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DESIGN, IMPLEMENTATION, AND INITIAL RESPONSE OF SELECTED HABITAT TREATMENTS WITHIN THE URAL-TWEED BIGHORN SHEEP RANGE

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Abstract: In response to the decline of the Ural-Tweed bighorn sheep (Ovis canadensis canadensis) herd between the 1960's and the 1970's, 2 separate but related habitat improvement projects were initiated. One is a Bonneville Power Administration (BPA) funded project to mitigate loss of bighorn habitat due to the completion of the Libby Dam hydroelectric project, and the other, a USDA, Forest Service (USFS) helicopter timber sale designed to improve bighorn sheep and other big game species habitat along Koocanusa Reservoir. Between 1984 and 1987, approximately 1753 ha of habitat have received some degree of treatment within the 9220 ha bighorn sheep range. Helicopter logging, slashing, prescribed fire, and fertilization are being used in various combinations to create a number of treatments located throughout the range. The initial phase of treatments (1938 ha total) is planned for completion in 1989. The types of treatments are discussed along with initial vegetation and animal monitoring efforts.

The Ural-Tweed bighorn sheep population, one of the few remaining native herds in northwestern Montana, occupies the steep slopes along the east side of Koocanusa Reservoir (Brown 1979, Yde et al. 1986). The range occupied by sheep is a series of broken, timbered, steep slopes (elevation 760-1680 m) with intermingled small grass/shrub openings. Several factors lead to a decline in the population from an estimated 150-250 animals in the 1960's to approximately 25-40 animals in the late 1970's. Construction of the Libby Dam hydroelectric facility on the Kootenai River resulted in the inundation of approximately 1740 ha of bighorn sheep winter and spring habitats. Additionally, approximately 240 ha of habitat were lost with the associated construction of Montana Highway 37. Thus, approximately 18% of the total initial range (11200 ha) has been irretrievably lost (Yde and Olsen 1984). Fifty years of active fire suppression has also allowed ecological succession to progress. This resulted in increased encroachment of Douglas-fir (Pseudotsuga menziesii) into the open ponderosa pine (Pinus ponderosa)-bunchgrass community (vegetation names follow Hitchcock and Cronquist, 1973). Pre-treatment tree densities ranged from 2470-3700 stems/ha for trees larger than 2.5 cm dbh and 90% of the stems were between 2.5 and 10 cm dbh. Dense stands of lodgepole pine (Pinus contorta) are also present as a result of several historic burns.

All previous studies conducted on the Ural-Tweed range determined the sheep preferred the bunchgrass communities under open stands of ponderosa pine and Douglas-fir (Ensign 1937, Brink 1941, Brown 1979). These compare favorably to studies conducted on other bighorn populations (Couey 1950, Smith 1954, Geist 1971, Risenhoover and Bailey 1985, Shannon et al. 1975). The quality of the Ural-Tweed range for bighorn sheep has historically been maintained by fire which produced the open bunchgrass communities. This has been documented by the abundance of fire scarred trees in the area (Brown 1979) and through aerial photos taken in 1949 which show evidence of numerous fires in the area adjacent to the Kootenai River.

As a result of a study completed by Brown (1979), and the availability of mitigation funds through the Northwest Power Planning Act of 1980, habitat treatments totalling 1946 ha have been initiated on the Ural-Tweed range. A USFS helicopter logging operation designed to selectively harvest 18 million board feet (mmbf) of mature ponderosa pine, Douglas-fir, and western larch (Larix occidentalis) was initiated on 1381 ha of primary bighorn sheep use areas. Secondly, 557 ha of selected habitats have been scheduled for treatment using funds provided by BPA (contract #84-38) as mitigation for the Libby Dam hydroelectric project. Monitoring of the vegetation and animal response to these treatments has also been funded by BPA (contract #84-39).

