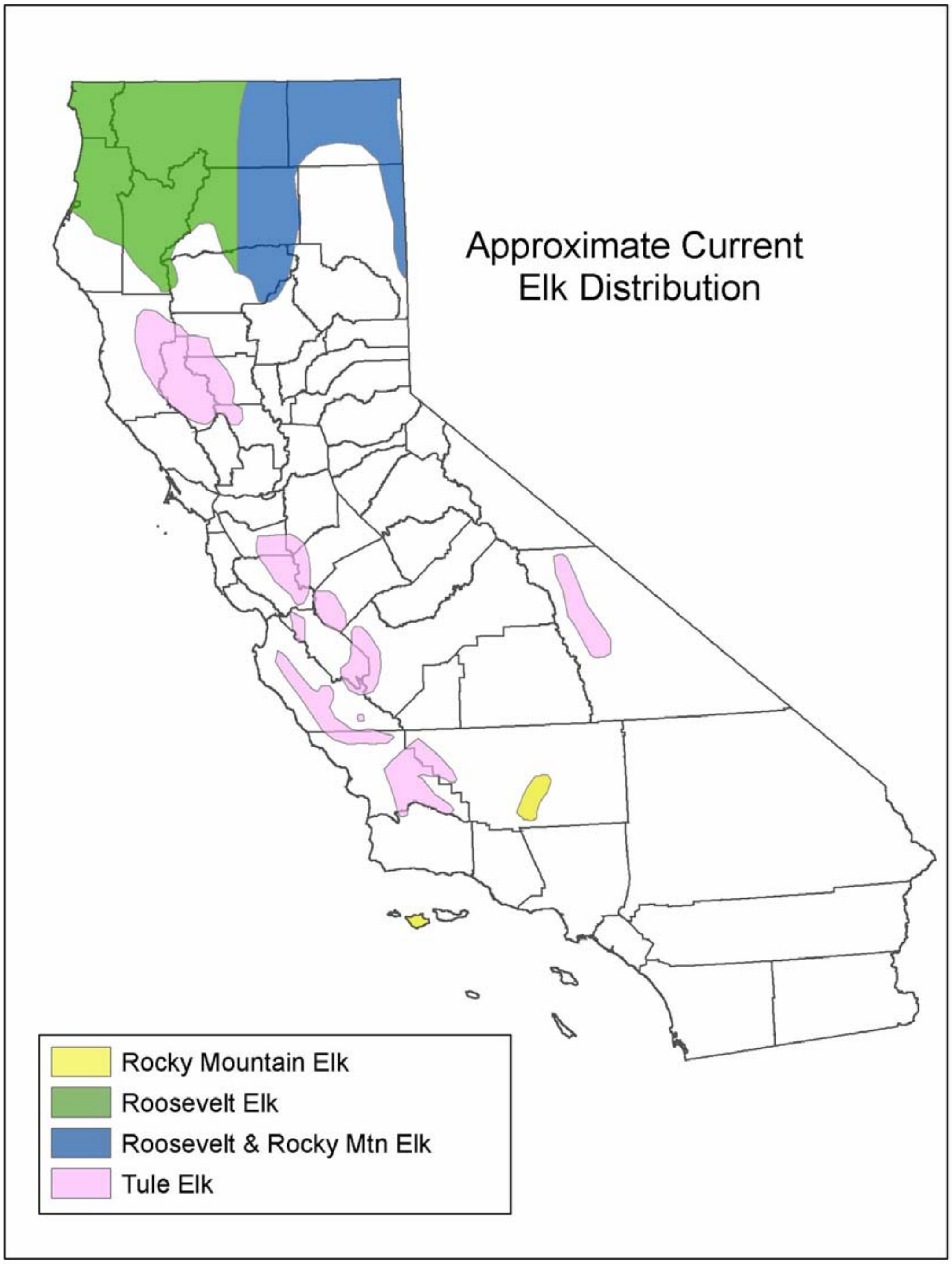
> *"These pits are dangerous traps; they are ten or fifteen feet deep, small at the mouth, but made to diverge in descent, so that it is impossible for anything to escape that once falls into their capacious maws. To add to their horror, at the bottom, elk and deer antlers that have been ground sharp at the points and are set up so as to pierce any unfortunate man or beast they may chance to swallow up." (Bruff 1849)*

The pitfall traps were so extensive in the area that early explorers named the major waterway the Pit River (Olmstead and Steward 1978). In an early nineteenth century translation of the Pit River Indians (Achumawi) ancestral lore of the wildlife in the Big and Pit River Valleys is described:

> *"The bigger game naturally gravitated toward the water and the lush feed of the valleys and included deer, antelope, occasionally elk, possibly a few bison, and bear (Kniffen 1928").*

Although pre-European levels of native ungulates in northeastern California were far less abundant than the coastal and Sacramento valley regions (Young and Clemons 1997), evidence suggest that Rocky Mountain Elk occupied the Mount Shasta region and extended eastward into the Great Basin locally where conditions were favorable (McCullough 1969). A recent study to evaluate the genetic differences among the three elk subspecies in California found that Roosevelt and Rocky Mountain elk are present and hybridizing throughout northeastern California (Meredith et. al. 2005).

Figure 1. The distribution of elk subspecies in California.



Reintroductions

In the late 1970's, the Klamath National Forest and the California Department of Fish and Game began investigating the potential to reestablish Roosevelt Elk. Years of investigation and several environmental documents later, the two agencies with assistance from the Rocky Mountain Elk Foundation, the Oregon Department of Fish and Wildlife and the National Park Service began a relocation program. By 1996, the cooperators moved 232 animals from locations in California and Oregon to four locations on the western side of the Forest. The reintroduction efforts are summarized in Table 1.

Table 1. History of Klamath National Forest cooperative Roosevelt Elk reintroduction program.

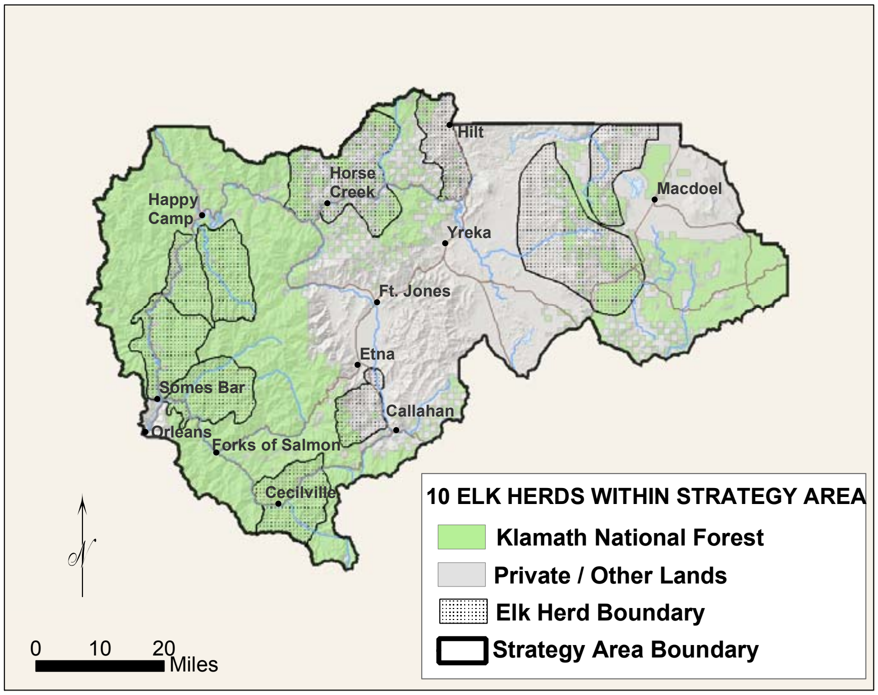
Year	# Elk	Source Location	Release Location	Cooperators
1985	6	Redwood NP	Elk Creek	USFS, NPS, CDFG, RMEF
1986	6	Redwood NP	Elk Creek	USFS, NPS, CDFG, RMEF
1987	6	Redwood NP	Elk Creek	USFS, NPS, CDFG, RMEF
1988	1	Humboldt Zoo	Elk Creek	USFS, CDFG, RMEF
1989	27	Jewell Mdws. OR	Elk Creek	USFS, ODFW, CDFG, RMEF
1990	27	Jewell Mdws. OR	S. Fk. Salmon	USFS, ODFW, CDFG, RMEF
1991	21	Jewell Mdws. OR	Elk Creek	USFS, ODFW, CDFG, RMEF
1992	30	Jewell Mdws. OR	S. Fk. Salmon	USFS, ODFW, CDFG, RMEF
1994	31	Dean Ck. OR	Steinacher Ck.	USFS, ODFW, CDFG, RMEF
1994	21	Jewell Mdws. OR	Independence Ck.	USFS, ODFW, CDFG, RMEF
1995	27	Jewell Mdws. OR	Independence Ck.	USFS, ODFW, CDFG, RMEF
1996	29	Jewell Mdws. OR	Independence Ck.	USFS, ODFW, CDFG, RMEF
Total	232	**************	****************	************************

Current Populations and Habitats

Biologists categorize the elk into 2 populations comprised of 10 distinct herds (Figure 2). The western most population is the Marble Mountain population and is found within the Klamath Mountains ecoregion to the west of the city of Yreka, or Interstate 5. The other population, the Goosenest population, is found east of Yreka, or Interstate 5, and is found within the Southern Cascades ecoregion.

It is not assumed that individual animals show complete fidelity to respective herds or even populations, as elk are capable of dramatic dispersals. However, it is likely that due to topographical restrictions or patterns of known use that elk herd's function largely as individual populations throughout their life histories.

Figure 2. KNF Elk Herds/Analysis Areas



Marble Mountain Population

This population consists of all eight Roosevelt Elk herds found in the Klamath Mountains west of Yreka or Interstate 5. There may be considerable interchange between some herds on summer and transitional ranges, with greater fidelity exhibited toward winter range attributes.

- *Elk Creek Herd*: This herd, due south of Happy Camp, ranges from Big Ridge on the east to Titus Ridge on the west and from the Klamath River to the Marble Mountain Wilderness encompassing the headwaters of Elk Creek, Grider Creek and Tickner Hole area. Summer range is predominately in the lush, high mountain meadows of the Marble Mountain Wilderness, centering around Elk Valley, Granite Valley, Rainey Valley, Bear Valley, Toms Valley and Tickner Hole. It is suspected that summer range is shared between Elk Creek, Independence, Ukonom, and Wooley Creek herds. Transition range is a broad elevation band between the summer and winter range, comprised of Douglas-fir – mixed evergreen types at lower elevations grading into white fir types at higher elevations. Within this conifer matrix, there are occasional brush fields associated with ridge tops, avalanche chutes and ecological disturbance. Conifer plantations of varying ages are dispersed throughout this transitional range. Winter range is typically below 2500 feet elevation and is within the Douglas-fir – tanoak zone. Steep rocky slopes of southerly aspects commonly have canyon live oak as the major hardwood. Remnant deciduous oak woodlands provide valuable grass and forb forage. Greatest forage utilization in the winter range occurs along the river bars and first terraces of the Klamath River and Elk Creek and oak woodlands and younger conifer plantations throughout the zone. There are also many small meadows and openings, often on private property, that the elk heavily utilize as well as grassy road right-of-ways.