The habitat treatments described in this paper are the initial efforts of a long-term approach to managing the Ural-Tweed bighorn sheep range. A long-range habitat management plan outlining a program of habitat treatments needed to maintain the productivity and suitability of the range is currently being developed. This plan will outline future treament areas, treatment schedules, and the need for retreatment. Treatments and retreatments will be scheduled to approximate the natural fire cycle.

METHODS

Treatments

The primary goal of all the treatments was to stimulate production of understory vegetation while maintaining mature ponderosa pine and Douglas-fir trees. In an attempt to achieve this objective, 4 basic habitat treatments--selective timber harvest, slashing, prescribed burning, and fertilization--have been utilized singly or in combination. Size of treatment units ranged from 6-255 ha.

Although the primary emphasis for both the BPA and USFS projects was habitat improvement for bighorn sheep, due to the extensive nature of the treatments the designs incorporated considerations for other wildlife species. The units were well distributed throughout the entire sheep range to enhance habitat diversity and create a habitat mosiac (Fig. 1). Habitat diversity was enhanced on a unit basis by leaving untreated small drainages, selected conifer covered benches, and patches of deciduous trees. Prescribed fires further enhanced diversity due to the varying intensities that resulted from discontinuous fuels, variable fuel loadings, and the burning prescriptions. Selected treatment units were actually designed to primarily benefit mule deer (Odocoileus hemionus) and moose (Alces alces). This was done in an attempt to reduce the interspecific competition between big game ungulates on important bighorn sheep wintering areas.