- *Independence Herd*: This herd, southwest of Happy Camp, roams from Ukonom Creek on the southern boundary to Titus Ridge on the northern boundary, across the Klamath River to Pony Peak on the southern edge and north into the Clear Creek drainage. The summer range is in the lush, high mountain meadows of the western Marble Mountain Wilderness centering around Independence Valley, Ukonom Lake and Hells Meadows. It is suspected that summer range is shared between Elk Creek, Independence, Ukonom, and Wooley Creek herds. Transition range is similar to those for the other Marble Mountain herds and consists of a broad elevation band between the summer and winter range, comprised of Douglas-fir types at lower elevations grading into white fir types at higher elevations. Within this conifer matrix, there are occasional brush fields associated with lightning-burned ridge tops, avalanche chutes and other vegetative disturbances. Conifer plantations of varying ages are dispersed throughout this transitional range. Winter range is typically below 2500 feet elevation and is within the Douglas-fir – tanoak zone. Remnant deciduous oak woodlands provide valuable grass and forb forage. Greatest forage utilization of winter range occurs along the river bars and first terraces of the Klamath River and Independence Creek and oak woodlands and younger conifer plantations throughout the zone. There are also many small private meadows and openings that the elk heavily utilize as well as road right-of-ways.

- *Ukonom Herd*: This herd, due north of Somes Bar, inhabits the area from Somes Bar, Merrill Mountain and Medicine Mountain to the south, and north along the ridge-line dividing Bridge Creek from the North Fork of Wooley Creek. It then proceeds west down the Ukonom Creek drainage, crossing the Klamath River and toward Little Medicine Mountain. Their range extends southerly toward Rock Creek Butte and straddles the Ukonom District boundary south to Somes Bar. Summer range is also in the lush, high mountain meadows of the western Marble Mountain Wilderness, stretching from Hells Meadows to Let-er-Buck Meadows area, including Albers, Haypress, Halfmoon, Ti Creek and Torgerson Meadows. It is suspected that summer range is shared between Elk Creek, Independence, Ukonom, and Wooley Creek herds. Transition range is a broad elevation band of relatively gentle terrain between the summer and winter range, comprised of Douglas-fir types at lower elevations grading into white fir types at higher elevations. Within this conifer matrix, there are occasional brush fields associated with ridge tops, avalanche chutes and disturbance. Conifer plantations of varying ages are dispersed throughout this transitional range. Winter range is typically below 2500 feet elevation and is within the Douglas-fir – tanoak zone. Remnant deciduous oak woodlands provide valuable grass and forb forage. Greatest forage utilization of winter range occurs along the river bars and first terraces of the Klamath River, between Irving and Carter Creeks, and in the oak woodlands and younger conifer plantations throughout the zone. Heavily used early-successional winter range habitats include small, often privately owned, meadows and openings such as landslides, burns, and road rights-of-way.

- *Wooley Creek Herd*: This herd, east of Somes Bar, ranges from the upper reaches of Somes Creek to the Hog range of Yellow Jacket Ridge at its southern boundary, then north to East Peak proceeding further north along the Wilderness boundary to Black Mountain. The eastern edge crosses Wooley Creek to Hancock Creek and includes Morehouse and Crapo Meadows. Summer range is situated in the high mountain meadows and glades of the Chimney Rock area. Summer range may be shared between Elk Creek, Independence, Ukonom, and

Wooley Creek herds, but relative isolation may limit herd mixing. Transition range is a broad elevation band between the summer and winter range, comprised of Douglas-fir types at lower elevations grading into white fir types at higher elevations. Within this conifer matrix, there are occasional brush fields associated with ridge tops, avalanche chutes and disturbance. Winter range is confined to the lower elevation areas along Wooley Creek, Steinacher Creek and the main stem of the Salmon River. River terraces and remnant patches of oak woodlands in Wooley Creek are some of the prime winter habitat. Plantations in Monte and Duncan Creeks south of the Salmon River also offer forage opportunities.

- *South Fork Herd*: This herd inhabits an area around the town of Cecilville and the old Petersburg town site in the upper South Fork Salmon River area. There is uncertainty about the full extent of this herd's range, but it probably extends beyond the Klamath Forest boundary, especially in summer and likely includes the high elevation meadows of the Salmon Mountains in the Trinity Alps Wilderness Area. There have been observations in the New River watershed suggesting that this herd is using habitat within the Shasta-Trinity National Forests as well. Within the Klamath Forest boundary the herd range is believed to extend from Plummer Creek to Grizzly Butte on the Trinity Divide, and south and southwest of the South Fork of the Salmon River. To the north of the river, it extends from Canyon Mountain to the Sixmile drainage, then south toward Deadman Peak. The summer range includes the high mountain meadows found along the Salmon-Scott and Salmon-Trinity divides from Deadman peak in the northeast to Mary Blaine Mountain in the southwest. Transition range includes the mostly conifer-dominated forests between the Salmon River valley and the montane meadow region. Vegetation is mostly Douglas-fir mixed conifer grading into white fir and red fir communities. There are small glades and shrub fields scattered throughout the transition range. Elk use appears to be on an elevation gradient that encircles the winter range. Winter range is primarily along the flats and meadows bordering the river. The forest communities are dominated by Douglas-fir – ponderosa pine types. Remnant oak woodlands are still relatively common; however, conifer invasion is common in these oak woodlands (Stewman, 2001). There are several small privately-owned meadows that the elk use for foraging.

- *Horse Creek Herd*: This herd inhabits the area of the Klamath River Corridor from Seiad Valley east to Beaver Creek, extending northward to the crest at Cook and Green Pass and Observation Peak. South of the Klamath River, the herd ranges from the Grider Creek drainage to Lake Mountain. This herd also ranges into Oregon and the Rogue River National Forest outside the boundaries of this management strategy. Summer range extends along the eastern Siskiyou Mountains crest, primarily in the montane meadows. Transition range is the typical broad elevation band between the summer and winter range, comprised of mixed conifer, oak woodlands and plantations. This is an area of mixed ownership, with private timber company land interspersed with USFS managed lands. Winter range is focused in the lower elevations along the Klamath River corridor, much of which is private property. Oak woodlands are common within the winter range.

- *Russian Herd:* This herd inhabits the western foothills of southern Scott Valley, between the towns of Callahan and Etna. It is centered in the Miners and French Creek drainages. Summer range extends into the Russian Wilderness Area. Transition and winter range is primarily on private property and agricultural lands where depredation may become a problem if herd size increases from its current small number of animals. Douglas fir – ponderosa pine types, interspersed with oak woodlands, are common in the foothill region of the winter range.

- *Hilt Herd:* These elk inhabit the headwater areas and valleys of Cottonwood Creek, along the Interstate Highway 5 corridor, from Siskiyou Summit to the town of Hilt. The herd appears to be confined to this sub drainage, except in summer when it ranges into the high elevation meadows of the Siskiyou Mountains along the Oregon and California border. The transition range is located mostly in California at the lower elevation lush grass-oak woodland stands in the valleys of Cottonwood Creek. Winter range is mostly on private lands in the small valleys along Interstate 5. This herd also has a substantial amount of interchange into Oregon and the Rogue River National Forest outside the boundaries of this plan.

Goosenest Population

This population has characteristics of both Rocky Mountain and Roosevelt elk and comprises 2 herds which use public and private lands of the South Cascades ecoregion east of Yreka or Interstate-5. These herds are not a result of planned re-introductions, but rather a result of natural population expansions from Oregon herds.

- *Shasta Valley Herd*. These elk mostly range from the eastern foothills of Shasta Valley, north to Klamath River, then south and east to Deer Mountain. They spend most of the winter on private ranches in the Shasta Valley. The gentle slopes from Eagle Rock to the Klamath River above Copco Lake offer many patches of oak woodlands and grasslands. In the spring the elk move south and east to transition and summer ranges around Grass Lake, Bull Meadows and Deer Mountain. They also range east of Highway 97 in the Long Prairie and Round Valley areas. Some animals in this population are believed to move into Oregon for certain time periods.

- *Butte Valley Herd.* This herd's primary winter range is valley lands, including Pleasant Valley, west of Highway 97. Butte Valley National Grasslands, Butte Valley Wildlife Area and private ranches occupy most of the valley habitat. Uplands immediately adjacent to the valley floor also provide winter habitat. In the summer they range throughout the mountains to the west and north of Butte Valley and likely go into Oregon. Much of this habitat is drier and typical of eastside pine or juniper woodland habitats. Around McGavin Peak the summer range includes mixed conifer and true fir communities interspersed with small glades associated with riparian areas.

Habitats and Distribution

<u>Seasonal Elk Habitat</u>

Three different areas of utilization or ranges have been identified for this plan and include; summer, transition and winter range. Elk habitat-use is affected by a variety of ecological and human caused factors including forage quality and abundance, forest and rangeland management, water availability, predator avoidance, topography, weather, cover, fire and anthropogenic disturbance.
The occurrence of Roosevelt and Rocky Mountain Elk within the boundary of this plan is defined as: "<u>The General Area Occupied and Utilized by Elk for Seasonal Use and Dispersal</u>". Optimum elk habitat is primarily determined by the amount and arrangement of forage and cover within these ranges. Specialized habitats of importance include movement corridors and calving areas. Most elk within the project area are considered partially migratory, making altitudinal shifts in winter when snows or forage quality prevent access or survival at upper elevations. Three different areas of utilization or ranges have been identified for this plan and include; summer, transition and winter range. Specialized habitats of importance include movement corridors and calving areas.

The average snow elevation and average minimum December temperatures along with seasonal observation of elk were used to delineate seasonal ranges across the forest. There are 3 general regimes for seasonal range from the East to the West as indicated in Table 2. Habitat was evaluated within each seasonal range.

Table 2. Elevation used for Seasonal Ranges

HERD	<u>Elevation</u> WINTER	<u>Elevation</u> TRANSITION	<u>Elevation</u> SUMMER
Shasta & Butte Valleys	< 4500 ft	4500-5500 ft	> 5500 ft
South Fork Salmon, Russian, & Hilt	< 3500 ft	3500-4500ft	> 4500 ft
Horse Cr., Elk Cr., Independence, Ukonom, Wooley	< 2500 ft	2500-4500 ft	> 4500 ft

Summer range is a pattern of use that typically occurs at higher elevations (generally above 4,000 feet) during summer months. Human disturbance, competitive ungulate foraging and forage quality are critical factors when assessing the condition of summer range. Competition with cattle is most common on summer range and can result in temporal and spatial displacement and shifts in niche use (K.M. Stewart et. al. 2002; P.K. Coe et. al. 2000). Condition of the late summer range greatly determines the health, reproductive success and survivability of an individual animal going into the physiologically demanding winter months. With increased vegetative diversity and nutritional quality the summer range typically offers more high quality habitat than winter range. Summer range components include wet meadows, grasslands, riparian areas, brush fields, and forested stands for security cover. For maximum use by elk, forage areas within the summer range should have no point farther than 600 feet from the edge of cover. This allows circular forage areas of up to 1200 feet wide or 26 acres to qualify as optimal habitat arrangement for summer range habitats (Hershey and Leege 1976).

Winter range is a pattern of elk use occurring at lower elevations (below the snowline or 2500 foot elevation) in the winter months. Winter ranges are typically more restricted in size than either summer or transition ranges and more often a limiting factor to the success of populations. Winter ranges are often susceptible to the impacts of poor forage quality and availability, human disturbances, and concentrated use by elk. Winter range includes open meadow areas and very early seral forests that produce forage through the coldest periods, young forests providing cover and shelter and mature conifer forests providing forage, cover and shelter. Optimal thermal cover within identified winter range areas should reflect canopy closures greater than 70 percent (Thomas et al. 1979). For many herds within the Marble Mountain population, numerous calf observations by local residents show that winter range also provides important calving habitat (Creasy, 2005).

Transition range lies in the elevation zone between summer and winter range (generally between 2500 and 4,000 feet in elevations) and contains characteristics of both. It can be described as spring/summer and fall/winter range. In general, transition range is used by elk when migrating between summer and winter ranges. Transition range is commonly made up of habitats such as Douglas fir, mixed conifer, grassland habitats, and riparian areas (NRCS 1999). Transitional range habitats provide forage needed by elk to build fat reserves in the fall and support calving in the spring. Since the quality of winter range habitats is often a limiting factor in the success of elk, the condition of transition ranges can be extremely important in sustaining populations (NRCS 1999).

Specialized Elk Habitats

Across all vegetation communities the desired end result for elk habitat is a mosaic of condition classes across the landscape, avoiding uniformity and increasing edge effect. Such conditions will better address the availability of the following specialized habitat needs.

Forage areas are those areas that provide nutrition needed for survival, growth, reproduction, and overall productivity of elk. The nutritive value (quality) and quantity of forage can have an inordinate influence on the number of animals that breed and successfully reproduce (Toweil and Thomas 2002). The mosaic of forage habitats should provide a variety of nutritious forage in a secure setting during the elk lifecycle. For example, during winter, the digestible energy of forbs and grasses is typically higher than that found in shrub twigs. However, the protein content of forbs and grasses in winter is quite low compared to shrubs (Hobbs et. al. 1981). Higher protein in browse shrubs and higher energy in grasses and forbs suggest that dietary mixes of the two forage types may improve the overall nutritional status (Otsyina et. al. 1982). Phenology, or growth stages, of plants result in marked differences in nutritive value among seasons, and account for more variation in plant nutritive value than any other environmental or plant factor. Forest cover will delay understory plant phenology, as much as two to three weeks (Krueger and Bedunah, 1988). Thus, south facing slopes and areas with low forest cover will provide valuable quality forage weeks ahead of other areas. This is especially important in the spring when nutritious forage has a significant effect on birth weight, the primary factor affecting calf survival (Toweil and Thomas

2002). Full use of forage areas is dependent upon adjacent security cover and adjacent density of roads and more specifically the amount and patterns of road use by humans.

Calving areas are habitats utilized for parturition and rearing, and are critical to the reproductive success of populations. Forested stands with dense understories in close proximity to riparian areas or meadows are key attributes for calving areas. In general, calving habitats are found on the winter and transitional ranges where slopes are less than 15% or on a bench within steep topography. The availability of succulent and nutritious forage is critical for lactating cows and water is usually found within 1,000 feet (Thomas et al. 1979). Downed woody debris can also be important for providing cover for newborn calves. Calving season typically runs from May through June.

Cover areas are habitats that provide protection from predators and enable individuals to safely rest periodically throughout the day. Elk also depend on security cover during calf-rearing and hunting seasons. Elk are not particular about the types of vegetation that provide security, as long as it conceals the animals. Security cover is considered adequate when 90% of a standing elk is hidden by vegetation from the view of a human at a distance equal or less than 200 feet (Thomas et al. 1979). Expanses of hiding/security cover need to be large enough to hide a number of elk at one time. Blocks of habitat containing multi-layered forest structure that are at least 800 feet wide can provide adequate hiding cover for elk (Thomas et al 1979). Lack of roads and human trails and their associated travel use are also important key elements for evaluating effective security cover.

Travel corridors are established routes, followed by the groups of elk moving from one location to another, either on or between ranges. In general travel corridors can reflect the path of least resistance considering topographic landform and the presence/absence of security cover. Elk use riparian zones along intermittent and perennial streams and rivers frequently as travel corridors between high elevation summer ranges and low elevation winter ranges (Thomas et al. 1979). When traveling from one watershed into another, elk often use ridgeline saddles.

Habitat Analysis Methodology

Analysis Areas

Use of summer and transitional ranges by multiple herds led us to lump ranges and analyze logical areas of habitat.

Four herds (Elk Creek, Independence, Ukonom and Wooley) share summer range in the Marble Mountain Wilderness, so we combined and analyzed all seasonal ranges for those herds together. This **Marble Mountain analysis area** spans nearly 300,000 acres of public (291,966 ac) and private (4196) lands.

The South Fork herd and Russian herd similarly have some overlapping seasonal range use and probably both originated from reintroduced elk released in the South Fork Salmon River (Table 1; 1990 and 1992 releases). Seasonal ranges for those herds were analyzed in the 131,000-acre **Salmon analysis area** (101,745 ac. public & 29,570 ac. private lands).

Habitat in the 220,000+-acre **Siskiyou analysis area (**107,470 ac. public & 114,313 ac. private lands) was evaluated for the Hilt and Horse Creek herds, which probably share summer range along the Siskiyou Crest.

The **Goosenest analysis area**, at over 640,000 acres (357,435 ac. public & 287,900 ac. private lands), was the largest of the analysis areas reviewed in this effort. The area includes both the Shasta Valley herd and the Butte Valley herd. Much of the included private land provides either winter range or transition range for this elk population.

<u>*Modeling Method*</u>

Models to evaluate elk habitat in the western United States have been used for many years (Thomas et. al., 1979; Toweil, D.E. and J.W. Thomas, 2002). Models provide standard methods that can be applied over different spatial scales and subsequent validation testing can provide a feedback mechanism to apply principles of adaptive management. Early elk habitat models were based on important life history variables of forage, cover and security. A model to calculate *habitat effectiveness* was developed for western Oregon (Wisdom et. al. 1986) and was initially used for development of this strategy. Studies for Roosevelt elk in western Oregon show that the interaction of four variables provides a framework to determine the current use or potential use of an area (Witmer et. al., 1985). Those four variables are: (1) size and spacing of forage and cover; (2) road density (use); (3) cover quality and (4) forage quality. Over the years, the Wisdom model has undergone refinement.

We used a geographic information system model, the "**Arc Habitat Suitability Index**" (**ArcHSI**), developed at the USDA-Forest Service Rocky Mountain Research Station (Juntti and Rumble, in press) to display the current ability of each geographic seasonal range to provide high value elk habitat. This model uses the same four evaluation variables as the Wisdom model. One major distinction is the ability to apply different weights to the input variables. It is also adapted for use in geographic information systems (GIS). We used this model, in conjunction with analysis of site conditions, to help locate areas that have the potential to yield highly suitable elk habitat. Site condition evaluation includes elevation, slope, aspect, soils and potential natural vegetation. Under favorable site conditions, managing for the correct vegetative cover and composition will increase forage quality and quantity yielding more suitable elk habitat. Sites may also be selected that favor early spring growth of forage, an important consideration for calving success.

Benkobi, et al (2004) first described this model as a habitat *capability* predictor; *capability* is the ability of habitat under optimal conditions to provide its highest potential value. Juntti and Rumble (in press) subsequently refined it and redescribed it as a *suitability* model (ArcHSI); *suitability* is the ability of habitat to provide some value level at its current condition. The ArcHSI model looks at the juxtaposition of habitat components (forage and cover) in relation to each other and road density/use to assign a suitability score to that habitat for elk use. For forage and cover, habitat condition quality indices (Wisdom, et al. 1986) from 0 to 1.0 (low condition to high condition, respectively) were assigned to each unique combination of vegetation type and structural stage. The model then accounts for the proximity of cover to forage, displayed as cover-forage proximity, as well as effects of road disturbance of elk (Benkobi, et al. 2004). General considerations of these model factors for this strategy are discussed below.

Vegetation - Current vegetation map products show 71 vegetation community types (CalVeg) across the landscape. Vegetation community polygons range in size from about 7 acres to over 20 acres, averaging approximately 10 acres. Each vegetation community type consists of species assemblages (e.g. grasses, forbs, shrubs, trees, etc.) combined with a specific structural category (density and size). Changes to structural composition of one or several vegetation species in the community, either species density or size, will result in responses from other species in the community. For example, thinning of ponderosa pine in an eastside pine community will result in increased grass and forb production due to increased light on the forest floor and increased moisture availability from reduced competition. Thinning conifer overstory in a Douglas-fir – black oak community would provide similar results.

Roads – The effects of roads on elk habitat suitability has been well documented (Rowland et. al. 2004). Instead of road density, we use a banded distance from road to habitat components in combination with road use to assess effects of roads. Overall habitat suitability indices were adjusted according to these use categories of roads and the banded distance. Roads were assigned to one of three use categories: primary, secondary and primitive. The ArcHSI model buffers roads based on their use category. Primary roads receive a 300m buffer and secondary roads receive a 60m buffer. Low use "primitive" roads are considered to have no effect on elk use of adjacent forage and/or cover habitats. Forage and/or cover values for habitat within the buffers for primary and secondary roads is reduced by 50%.

Forest Service roads were grouped by maintenance level and classified as follows:

Level 1 – custodial / closed = primitive
Level 2 – high clearance vehicles = primitive
Level 3 – suitable for passenger cars = secondary
Level 4 – moderate degree of user comfort = secondary
Level 5 – high degree of user comfort = primary

State and County roads were classified as "primary" as a result of their relatively high use level. Private roads were classified as "primitive" because most are gated and receive little public use.

<u>Cover -</u> Canopy closure, or cover, is derived from a geometric optical canopy model that estimates canopy closure within each tree stand as a percent cover value. This canopy closure attribute is associated with each tree polygon in the vegetation layer. Shrub and herbaceous polygons do not carry canopy cover attributes. ArcHSI assigns cover by the size classes: grass/forbs, seedling/shrub, sapling/pole (2-23 cm dia.), and mature (> 23 cm dia.). The canopy cover of the sapling/pole and mature classes is grouped and evaluated in the following classes: 0-40%, 40-70% and > 70%.

Cover values (CV) are assigned to each structural stage for each vegetation type. The cover values used are 0, .2, .5, and 1. If a polygon has a cover value >= .5 and a forage value >= .5 then the polygon is treated as both cover and forage.

<u>Forage</u> – Each of the 71 KNF vegetation communities (CalVeg; http://www.fs.fed.us/r5/rsl/projects/) was assigned a forage value (FV) based on palatability and nutritional quality of associated species (Appendix A).

Thirty of the vegetation communities (Table 3) have either "**high value elk habitat**" or "**high restoration potential**". These communities currently exhibit or have *potential* to produce high quality forage (fv > 0.8) under certain vegetation structural stages *and* still achieve a habitat suitability score of >0.7. Four communities have grasses as a principal component, 9 have shrubs as a principal component, 5 have deciduous hardwoods as the principal component, and the remaining 12 have conifers as a principal component.

Table 3. California Vegetation Communities on Klamath National Forest, by analysis area, with either existing high value elk forage habitat (FV) or high restoration potential (RP) to achieve a high FV.

Veg. Type	Description	Analysis Area	Cover type	FV	RP
HG	Ann. Grass/Forb wet mdw.	All	HEB	1.0	1.0
HJ	Grass/Sedge/Rush	All	HEB	1.0	1.0
HM	Perennial Grass/Forb	All	HEB	1.0	1.0
IG	Grass	All	HEB	1.0	1.0
BB	Bitterbrush	GN, SI	SHB	1.0	1.0
BR	Rabbitbrush	GN, SI	SHB	0.5	0.8
BS	Basin Sagebrush	GN	SHB	0.9	0.9
CJ	Brewer Oak	SI, MM, SA	SHB	0.9	0.9
CQ	Chaparral	All	SHB	0.8	0.9
CS	Scrub Oak	MM, SA	SHB	0.8	0.9
CV	Snowbrush	All	SHB	0.8	0.8
CX	Upper Mntn. Mixed Chaparral	All	SHB	0.7	0.8
WM	Birchleaf Mtn Mahogany	GN, SI, SA	SHB	0.8	0.8
NR	Mixed Riparian Hardwood	All	HDW	0.8	0.8
QG	Oregon White Oak	All	HDW	0.9	1.0
QK	California Black Oak	All	HDW	0.8	1.0
QQ	Quaking Aspen	All	HDW	0.8	1.0
QY	Willow - Alder	All	HDW	0.8	0.8
DF	Pacific Douglas–Fir	MM, SI, SA	CON	0.6	0.8
DP	Douglas–Fir – Pine	All	CON	0.7	0.8
DW	Douglas-fir – White Fir	MM, SI, SA	CON	0.7	0.8
EP	Eastside Pine	GN	CON	0.8	0.8
JP	Jeffery Pine	All	CON	0.8	0.8
KP	Knobcone Pine	All	CON	0.6	0.8
MF	Mixed Conifer – Fir	All	CON	0.7	0.8
MK	Klamath Mixed Conifer	MM, SI, SA	CON	0.7	0.8
MP	Mixed Conifer – Pine	All	CON	0.7	0.8
PD	Gray Pine	SA	CON	0.7	0.8
PP	Ponderosa Pine	All	CON	0.8	0.8
PW	Ponderosa Pine – White Fir	GN	CON	0.7	0.8

Cover to Forage Proximity – Areas of forage located close to cover are desirable for elk use. Forage areas within 100m of cover edge are most desirable and were assigned a Habitat Distribution Value (HDV) score of 1.0; those forage areas further than 300m from cover edge were considered unusable by elk and assigned a HDV score of 0.0 (Benkobi, et al 2004). Intermediate distances between forage and cover were assigned intermediate HDV scores.