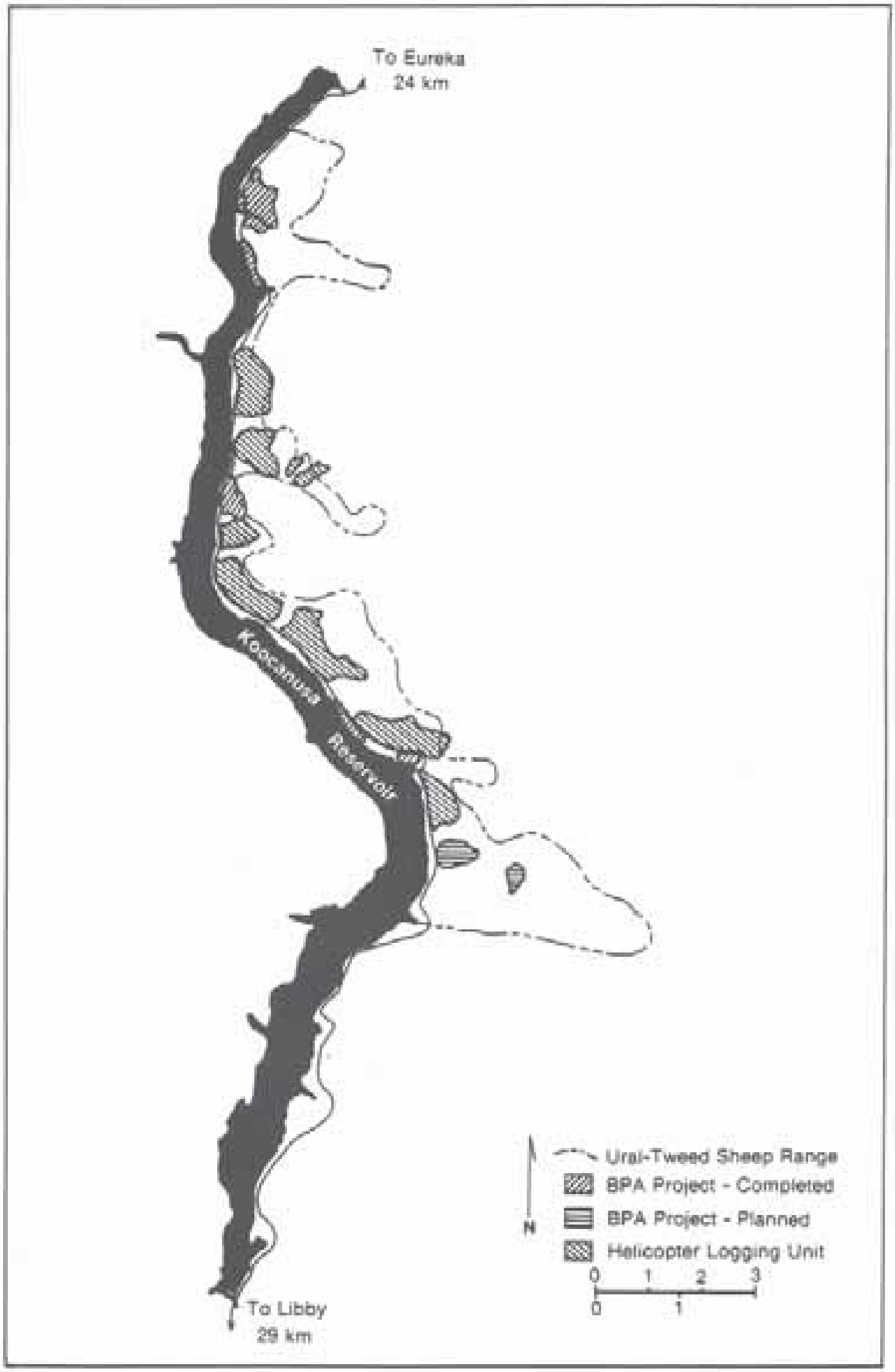

Fig. 1. Map of the Ural-Tweed bighorn sheep range delineating BPA-funded habitat treatments and helicopter logging units.

Selective timber harvest.--A large timber sale containing 9 separate units was specifically designed to benefit bighorn sheep with considerations for other big game species. Selective harvest of merchantable sized trees was used to open the overstory canopy while retaining mature and overmature, fire resistant ponderosa pine and Douglas-fir. Based on a study of habitat utilization by the sheep population (Brown 1979), the objective of the harvest was to leave 37-74 mature trees/ha.

Seasonal timing restrictions on logging activity were incorporated into the sale contract. Timber harvest and removal was timed to reduce disruption of bighorn sheep during lambing/nursery and rutting seasons. Helicopters were used to extract the trees to landings adjacent to Highway 37. Therefore, soil disturbance was negligible and access to the area was not increased by construction of roads and skid trails. Slashing and prescribed fire were used after timber harvesting to complete the treatment on each unit.

Slashing.--Slashing (sawing down trees) treatments have been used on both BPA and USFS projects to achieve one or more of the following objectives:

1. Increase the fuel loading to create a desired fire intensity or behavior;
2. Directly reduce the conifer overstory--primarily regeneration or subdominant trees; and
3. Protect specific tree species and individuals from the effect of heating or consumption.

Slashing was done manually within treatment areas. Broadcast slashing (conifers slashed to a specified dbh limit over the entire treatment unit except for areas designated to be untreated to increase habitat diversity) was the most common slashing treatment, but other variations have also been used. Sometimes more than 1 slashing treatment was combined within a given unit. One variation was strip slashing in which alternating strips 15-23 m wide were slashed with an objective of creating sufficient fuel to generate a fire that would carry into the unslashed strip and thin the canopy. Strip slashing was utilized in areas of dense, small dbh conifers to create a heavy fuel loading. Another variation used was hand piling slashed conifers away from fire sensitive black cottonwood trees (*Populus trichocarpa*) to prevent them from being killed or injured by the follow up prescribed burn.

Slashing was accomplished by USFS saw crews or through contracting with a private company. Slashing was conducted during all seasons of the year depending on the suitability of weather, terrain, and availability of crews. Slash was allowed to dry for at least one summer and normally 1 year or more before burning.

Prescribed burning.--Prescribed burning was normally the final phase of all habitat treatments except when a fertilization treatment was used. Burning was used to meet one or more of the following objectives:

1. Rejuvenate decadent stands of shrubs, grasses, and forbs;
2. Reduce the conifer overstory--primarily seedling,

sapling, and pole sized subdominate trees, and
3. Reduce slash accumulation from previous treatments.