The ArcHSI model can weight any of the habitat variables (cover value, forage value, habitat distribution value) as instructed by the modeler. The default is that forage value is weighted 3 times above cover and distribution values. Because we agree that forage is most important to elk population success, we did not deviate from the default weighting. Each vegetation community polygon received respective scores as previously described for cover value, forage value, and habitat distribution value. The model then derived a habitat suitability index score (HSI) between 0 and 1.0, accounting for weighted forage value, for individual polygons. Lastly, we produced area-weighted mean scores across each seasonal range within each analysis area for those same variables and the habitat suitability index.

The final analysis step, since we are most interested in identifying restoration opportunities that can enhance availability of high quality habitat, was identification of vegetation community types that have the potential to provide high forage values and are found within desired distances to cover and roads. As previously noted, we were most interested in vegetation communities that have either existing "**high value elk habitat**" (fv>0.8 and hsi>0.7) or "**high restoration potential**" (potential fv>0.8 and potential hsi>0.7)*;* we believed these areas would basically be the "cream of the crop" habitats most sought by elk and provide the best opportunity for successful elk habitat restoration. This step allowed us to locate polygons (sites or stands) where habitat structural manipulation would result in forage value score and habitat suitability index score increased to a very high level. The Douglas-fir – black oak community can be used to illustrate how "restoration potential" might be achieved in the following simplistic example. Mature stands of the Douglas-fir – black oak community have a grass/forb groundcover, which is often suppressed by shading from a dense conifer tree canopy. If the overstory structure of Douglas-fir is reduced, the highly palatable, nutritious grass/forb groundcover vegetation is stimulated or "released". The deciduous oaks have a relatively low leaf-area index and allow for high cover of grasses and forbs. The increased canopy cover and crown ratios of the oaks will also increase mast production.

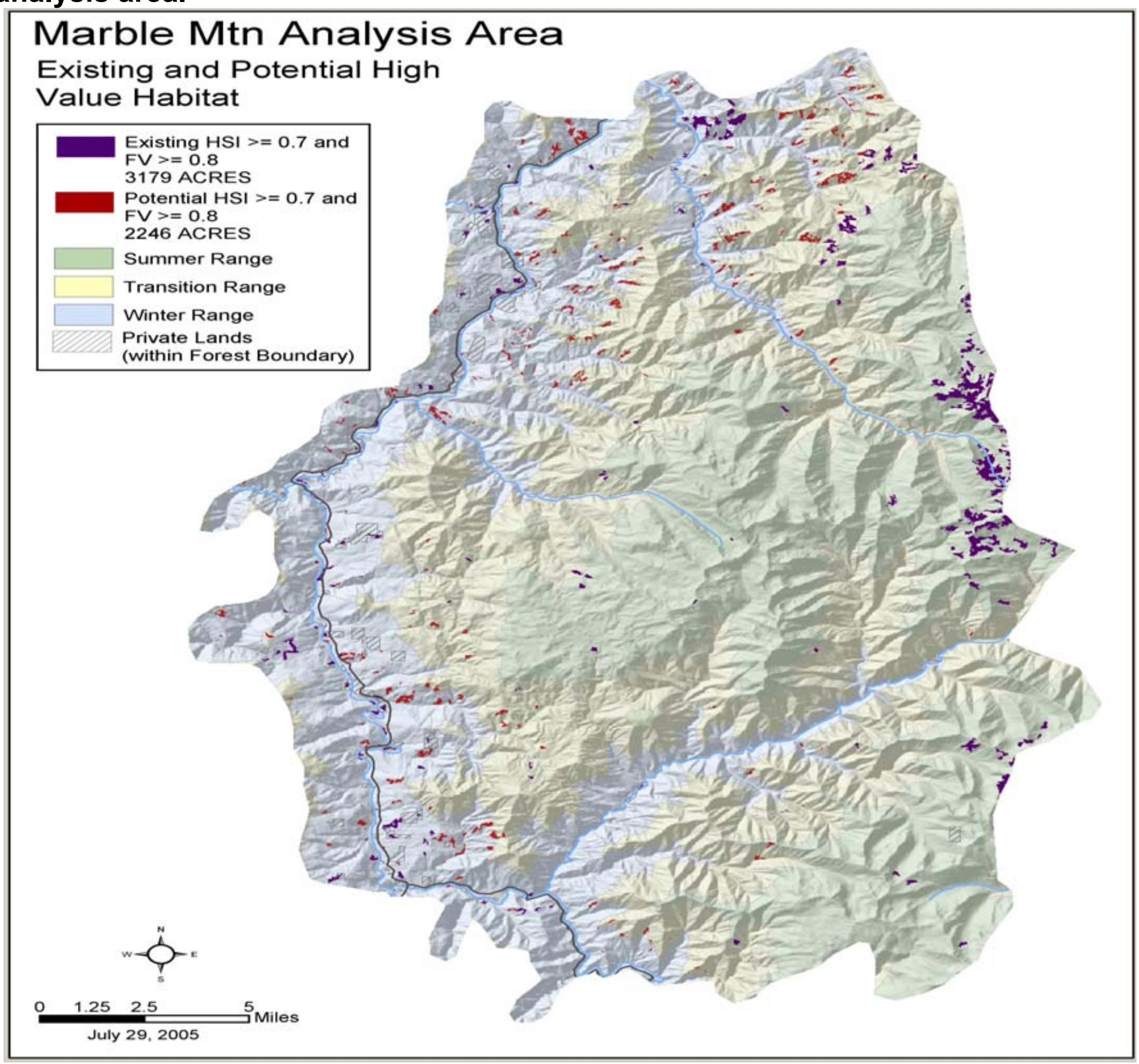
Results

Marble Mtn. analysis area had high average cover values in each of the seasonal ranges (Table 4 and Figures 7, 8 and 9). That high cover value, conversely, results in relatively low scores for forage value. Basically, much of the habitat is densely forested in each of the seasonal ranges and the dense overstory canopy shading restricts growth of forage species. Winter range forage value in this analysis area is lower than that found in any of the other analysis areas (Figure 7).

The analysis identified 3179 acres of existing "high value elk habitat" found in 613 vegetation community polygons. High value habitat is defined as having a forage value >= 0.8 and a habitat suitability score of >= 0.7. The greatest proportion of existing high value elk habitat is in higher elevation summer and transitional ranges (Figure 3). There is proportionally very little of this high value habitat (only 879 acres) in the low elevation winter range. Those high value habitats in winter range were also much smaller in average size (averaging less than 3 acres per polygon) than high value habitats in either transition range (nearly 6 acres average) or summer range (over 10 acres average).
We also located an additional 2246 acres of "high restoration potential" distributed in 21 vegetation community types (Table 3). Little of that restoration potential can be found in

the summer range. A consideration for restoration potential in the summer range would be to look at conifer encroachment in both wet and dry meadows. The great majority of the potential is in the winter range where nearly 1300 additional acres could be modified to produce “high value elk habitat” (Figure 3). There is significant restoration potential in the transition range, where over 900 acres could be modified to produce “high value elk habitat”.

Figure 3. Existing and potential “high value elk habitat” in Marble Mountain analysis area.

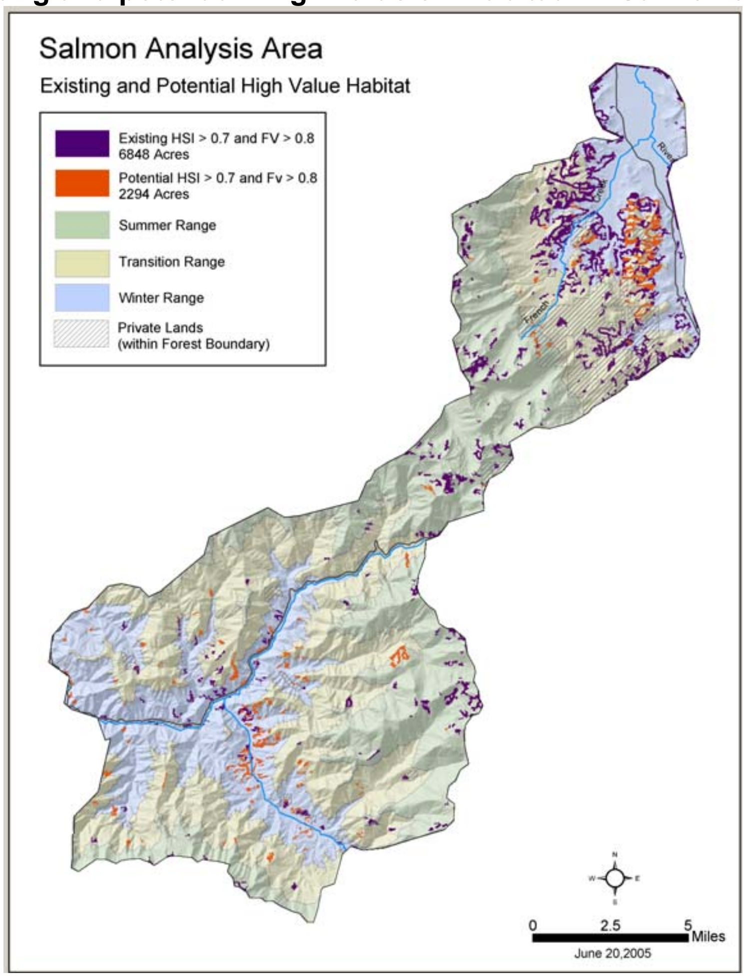


Salmon analysis area exhibited winter range with relatively high forage value and low habitat distribution value. This result is possibly related to the amount of winter range that is provided by Scott Valley ranch land within the analysis area, where forage is a long distance from available cover, yielding low HDV scores.

The analysis identified 6848 acres of existing “high value elk habitat” found in 1245 vegetation community polygons (Figure 4). Over sixty percent of the existing high value habitat is located on private lands in and around Scott Valley and its foothills. That habitat is dominated by winter and transition range. The high value habitat in existing summer range (nearly 1600 acres) is almost entirely in public ownership.

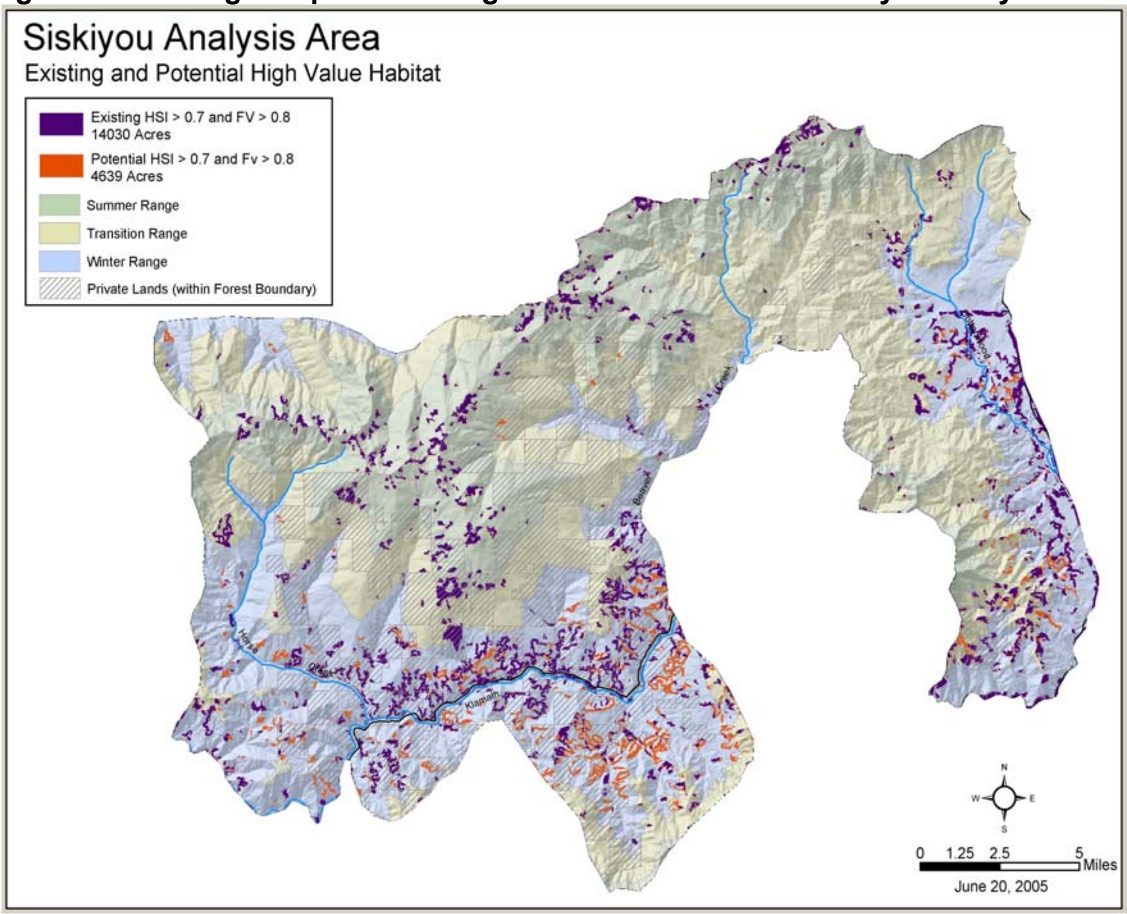
We also found an additional 2294 acres of “high restoration potential” located mostly on public lands especially in winter range along the upper South Fork Salmon River. High value habitats could be more than doubled in the publicly owned winter and transition ranges using the appropriate types of habitat modifications. The amount of high value habitat in those ranges could be increased from the current 1089 acres to over 2300 acres with appropriate actions. Opportunities for modifications on private lands to create additional high value elk habitat are also substantial at over 800 acres.

Figure 4. Existing and potential “high value elk habitat” in Salmon analysis area.



Siskiyou analysis area transition range exhibited the lowest mean forage value of any of the seasonal ranges analyzed. Similar to the Marble Mtn. analysis area, this transition range habitat is densely forested and the dense overstory canopy shading restricts forage growth. The analysis identified 14,030 acres of existing “high value elk habitat” found in 2,998 vegetation community polygons (Figure 5). We also located an additional 4,639 acres of “high restoration potential” habitat divided between public (2430 acres) and private (2209 acres) ownerships. Those sites with high restoration potential are predominantly in the winter range and if modifications were implemented, the high value habitat could be increased by over 50%.

Figure 5. Existing and potential "high value elk habitat" in Siskiyou analysis area.



Goosenest analysis area winter range forage exhibited the highest mean value (FV = 0.766) of any of the ranges analyzed Table 4. However, that same winter range also had the lowest mean cover value (CV = 0.128) and correspondingly the poorest current habitat suitability index of any of the ranges analyzed. Goosenest winter range is predominated by private agricultural and grazing land, accounting for the high quality of forage available and the poor associated cover. The analysis identified 58,057 acres of existing "high value elk habitat" found in 10,056 vegetation community polygons (Figure 6). We located only 2367 acres of additional "high restoration potential" habitat.

Figure 6. Existing and potential "high value elk habitat" in Goosenest analysis area.

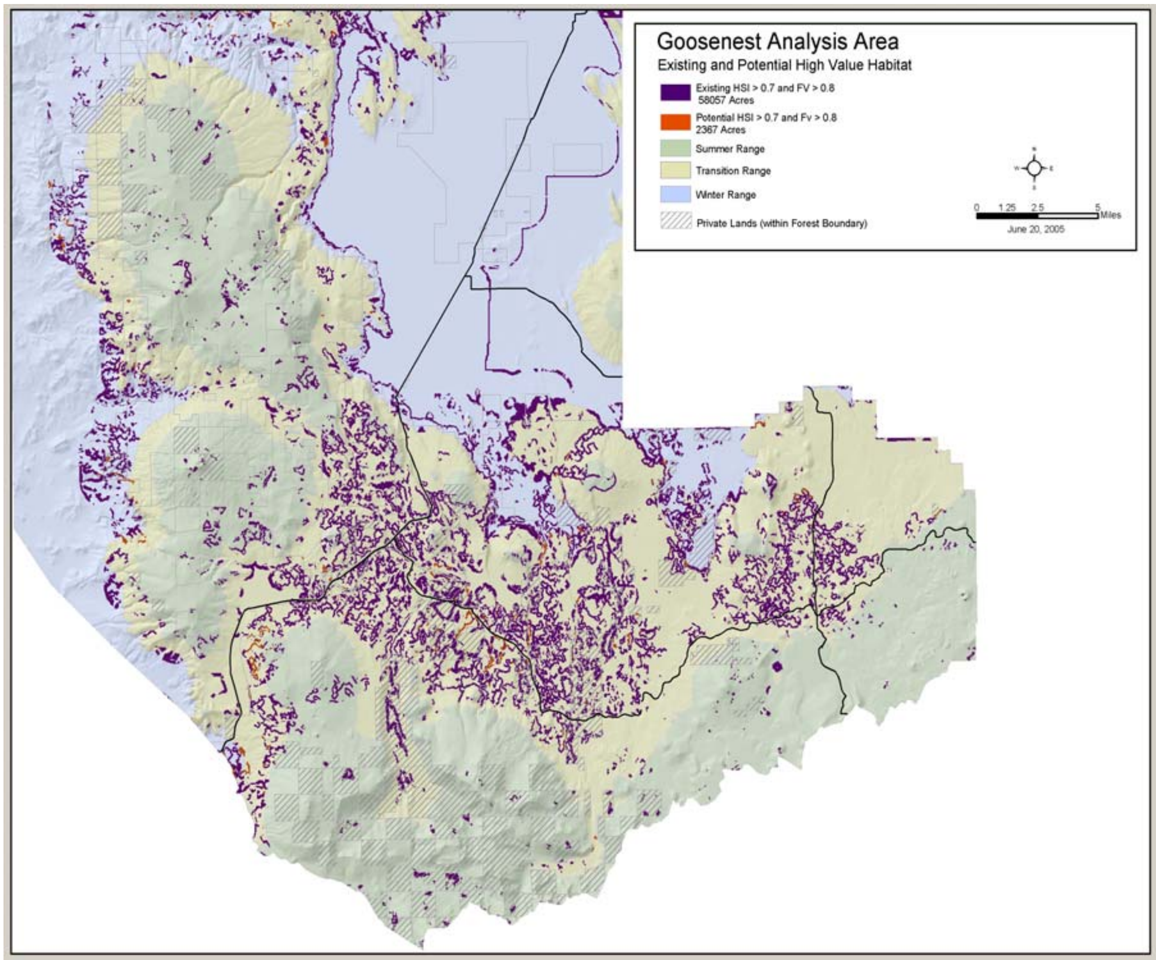


Table 4. Current average elk habitat forage value (FV), cover value (CV), distribution value (HDV), and suitability index (HSI) score of seasonal ranges within and adjacent to Klamath National Forest.

Seasonal Elk Range	Acres	Mean FV	Mean CV	Mean HDV	Mean HSI
Marble Winter	96968	.471	.654	.960	.606
Marble Transition	111991	.459	.717	.986	.616
Marble Summer	87177	.464	.619	.955	.593
Salmon Winter	38768	.578	.470	.781	.597
Salmon Transition	52609	.505	.656	.962	.626
Salmon Summer	39683	.470	.645	.962	.603
Siskiyou Winter	90426	.599	.473	.867	.628
Siskiyou Transition	80418	.446	.737	.982	.611
Siskiyou Summer	50410	.474	.631	.964	.603
Goosenest Winter	162316	.766	.128	.381	.562
Goosenest Transition	230400	.693	.316	.739	.627
Goosenest Summer	176798	.534	.453	.917	.594

Figure 7. Percent of elk winter range currently considered high quality habitat in each of four analysis areas on Klamath National Forest.

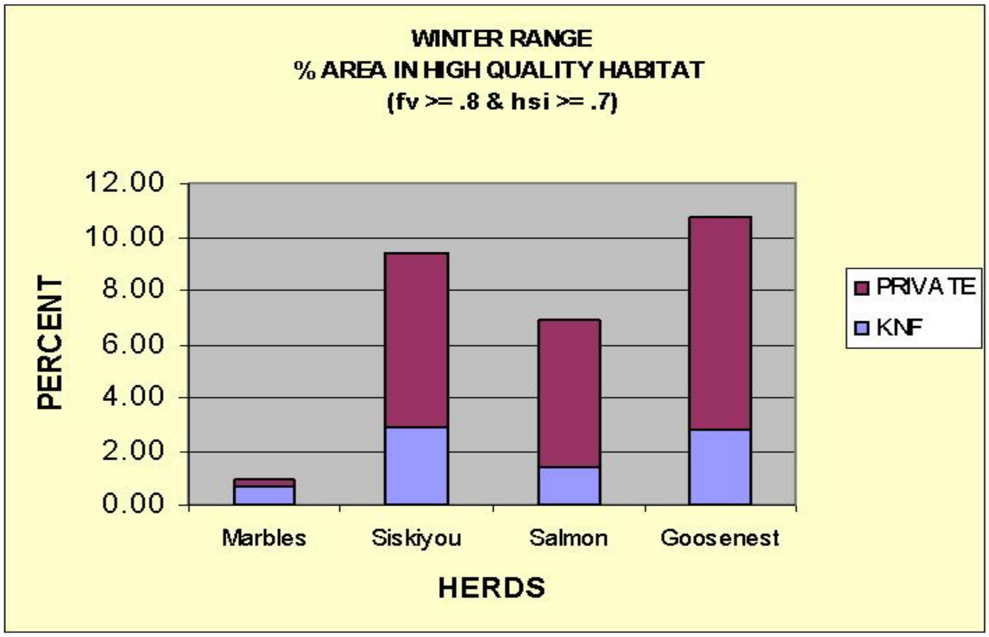


Figure 8. Percent of elk transition range currently considered high quality habitat in each of four analysis areas on Klamath National Forest.