A specific burning prescription was written using the BEHAVE program (Andrews 1986) after the objectives for a unit were defined. This fire behavior computer program defines a range of climatic conditions and fuel moistures under which a fire would achieve specific objectives. Spring and late fall burns were planned for areas containing the important fire sensitive browse species bitterbrush (Purshia tridentata). Soil moisture is usually sufficient during these periods to reduce the damage to plant root collars (Noste and Bushey 1987). These cooler season burns were also utilized when slashing had created heavy fuel loading and minimal damage (<10% mortality) to the remaining trees was desired. Late spring and early fall burns were scheduled in areas where more intense fires were needed for slash reduction or to produce 15 to 75% mortality in conifers remaining. Late August burning was utilized in areas where fuel loadings were light and discontinuous. Under warmer and drier conditions, burning produced the desired results of slash reduction and 25-75% mortality of the remaining conifers.

Aspect, fuel loading, soil type, presence or absence of fire sensitive species, and desired level of conifer mortality were utilized in selection of the burning season. Either hand or aerial ignition was used depending on the terrain and the size of the unit. Drip torches or, infrequently, fusees were used for hand ignition. Aerial ignition was accomplished either with a PREMO MARK III aerial ignition device or with a helitorch.

Natural fuel breaks were utilized with only 2 exceptions where short hand-dug fire lines were built. State of Montana air quality guidelines for smoke managment were followed.

Fertilization.--Several open, rocky, steep areas exist within the sheep range that do not lend themseleves to slashing and burning type treatments. These areas contain a scattered stand of grasses dominated by rough fescue (Festuca scabrella), Idaho fescue (F. idahoensis), and bluebunch wheatgrass (Agropyron spicatum). Due to the discontinuous fuels and broken topography these areas can not be effectively treated with fire. The objective of the fertilization treatments was to improve the short-term forage quality.

A 10 ha trial plot was established in 1986 using an aerial application of 225 kg/ha of nitrogen (20-0-0). A flat, rocky bench with a vegetation composition similar to the steep, broken areas was chosen as a trial plot. The topography of the plot will facilitate monitoring of the vegetation response which could not be logistically accomplished on the majority of the proposed units.

Vegetation Monitoring

Vegetation composition, productivity, and structure have been monitored to determine response to the treatments (Yde et al. 1986). Transects were established in both pre- and post-treatment areas, as well as in paired control areas. Food habits, diaminopimelic acid (DAPA), fecal nitrogen, and crude fiber analyses have been conducted in an attempt to provide an indication of changes in diet composition and quality.

Animal Monitoring

A combination of radio-telemetry, visual observations, and browse utilization/pellet group transects were used to monitor bighorn sheep and mule deer response to the treatments. Five to 15 radio-collared bighorn sheep have been monitored annually from 1985 through 1987. In 1987-1988, 26 mule deer have been radio-collared. Additionally, fecal analysis--DAPA, fecal nitrogen, crude fiber, food habits--, body size, horn growth, and population growth are being monitored to determine the response of the bighorn sheep population. Yde et al. (1986) discusses the monitoring in detail.

RESULTS

Approximately 1753 ha of the 1938 ha planned for the initial phase of habitat treatment have recieved at least partial treatment by 1987. Nineteen percent of the total sheep range (9220 ha) has been treated. When the total planned area of 1938 ha has been completed, 21% of the sheep range will have been treated. Table 1 details the treatment type, season, year, and size of each unit. Table 2 gives the costs associated with the treatments. Juxtaposition of the treatment units are illustrated in Fig. 1.

Eighteen mmbf of timber sale was harvested between 1985 and 1987. The sale of this timber helped achieve treatment objectives as well as providing funds through the Knutson-Vandenburg Act of 1930 to complete the various treatments.

Slashing and prescribed burning treatments were used on 6 BPA units (328 ha total). All units were slashed by 1987. Slashing was prescribed for all 9 timber sale units (1381 ha total). To date it has been completed on 6 of the units with the remainder scheduled for 1988.