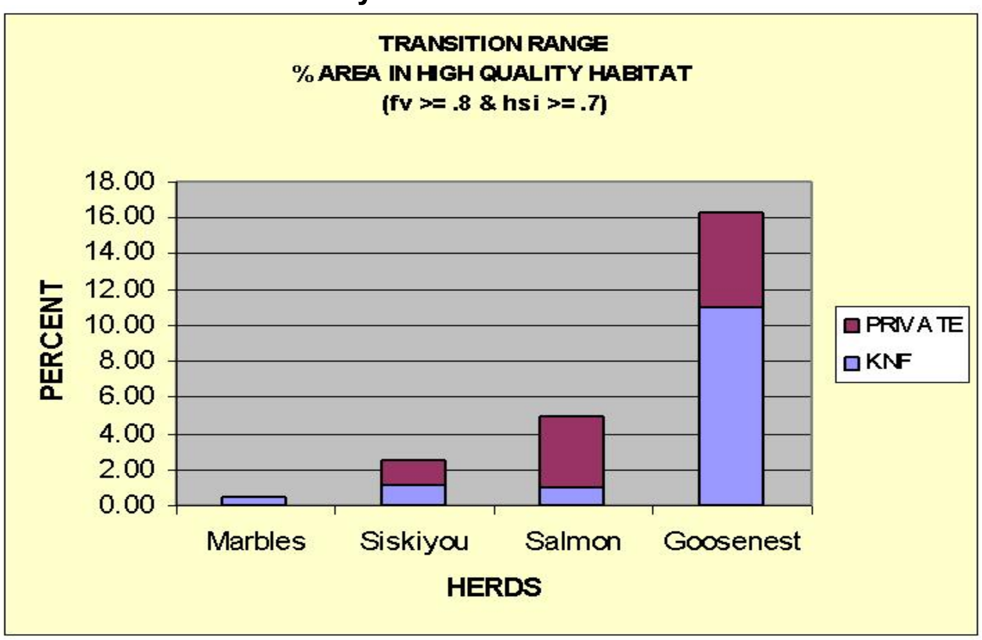
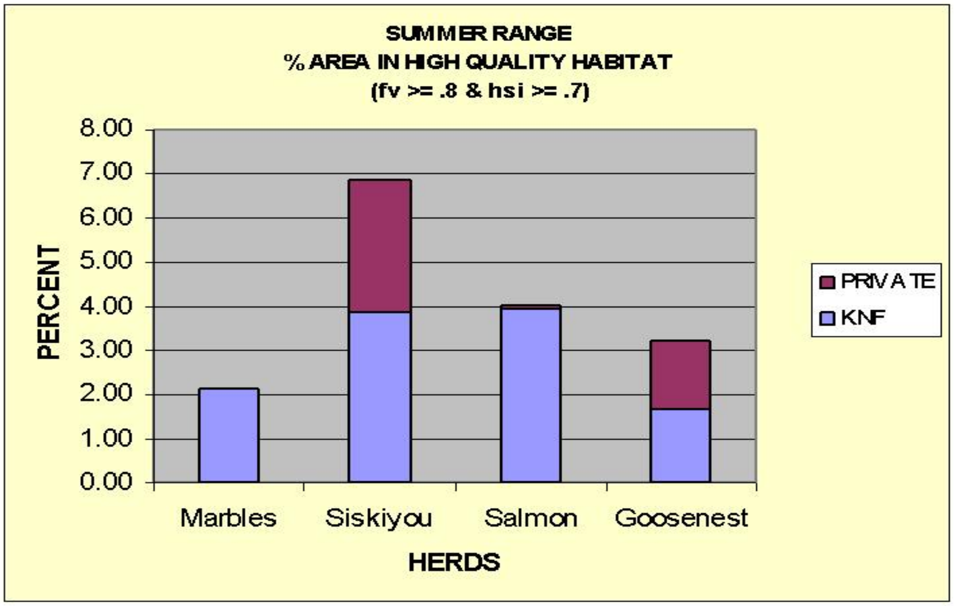


Figure 9. Percent of elk summer range currently considered high quality habitat in each of four analysis areas on Klamath National Forest.



Discussion of Habitat Objectives and Opportunities

We assumed that habitat modifications appropriate to each community type would result in realization of high value elk habitat where there was high restoration potential. Where grasses are the primary vegetation component (e.g. wet meadows), the existing FV (forage value) and HSI (habitat suitability index) scores were assumed to be high. Many high elevation (summer range) grass-forb dominated ecosystems (dry and wet meadows) have experienced conifer encroachment in recent decades and would benefit from prescribed fire or other restoration methods (Murray, 2003).

The size and number of openings within the forest matrix has declined over the last half century (Skinner 1995). Restoration potential was assumed to be high where grass and forb species comprise the understory vegetation (many of the conifer communities) and habitat modifications such as conifer overstory reduction would stimulate grass/forb production and result in high value elk habitat.

Vegetation communities with a deciduous oak component (California black oak and Oregon white oak) where conifer presence has taken on dominance would benefit from habitat modification (conifer overstory reduction) to release understory grass/forb vegetation and increase mast production resulting in higher value elk habitat.

Shrub dominated communities were assumed to be in a decadent condition that could be rejuvenated by burning or similar disturbance to produce younger, palatable forage of a higher nutritional value resulting in high value elk habitat. Old-growth conifer stands often contain shrubs and herbs in higher cover than younger mature stands and understory thinning treatments or prescribed fire can increase the abundance, palatability and/or nutritive quality of the forage.

A caveat applies to over reliance on outputs of the HSI Model; the outputs are only as good as the vegetation type map that the model uses for inputs. The CALVEG map is intended for use for Regional or Forest level analyses. With the aggregation of vegetation types done for the model it may be appropriate for use at the watershed scale. However, results are most meaningful for comparison of herd values across the Forest. At Ranger District, watershed, or project level, it is encouraged to solicit local data or expert assessments on elk use patterns and areas of deficiency, understanding how habitat components interact to produce highly suitable habitat. Expert opinion was used in western Oregon to evaluate the predictive reliability of a habitat effectiveness model for elk. Ratings of 21 of the 25 experts were significantly correlated with model output suggesting that with certain habitats expert opinion is a reliable predictor of model output (Holthausen et. al. 1994). Telemetry data showing how elk use the habitat are available for the Goosenest herds, but are generally lacking for the Marble Mountain herds. To fill this information gap, local observations and expert opinion may prove valuable in designing effective elk habitat restoration projects.

Restoration Opportunity Focus

The results of this strategy are useful only if applied in a focused manner.
The primary focus of restoration opportunities should be on the most limiting seasonal habitat type in each respective analysis area. GIS shape files that display restoration potential, transportation systems, and existing vegetation should be used to group similar potential vegetation polygons that warrant similar treatments and achieve cost efficiency. The transportation system shape file simply outlines any access issues or road density problems. Treatments should be prioritized within polygons that have high restoration potential.

Analysis area potential restoration opportunities that warrant more detailed investigation are suggested as follows:

The **Marble Mountain** Analysis area has limited forage value in the winter range. The opportunity to increase forage value of the winter range can be realized by reducing conifer basal area and canopy closure in high restoration potential polygons that have black oak or white oak components in the stand.

The **Goosenest Analysis** area has limited forage value in the transition range, particularly in the area near Grass Lake. The opportunity to increase forage value of the transition range can be realized by modifying shrub community age structure to improve palatability and nutritive value.

The **Salmon Analysis** area has limited forage value in the winter range on federally managed lands (private lands currently provide most quality winter range). The opportunity to increase forage value and reduce depredation on private property can be realized by reducing conifer basal are and canopy closure in high restoration potential polygons that have black oak or white oak stand components.

The **Siskiyou Analysis** area has limited forage value in the winter range. There is opportunity to increase forage value by reducing conifer stocking levels within existing conifer plantations.

Elk Habitat Objectives by Vegetation Community Type, Herd, and Range
The nutritive value and quantity of forage can have a strong influence on the number of animals that breed and successfully reproduce (Toweil and Thomas. 2002). The weighting of the forage value in the habitat suitability model as well as the following objectives addresses the need to strive for nutritionally optimum environments.

Herbaceous vegetation communities

- Create or re-establish meadows or grasslands in landscapes deficient in such communities (based on historical range of variability). Emphasize small (< 40 ac.) and irregular shaped meadow/grasslands where security cover is within 600 feet, and south-facing moderate slopes where early green-up will enhance optimal benefits. Historical reference conditions include Wieslander VTM maps, Fire Regime Condition Class maps, historical photographs and anthropological accounts.
- Control conifer encroachment within existing meadow areas and/or increase size to mimic historic size (emphasis on dry meadows).
- Prevent over utilization by cattle and manage cattle allotments to minimize competition during critical late summer-early fall use.
- Maintain or enhance proper functioning condition of wet meadows (Riparian Area Management; B.L.M. TR 1737-9).
- Provide adjacent security cover where deficient.
- Select for or promote those species with high palatability and nutritive content (Appendix).

Shrub vegetation communities

- Establish and maintain acres of shrub communities or shrub seral stages in proportion with historical range of variability.
- Establish age class diversity (25% early, 50% mid, 25% mature)(KNF, LRMP)
- Prevent conifer canopy encroachment and closure in shrub communities managed for the long term.
- Prevent over utilization.
- Promote desirable species in shrub overstory and herbaceous under story.

Hardwood vegetation communities

- Establish and maintain acres of hardwood communities or hardwood seral stages in proportion with historical range of variability.
- Prevent or reduce conifer encroachment.
- Promote desirable herbaceous understory vegetation.
- Retain desirable hardwood species. Desirability is defined as ability to produce palatable leafy forage or mast, and/or support a grass-forb understory.
- Encourage basal sprouting and increased mast production by maintaining appropriate crown size and ratio.
- Prevent over utilization of riparian-associated hardwood species (willow, aspen, maple, etc.).

Conifer vegetation communities

- Increase forage production by reducing canopy closure while keeping forage proximal to cover (within 100 meters of cover).
- Create canopy gap openings with opening size averaging 4 acres or less and designed to maximize edge. Canopy gaps will emphasize desirable shrub and herbaceous species.
- Promote desirable understory hardwood, shrub and herbaceous vegetation. Recent sprouts of some hardwood species, e.g. canyon live oak, provide valuable winter forage.

Information Needs

Landscape and population connectivity.
Loss of landscape connectivity and the fragmentation of habitats are major threats to the biodiversity of plant and animal life in northern California. Large mammals such as elk are spatially dominating species requiring vast interconnected regions for maintaining the genetic diversity of healthy populations. Elk in the Klamath Mountains are partially migratory with the majority of individuals making altitudinal shifts between winter and summer ranges. Occasional movements of distances over 140 miles (DFG unpublished data) suggests the capability and need for elk to disperse into new environments or interchange with distant populations. It is important to identify movement corridors for elk so that the connectivity of landscapes can be understood, potential barriers to populations prevented, and strategies for conservation prioritized.

Vegetation change detection.
Need better information on changes in vegetation composition and structure from present to past, including pre-European settlement conditions. Particular emphasis on seral stage distributions and meadow size needed. This can be tied into the reference condition needs for Fireshed analyses.

Meadow utilization capacity (ungulates).
Need better information on how best to manage to reduce the temporal, spatial and resource competition between native and non-native herbivores

Influences of harvest strategies on population dynamics
The impacts of selective harvest strategies on the population demographics of elk have been widely speculated but poorly documented. Since the 1996 inception of the Marble Mountain elk hunt a limited either-sex harvest has removed 197 elk of which >90% have been males. The Siskiyou Elk hunt was established in 1994 and has harvested >100 elk of which >70% have been male. Understanding the influences of harvest and hunter density on the productivity, survival, and age structure of local populations is important for assessing management objectives and gauging changes in harvest strategies.

Evaluate effectiveness of current monitoring.

Determine desired herd size for appropriate landscape.
Balancing the need for accurate estimates of wild ungulate populations with rising survey costs continues to challenge wildlife agencies. Elk populations on the Klamath National Forest occur in remote and topographically diverse environments predominated by dense and closed canopy forests where clumped distributions and reduced sightability prevent commonly used survey techniques for estimating populations. Developing innovative and cost effective methods for estimating elk abundance is important for conservation and population management, and can provide understanding of resource partitioning and potential impacts to habitats by herbivores.

Model validation.
Assumptions within the model that should receive review include patterns of seasonal range use, forage values associated with vegetation types or species, relative importance of forage contributions by seasonal range types with respect to health and productivity of herds. and connectivity corridors, and calving areas identified with satellite telemetry.

Monitor effectiveness of treatments and elk use.
Monitor response of vegetation to treatments and associated use by elk.

Preferred forage species, their nutritional value, associated plant communities and spatial distribution.
Current information comes from literature, none of which was published from studies within the bioregion that includes the Klamath National Forest. The closest studies on foraging were done in Redwood N. P. and Oregon Coast Range. Although similarities exist, there are many different plant communities found on Klamath N. F. and the spatial distribution and abundance differs.

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APPENDICES

Appendix A. Arc/Info aml used for crosswalking existing vegetation (CalVeg) to ArcHSI covertype categories. “Covertype” and “Vegtype” are attributes in the CalVeg data table and represent broad covertypes and vegetation communities, respectively. See the Region 5 Remote Sensing Lab website, www.fs.fed.us/r5/rsl for documentation describing these attributes.

```
/*Assign covertype (CT) based on RSL vegtype (CalVeg) and
/* Associated forage value potential (usually highest for structural stage A)
/* April 20, 2005
/* Revised May 11, 2005 - Max Creasy

/*Barren
res covertype in {'BAR','BA'}
calc ct = 'BAR'
asel

res covertype = 'URB'
calc ct = 'URB'
asel

res covertype = 'WAT'
calc ct = 'WAT'
asel

/*Agriculture
res covertype = 'AGR'
calc ct = 'AGR'
asel

/*herbaceous
res covertype = 'HEB'
calc ct = 'HEB'
asel

/*shrubs
res vegtype in {'BB'}
calc ct = 'SH1'
asel
res vegtype in {'BS','CJ'}
calc ct = 'SH9'
asel
res vegtype in {'CQ','CS','CV','WM'}
calc ct = 'SH8'
```

```
asel
res vegtype in {'BM','BX','CH','CM','CX','TA'}
calc ct = 'SH7'
asel
res vegtype in {'BL','CL','SS''SS'}
calc ct = 'SH6'
asel
res vegtype in {'BR'}
calc ct = 'SH5'
asel
res vegtype in {'CG','CN','CW'}
calc ct = 'SH4'
asel

/*Hardwoods
res vegtype in {'QT'}
calc ct = 'HW5'
asel
res vegtype in {'QC','QE','QR','TC','TX'}
calc ct = 'HW6'
asel
res vegtype in {'QF','QH','TA','QM','QO','QX','WL'}
calc ct = 'HW7'
asel
res vegtype in {'QG','QK','QQ','QY','NR'}
calc ct = 'HW8'
asel

/*conifers with hardwood component


res vegtype in {'DF','DG','DW','EP','KP','JP','MF','MK','MP','PD','PP','WJ'}
res vegtype2 in {'CX','CQ','QC','QM','QT','TC','TX'}
calc ct = 'CH7'
asel

res vegtype in {'DF','DP','DW','EP','JP','KP','MF','MK','MP','PD','PP','WJ'}
res vegtype2 in {'HG','NR','QG','QK'}
calc ct = 'CH8'
asel


/*Conifer with no hardwood component

res vegtype in {'EP','JP','PP','SA'}
res ct = ''
calc ct = 'CF8'
asel
```

```
res vegtype in {'DP','DW','MF','MK','MP','MU',~
'PD','PO','PW','WJ'}
res ct = ''
calc ct = 'CF7'
asel

res vegtype in {'DF','DG','KP','RD','RF','WF','WW'}
res ct = ''
calc ct = 'CF6'
asel

res vegtype in {'LP','MH','MO','MM','PB'}
res ct = ''
calc ct = 'CF5'
asel

res area < 0
calc ct = ''
asel
```

Appendix B. Crosswalk used to assign forage value (FV) and cover value (CV) to polygons based on covertype and structural stage (COVSS) for ArcHSI model.

SP	SP_ABBR	SEASON	S_ABBR	COVTYPE	STAGE	COVSS	FV	CV
Elk	Elk	Year	Yr	Barren	0	BAR00	0	0
Elk	Elk	Year	Yr	Water	0	WAT00	0	0
Elk	Elk	Year	Yr	Urban	0	URB00	0	0
Elk	Elk	Year	Yr	Agriculture	1	AGR01	0.9	0
Elk	Elk	Year	Yr	Grass/Herb	1	HEB01	1	0
Elk	Elk	Year	Yr	Shrubs fv 8	2	SH802	0.8	0
Elk	Elk	Year	Yr	Shrubs fv 7	2	SH702	0.7	0
Elk	Elk	Year	Yr	Shrubs fv 6	2	SH602	0.6	0
Elk	Elk	Year	Yr	Shrubs fv 5	2	SH502	0.5	0
Elk	Elk	Year	Yr	Hardwoods fv 8	2	HW802	0.8	0
Elk	Elk	Year	Yr	Hardwoods fv 8	3A	HW83A	0.8	0.2
Elk	Elk	Year	Yr	Hardwoods fv 8	3B	HW83B	0.7	0.5
Elk	Elk	Year	Yr	Hardwoods fv 8	3C	HW83C	0.6	1
Elk	Elk	Year	Yr	Hardwoods fv 8	4A	HW84A	0.8	0.2
Elk	Elk	Year	Yr	Hardwoods fv 8	4B	HW84B	0.7	0.5
Elk	Elk	Year	Yr	Hardwoods fv 8	4C	HW84C	0.6	1
Elk	Elk	Year	Yr	Hardwoods fv 7	2	HW702	0.8	0
Elk	Elk	Year	Yr	Hardwoods fv 7	3A	HW73A	0.7	0.2
Elk	Elk	Year	Yr	Hardwoods fv 7	3B	HW73B	0.5	0.5
Elk	Elk	Year	Yr	Hardwoods fv 7	3C	HW73C	0.3	1
Elk	Elk	Year	Yr	Hardwoods fv 7	4A	HW74A	0.7	0.2
Elk	Elk	Year	Yr	Hardwoods fv 7	4B	HW74B	0.5	0.5
Elk	Elk	Year	Yr	Hardwoods fv 7	4C	HW74C	0.3	1
Elk	Elk	Year	Yr	Hardwoods fv 6	2	HW602	0.8	0
Elk	Elk	Year	Yr	Hardwoods fv 6	3A	HW63A	0.6	0.2
Elk	Elk	Year	Yr	Hardwoods fv 6	3B	HW63B	0.5	0.5
Elk	Elk	Year	Yr	Hardwoods fv 6	3C	HW63C	0.2	1
Elk	Elk	Year	Yr	Hardwoods fv 6	4A	HW64A	0.6	0.2
Elk	Elk	Year	Yr	Hardwoods fv 6	4B	HW64B	0.4	0.5
Elk	Elk	Year	Yr	Hardwoods fv 6	4C	HW64C	0.2	1
Elk	Elk	Year	Yr	Hardwoods fv 5	2	HW502	0.8	0
Elk	Elk	Year	Yr	Hardwoods fv 5	3A	HW53A	0.5	0.2
Elk	Elk	Year	Yr	Hardwoods fv 5	3B	HW53B	0.3	0.5
Elk	Elk	Year	Yr	Hardwoods fv 5	3C	HW53C	0.2	1
Elk	Elk	Year	Yr	Hardwoods fv 5	4A	HW54A	0.5	0.2
Elk	Elk	Year	Yr	Hardwoods fv 5	4B	HW54B	0.3	0.5
Elk	Elk	Year	Yr	Hardwoods fv 5	4C	HW54C	0.2	1
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	2	CH702	0.8	0
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	3A	CH73A	0.7	0.3
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	3B	CH73B	0.5	0.7
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	3C	CH73C	0.3	1
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	4A	CH74A	0.7	0.3
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	4B	CH74B	0.5	0.7
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	4C	CH74C	0.3	1
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	5A	CH75A	0.8	0.3
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	5B	CH75B	0.7	0.7

SP	SP_ABBR	SEASON	S_ABBR	COVTYPE	STAGE	COVSS	FV	CV
Elk	Elk	Year	Yr	Conifer/Hardwood fv 7	5C	CH75C	0.5	1
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	2	CH802	0.8	0
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	3A	CH83A	0.8	0.3
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	3B	CH83B	0.7	0.7
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	3C	CH83C	0.3	1
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	4A	CH84A	0.8	0.3
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	4B	CH84B	0.7	0.7
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	4C	CH84C	0.3	1
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	5A	CH85A	0.8	0.3
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	5B	CH85B	0.7	0.7
Elk	Elk	Year	Yr	Conifer/Hardwood fv 8	5C	CH85C	0.5	1
Elk	Elk	Year	Yr	Conifer fv 5	2	CF502	0.8	0
Elk	Elk	Year	Yr	Conifer fv 5	3A	CF53A	0.5	0.2
Elk	Elk	Year	Yr	Conifer fv 5	3B	CF53B	0.4	0.5
Elk	Elk	Year	Yr	Conifer fv 5	3C	CF53C	0.2	1
Elk	Elk	Year	Yr	Conifer fv 5	4A	CF54A	0.5	0.2
Elk	Elk	Year	Yr	Conifer fv 5	4B	CF54B	0.4	0.5
Elk	Elk	Year	Yr	Conifer fv 5	4C	CF54C	0.2	1
Elk	Elk	Year	Yr	Conifer fv 5	5A	CF55A	0.5	0.2
Elk	Elk	Year	Yr	Conifer fv 5	5B	CF55B	0.4	0.5
Elk	Elk	Year	Yr	Conifer fv 5	5C	CF55C	0.3	1
Elk	Elk	Year	Yr	Conifer fv 6	2	CF602	0.8	0
Elk	Elk	Year	Yr	Conifer fv 6	3A	CF63A	0.6	0.2
Elk	Elk	Year	Yr	Conifer fv 6	3B	CF63B	0.5	0.5
Elk	Elk	Year	Yr	Conifer fv 6	3C	CF63C	0.3	1
Elk	Elk	Year	Yr	Conifer fv 6	4A	CF64A	0.6	0.2
Elk	Elk	Year	Yr	Conifer fv 6	4B	CF64B	0.5	0.5
Elk	Elk	Year	Yr	Conifer fv 6	4C	CF64C	0.3	1
Elk	Elk	Year	Yr	Conifer fv 6	5A	CF65A	0.8	0.2
Elk	Elk	Year	Yr	Conifer fv 6	5B	CF65B	0.7	0.5
Elk	Elk	Year	Yr	Conifer fv 6	5C	CF65C	0.5	1
Elk	Elk	Year	Yr	Conifer fv 7	2	CF702	0.8	0
Elk	Elk	Year	Yr	Conifer fv 7	3A	CF73A	0.7	0.2
Elk	Elk	Year	Yr	Conifer fv 7	3B	CF73B	0.6	0.5
Elk	Elk	Year	Yr	Conifer fv 7	3C	CF73C	0.3	1
Elk	Elk	Year	Yr	Conifer fv 7	4A	CF74A	0.7	0.2
Elk	Elk	Year	Yr	Conifer fv 7	4B	CF74B	0.6	0.5
Elk	Elk	Year	Yr	Conifer fv 7	4C	CF74C	0.3	1
Elk	Elk	Year	Yr	Conifer fv 7	5A	CF75A	0.8	0.2
Elk	Elk	Year	Yr	Conifer fv 7	5B	CF75B	0.7	0.5
Elk	Elk	Year	Yr	Conifer fv 7	5C	CF75C	0.5	1
Elk	Elk	Year	Yr	Conifer fv 8	2	CF802	0.8	0
Elk	Elk	Year	Yr	Conifer fv 8	3A	CF83A	0.8	0.2
Elk	Elk	Year	Yr	Conifer fv 8	3B	CF83B	0.7	0.5
Elk	Elk	Year	Yr	Conifer fv 8	3C	CF83C	0.5	1
Elk	Elk	Year	Yr	Conifer fv 8	4A	CF84A	0.8	0.2
Elk	Elk	Year	Yr	Conifer fv 8	4B	CF84B	0.7	0.5
Elk	Elk	Year	Yr	Conifer fv 8	4C	CF84C	0.5	1
Elk	Elk	Year	Yr	Conifer fv 8	5A	CF85A	0.8	0.2
Elk	Elk	Year	Yr	Conifer fv 8	5B	CF85B	0.7	0.5
Elk	Elk	Year	Yr	Conifer fv 8	5C	CF85C	0.5	1