As a final phase of combinations with other basic treatment types, prescribed burning has been completed on 10 units totalling 1025 ha through 1987 with 5 more units totalling 684 ha scheduled in 1988 and 1989. Prescribed burning alone has been selected for 3 units of the BPA project. One 22 ha burn was accomplished in 1986 and 2 more totalling 121 ha are planned for 1988.

A 10 ha trial fertilization plot was established in spring 1986. Five more fertilization units are planned for a total of 64 ha if the results are favorable. Visual observations of the trial plot after one year showed a favorable response.

Due to the recent or partial completion of treatments on several units, sufficient post-treatment data has not been gathered to allow a comparative analysis between pre- and post-treatment conditions. Vegetative and animal response will be analyzed and reported at a later date.

Table 1. Habitat treatments and unit sizes on the Ural-Tweed bighorn sheep range in northwestern Montana.

Unit name	Treatment by year	Size (ha)
BPA contract		
South Sheep Creek	slash 1984/burn late spring 1987	49
North Stonehill	slash 1985/burn late summer 1987	113
Tenmile	slash 1985/burn spring 1988	40
McGuire-Tweed	slash 1986/burn late summer 1987	57
Rocky Gorge	slash & handpile 1985/burn fall 1985	12
South Stonehill	strip slash 1985/burn late summer 1987	57
Lower Stonehill	prescribed burn spring 1986	34
Lower Sutton Face	prescribed burn spring 1988	40
Volcour	prescribed burn late summer 1988	81
Stonehill-pilot	fertilize spring 1986	10
Sutton	fertilize 1988	28
Tweed	fertilize 1988	10
Allen Gulch	fertilize 1988	12
Sheep Creek	fertilize 1988	6
Pack Rat	fertilize 1988	8
	subtotal	557
USFS Helicopter Timber Sale[a]		
McGuire Creek	harvest/slash 1987/burn spring 1988	237
Rocky Gorge	harvest/slash 1985/burn spring 1987	255
Packrat Gulch	harvest/slash 1987/burn late summer 1987	141
Peters Gulch	harvest/slash 1988/burn spring 1989	62
Peck Gulch	harvest/slash 1988/burn spring 1989	230
Tenmile	harvest/slash 1985/burn spring 1987	180
Tweed Creek	harvest/burn late summer 1987	121
Sheep Creek	harvest/slash 1988/burn fall 1988	113
Allen Gulch	harvest/slash 1987/burn fall 1988	42
	subtotal	1381
	total	1938

[a]All harvesting was completed between 1985-1987.

DISCUSSION

A number of effects have been observed from the various treatments used on the bighorn sheep range. Many of these have biological, logistical, political, and social implications for future treatments.

It became apparent very early in the project that flexibility was needed in scheduling treaments. Unfavorable weather often caused prescribed burns to be postponed or rescheduled, and narrow burning

Table 2. Costs associated with habitat treatments between 1984 and 1987 on the Ural-Tweed bighorn sheep range in northwestern Montana.

Treatment	Cost ($U.S./ha)[a]
spring burn	37-89
late summer or fall burn	74-198
slash	99-326
strip slash	158
slash and hand pile	252
fertilization	316
selective timber harvest	247[b]

[a]Average cost/ha for period 1984-1987.

[b]Cost for preparation and administration. Purchaser paid $760 U.S./ha of which $705/ha was available in Knudtson-Vandenburg funds for follow up treatments.

prescription "windows" increased the probablility of delays. In some cases, burns have been delayed 2-3 years.

Large treatment units (40-250+ ha) were used with a few exceptions. These were well distributed throughout the range. Large units are expected to benefit bighorn sheep by reducing intraspecific and interspecific competition. A habitat mosiac was obtained within each of the units due to the variations in topography, fuel loadings, and vegetative conditions throughout a large unit. This mosiac helped ensure the suitability of the unit for bighorn sheep use following treatment. Also, the per hectare costs of prescribed burning were reduced.