Appendix C. Arc/Info AML used for crosswalking existing vegetation polygon size and density to structural stage (SST) for ArcHSI model.

```
 /*Assign Structural Stage (SST)
/*for RSL vegetation types to run in ArcHSI model
/* April 20, 2005

asel

/*shrub seedling
res covertype in {'SHB','CHP','SCH','SSB'}
calc sst = '02'
asel
res size in {'0','X','N'}
calc sst = '02'
asel
res size = '_' and density = '_'
res origin > 95
calc sst = '02'
asel
res size = '_' and density = '_'
res origin < 96
calc sst = '3A'
asel
res size = '_' and density = '_'
res origin = 0
calc sst = '02'
asel

/*Barren
res covertype in {'BAR','WAT','URB'}
calc sst = '00'
asel

/*Agriculture
res covertype = 'AGR'
calc sst = '01'
asel

/*herbaceous
res covertype in {'HEB','HER'}
calc sst = '01'
asel


/*sapling pole
res size in {'1','2'} and density in {'X','0','1','2','3'}
```

```
calc sst = '3A'
asel
res size in {'1','2'} and density in {'4','5','6'}
calc sst = '3B'
asel
res size in {'1','2'} and density in {'7','8','9'}
calc sst = '3C'
asel

/*mature
res size in {'3','4'} and density in {'X','0','1','2','3'}
calc sst = '4A'
asel
res size in {'3','4'} and density in {'4','5','6'}
calc sst = '4B'
asel
res size in {'3','4'} and density in {'7','8','9'}
calc sst = '4C'
asel

/*old growth
res size in {'5','6'} and density in {'X','0','1','2','3'}
calc sst = '5A'
asel
res size in {'5','6'} and density in {'4','5','6'}
calc sst = '5B'
asel
res size in {'5','6'} and density in {'7','8','9'}
calc sst = '5C'
asel

res area < 0
calc sst = ''
asel
```

Appendix D. Arc/Info AML used to modify covertype values for recalculation of ArcHSI to simulate habitat restoration potential.

```
/* First, Identity veg coverage with slapt_p (slope/aspect coverage) to create vegslap
/*Alter item name “grid-code” to “slapt”

/**** Restore TX (mixed hardwoods) and QO (willow) restoration values******
Res vegtype = ‘TX’ or vegtype2 = ‘TX’
Calc restoration = 0.7
Asel

/*****Polygons of existing riparian hardwoods or QG, QK but conifer dominant***
Res restoration ge 0.8
Res ct = ‘CH7’ and sst nc ‘5’
Calc ct = ‘HW8’
Asel

/**Areas with shrubs that could have grass component or need to be maintained for vigor**
Res  restoration > 0.79 and restoration < 0.89 and ct cn ‘SH’
Calc ct = ‘SH8’
Asel
Res  restoration > 0.89 and restoration < 0.99 and ct cn ‘SH’
Res ct nc ‘SH1’
Calc ct = ‘SH9’
Asel

/*****Change DFQC based on slapt ************
Res vegtype = ‘DF’ and vegtype2 = ‘QC’ and slapt in {9,10,11,12,13}
Calc restoration = 0.8
Res sst ne ‘5’
Calc ct = ‘HW8’
Asel

/******For Goosenest vegetation data

Res calveg in {‘QK’,’QC’} and lifeform = ‘CON’
Res sst nc ‘5’
Calc ct = ‘HW8’
Asel
Res calveg = ‘BB’ and lifeform = ‘CON’
Calc ct = ‘CF8’
Asel

/**Goosenest polygons with shrubs that could have grass component or need to be maintained for vigor**
```

```
Res  restoration > 0.79 and restoration < 0.89 and ct cn ‘SH’
Calc ct = ‘SH8’
Asel
Res  restoration > 0.89 and restoration < 0.99 and ct cn ‘SH’
Res ct nc ‘SH1’
Calc ct = ‘SH9’
Asel
```

Appendix E. Relative seasonal use and values of forage plants eaten by Roosevelt elk: 1.00 (light use, limited value); 2.00 (moderate use, valuable); 3.00 (high use, very valuable). (adapted from Toweill and Thomas, 2002)

Common Name	Lifeform	Winter Use	Winter Value	Spring Use	Spring Value	Summer Use	Summer Value	Autumn Use	Autumn Value
Ladyfern	fern	2.00	2.00	2.00	2.00				
Deerfern	fern	1.33	1.00	1.50	2.00				
Western swordfern	fern	1.80	2.00	1.80	2.00	1.40	2.00	1.40	2.00
western bracken	fern	1.33	1.00	1.50	2.00	1.67	2.00	1.00	1.00
Pearly-everlasting	forb					1.00	1.00		
Sea-watch	forb			2.00	2.00				
Bigleaf sandwort	forb	2.00	2.00	2.00	2.00				
Pacific bleedingheart	forb					1.00	1.00	1.75	2.00
Fireweed	forb					1.00	1.00		
Smooth willowweed	forb					2.33	3.00	2.33	3.00
Watson willowweed	forb					1.00	1.00		
Horsetail	forb			1.00	1.00	1.00	1.00		
Common cowparsnip	forb			2.00	2.00	3.00	3.00		
Spotted catsear	forb			2.00	2.00	2.00	2.00		
Sea lovage	forb	2.67	3.00	2.33	3.00	2.60	3.00	2.00	2.00
Lupine	forb							1.00	1.00
Nootka lupine	forb					2.00	2.00		
Indian lettuce	forb					2.00	2.00		
Siberian montia	forb	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00
Oregon oxalis	forb	2.00	2.00	2.00	2.00	1.75	2.00	1.75	2.00
Buckhorn plantain	forb			1.00	1.00	2.00	2.00	2.00	2.00
Common selfheal	forb					1.00	1.00	1.00	1.00
Creeping buttercup	forb					1.00	1.00	1.00	1.00
Sitka burnet	forb					2.00	2.00		
Mexican betony	forb			1.00	1.00	1.00	1.00		
Trefoil foamflower	forb	2.00	2.00	2.00	2.00			2.00	2.00
Menzies tolmiea	forb	2.00	2.00	2.00	2.00			2.00	2.00
Clover	forb					1.00	1.00	1.00	1.00
Escholtz falsehellebore	forb					2.00	2.00		
Bentgrass	gram	1.00	1.00	1.00	1.00	3.00	3.00	2.00	2.00
Redtop	gram	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00
Vernalgrass	gram	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00
Brome	gram							1.00	1.00
Mountain brome	gram					1.00	1.00		
Bluejoint reedgrass	gram			2.00	2.00				
Sedge	gram	1.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00
Windseed sedge	gram					3.00	3.00	3.00	3.00
Dewey's sedge	gram			2.00	2.00				
Slough sedge	gram	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00
Orchard grass	gram	3.00	3.00	3.00	3.00	2.50	3.00		
California danthonia	gram	3.00	3.00	3.00	3.00	3.00	3.00	2.50	3.00
Tufted hairgrass	gram	2.00	2.00					1.00	1.00
Slender hairgrass	gram							1.00	1.00

Common Name	Lifeform	Winter Use	Winter Value	Spring Use	Spring Value	Summer Use	Summer Value	Autumn Use	Autumn Value
Wildrye	gram					3.00	3.00	1.00	1.00
Blue wildrye	gram					1.00	1.00	2.00	3.00
Fescue	gram	2.00	1.00						
Meadow fescue	gram	1.00	1.00						
Red fescue	gram	1.00	1.00			1.00	1.00	3.00	3.00
Common velvetgrass	gram	1.00	1.00			1.00	1.00	1.50	2.00
Rush	gram	2.00	2.00						
Ryegrass	gram							2.00	2.00
Common timothy	gram	1.00	1.00					1.00	1.00
Bluegrass	gram	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00
Millet woodrush	gram	1.00	1.00			1.00	1.00	1.00	1.00
California Spanish moss	lichen	2.00	2.00						
Bearded usnea	lichen	2.00	2.00	2.00	2.00				
Pleated usnea	lichen	2.00	2.00						
Gooseberry currant	shrub					3.00	3.00		
Vine maple	shrub	1.75	2.00	2.50	3.00	3.00	3.00	2.00	2.00
Sitka alder	shrub					1.00	1.00		
Kidneywort baccharis	shrub						1.00	1.00	
Cascades mahonia	shrub	2.50	3.00	2.00	3.00	2.00	2.00	3.00	3.00
Salal	shrub	2.40	3.00	1.75	2.00	1.67	2.00	1.75	2.00
American twinflower	shrub	3.00	3.00						
California rose	shrub					1.00	1.00	1.00	1.00
Nootka rose	shrub	2.00	2.00						
Cutleaf blackberry	shrub			2.00	2.00	2.00	2.00	2.00	2.00
Whitebark raspberry	shrub					1.00	1.00	1.00	1.00
Western thimbleberry	shrub			2.00	2.00	2.00	2.00	1.50	2.00
Five-leaved bramble	shrub	2.00	2.00						
Himalaya blackberry	shrub	1.00	1.00	3.00	3.00	1.00	1.00		
Salmonberry	shrub	1.17	1.00	2.33	3.00	2.14	2.00	1.75	2.00
California dewberry	shrub	3.00	3.00	2.67	3.00	2.50	3.00	2.33	3.00
Grapeleaf Calif. dewberry	shrub	3.00	3.00	2.00	2.00	1.00	1.00	2.00	2.00
Willow	shrub	2.00	2.00			2.00	2.00	2.00	2.00
Scouler willow	shrub	2.00	2.00	2.00	2.00				
Sitka willow	shrub	2.00	2.00	2.00	2.00				
Red elder	shrub	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00
Blueberry	shrub	2.00	2.00	3.00	2.00	1.00	1.00	1.00	1.00
Big whortleberry	shrub			2.00	2.00	2.00	2.00	2.00	2.00
Ovalleaf whortleberry	shrub			2.00	2.00	2.00	2.00	2.00	2.00
Box blueberry	shrub	1.50	2.00	1.50	2.00			1.50	2.00
Red whortleberry	shrub	2.33	3.00	2.00	2.00	2.50	3.00	2.25	3.00
Moosewood viburnum	shrub	2.00	2.00					2.00	2.00
Bigleaf maple	tree							2.00	2.00
Red alder	tree	1.00	1.00					2.50	3.00
Douglas-fir	tree	2.25	2.00	1.00	1.00	1.00	1.00	2.00	2.00
Cascara buckhorn	tree	2.00	2.00	1.00	1.00	2.00	2.00	1.00	1.00
Pacific yew	tree	3.00	3.00						
Western red cedar	tree	3.00	3.00					1.00	1.00