Aerial ignition was demonstrated to be the most efficient and practical technique for prescribed burning large units and rugged terrain. A 6-8 person crew could safely ignite approximately 40 ha on gentle to moderately rough terrain in one daily burning period while 400+ ha could be safely ignited in any sort of terrain in the same amount of time using the PREMO MARK III aerial ignition device. Rapid ignition capability also permitted us to take advantage of short-lived, yet favorable weather conditions to complete several burning units.

The PREMO MARK III aerial ignition device worked well where fine fuels (such as grasses, litter, and slash with dead conifer needles) were available. The helitorch was more efficient at igniting larger fuels and it also was capable of generating an intense fire more rapidly. Hand ignition worked well in all fuel types and was the most precise method. It was especially valuable in heavy fuel loadings where the pattern and rate of ignition was critical to meet an objective of retaining most of the mature overstory conifers.

The response of bitterbrush in the Lower Stonehill unit demonstrated that bitterbrush stands of this species can successfully be treated with fire. A high soil moisture content at the time of the spring burn plus a low fire intensity seemed to contribute to good resprouting of the mature plants. An estimated 75% of the bitterbrush plants resprouted following burning.

Retention (or lack thereof) of needles on conifer slash is critical to achieving fire intensity, and fire intensity is directly related to achievement of desired objectives. It was much easier to generate the fire intensities needed to meet objectives where the pine and fir needles had dried but not fallen off the limbs. Treatments on the Ural-Tweed bighorn sheep range as well as elsewhere on the Rexford Ranger District of the Kootenai National Forest have demonstrated that Douglas-fir will retain a majority of its needles for a maximum of 1 year after slashing and ponderosa pine and lodgepole pine will retain needles for up to 3 years. In one case in heavy lodgepole pine slash on a BPA treatment unit, green needles were still present near the ground after 1 year. Because of the difference in needle retention, units with predominately Douglas-fir slash were much more critical for scheduling and accomplishing the prescribed burn than those units with ponderosa pine or lodgepole pine.

Needle retention is also directly related to the visual effects of prescribed burning. Since all of the treatment units are visible from Koocanusa Reservoir and a major highway, visual effects were important. Standing dead conifers with "red" needles are visually objectionable to much of the public, but it is a short-term impact since the needles drop over a 1-3 year period.

In both the BPA and USFS projects, fuel loadings created by slash were directly related to the ability to achieve a desired level of conifer mortality. This was true for all size classes of trees. On treatments where an objective was to remove sapling and pole sized conifers (13-26 cm dbh), it was generally necessary to slash most of those trees to achieve the desired results. Where the intermediate sized trees were common, the fire intensity created by slash from timber harvest or smaller conifers was not adequate to achieve the desired mortality levels.

Large ponderosa pine on the South Sheep Creek unit that were stressed by a late spring burn were observed to become more susceptible to attack by mountain pine beetle (Dendroctonus ponderosae) and western pine beetle (Dendroctonus brevicomus). These trees were stressed immediately prior to the major flight of the pine beetles. The objective of the slashing and prescribed burn treatment was to kill 20-30% of the mature overstory and that was the initial result. However, after the infestation by the pine beetles, the mortality increased to 50-60%. The total mortality was significantly increased over that caused by the prescribed burning alone and the secondary (indirect) effects need to be considered in defining future treatment objectives.

Use of timber harvesting to achieve wildlife objectives increased public acceptance of the project because the local economy is based on forest products. Social and political support is needed for the long term habitat management of the Ural-Tweed bighorn sheep range. Another benefit from using timber harvesting was that the sale generated additional funding through the Knutson-Vandenburn Act of 1930. The Knutson-Vandenburg funds were used to accomplish the follow-up slashing and burning phases to complete the total treatment.

To summarize, the BPA and USFS projects have demonstrated a variety of treatments successfully used to manage the vegetation over a large proportion of the Ural-Tweed bighorn sheep range. Gathering of quantitative data on the vegetative and animal response to the treatments is ongoing and will be reported at a later date.

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