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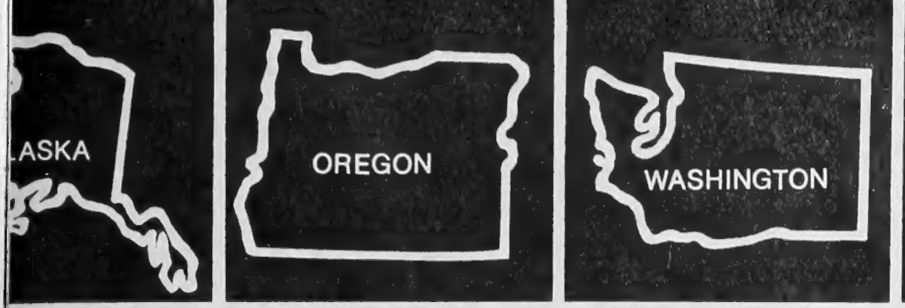

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

USDA FOREST SERVICE RESEARCH NOTE

PNW-277 July 1976

DIURNAL TEMPERATURE REGIMES OF LOGGED AND UNLOGGED MIXED CONIFER STANDS ON ELK SUMMER RANGE

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FEB 16 1977
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by

Paul J. Edgerton, *Wildlife Biologist*

and

Burt R. McConnell,[1/] *Principal Wildlife Biologist*

ABSTRACT

Temperature profiles for unlogged, partial-cut, and clearcut stands showed that removal of all or a portion of the tree canopy resulted in cooler nights and warmer days. Range of temperature extremes was greatest in the clearcut and least in the unlogged stand. Differences in canopy cover between the unlogged and partial-cut stands were relatively small, but there was a noticeable difference in thermal regimes. Daytime temperatures in the partial-cut stand were warmer, but nocturnal temperatures were somewhat cooler than in the unlogged stand. These differences influence selection of thermal cover by elk.

KEYWORDS: Temperature -)partial cutting, temperature -)clear-cutting, temperature (-wildlife habitat, Rocky Mountain elk.

[1/] Burt R. McConnell is now with Pacific Southwest Forest and Range Experiment Station, Institute of Pacific Islands Forestry, Honolulu, Hawaii.

Logging is dramatically changing the character of Rocky Mountain elk (*Cervus canadensis nelsoni*)[2/] summer ranges in mixed conifer forests of northeastern Oregon. Biologists are concerned that increased human activity coupled with the rapid harvest of old-growth timber stands, which provide essential cover for hiding and thermal comfort, will significantly lower the suitability of these ranges for elk. Research is underway in several Western States to determine animal response to different timber management practices and to develop alternatives that will insure a balance of suitable habitats.

Influence of the temperature regime on ungulate behavior is well known (Beall [in press], Loveless 1967, Moen 1973). Elk respond to environmental temperatures in various ways (e.g., changes in orientation, posture, or activity), but selection of cover is probably the most effective means of adjusting the balance between heat loss and heat production. The importance of protective cover during winter is well documented, but the use of cover for thermal comfort in summer is not fully appreciated. There is a need for environmental data to better understand the influence of silvicultural treatments on elk behavior. This note compares diurnal temperature patterns in adjacent unlogged, clearcut, and partial-cut mixed conifer stands during the June-September period.

THE AREA

The study area is located approximately 12 miles (19 km) west of Troy, Oregon (latitude 45°56', longitude 117°36'), at 4,000-foot (1 200-m) elevation. Annual precipitation is estimated to be 30-40 inches (75-100 cm) and occurs mainly as winter snow and spring and fall rains. Topography is a gently rolling plateau bounded by deep canyons. Elk, or their signs, are observed frequently from early May through late November. Physical characteristics of the study sites are listed in table 1.

The unlogged study site (fig. 1) was a representative 200-year-old, mixed conifer stand approximately 820

Table 1--*Characteristics of termperature profile study sites in a mixed conifer forest, northeastern Oregon*

Site	Aspect	Slope	Stand basal area	Stand density	Canopy cover (stand average)
		Percent	*ft^2/acre (m^2/ha)*	*Stems/acre (stems/ha)*	*Percent*
Unlogged	SE	14	229 (52.6)	401 (1 000.8)	94
Clearcut	ESE	12	0	0	0
Partial-cut	ESE	15	171 (39.2)	430 (1 178.7)	83

[2/] Sources for scientific nonmenclature are Little (1953), Hitchcock et al. (1955-69), and Ingles (1965).

Figure 1.--Unlogged study site.

Figure 2.--Clearcut study site.

feet (250 m) wide surrounding a 39-acre (15.8-ha) clearcut (fig. 2). It is dominated by grand fir (*Abies grandis*), with lesser amounts of western larch (*Larix occidentalis*), Douglas-fir (*Pseudotsuga menziesii*), Engelmann spruce (*Picea engelmannii*), lodgepole pine (*Pinus contorta*), and occasional ponderosa pine (*Pinus ponderosa*). The understory is mostly big huckleberry (*Vaccinium membranaceum*). Several other low shrubs, many shade-tolerant forbs, and occasional sedges and grasses are also present.

After logging in 1963-64, slash and cull logs were left untreated in the clearcut and the unit was planted with ponderosa pine and seeded to grass.

The nearby partial-cut site (fig. 3) was part of an extensive tract of mixed conifer forest selectively logged in 1964. Only the larger trees were removed, so the harvest was relatively light. In addition, the stand had a wider distribution of ages than the unlogged area, so scattered groups of smaller trees remained undisturbed after logging. Disturbance of soil and vegetation was not as extensive as in the clearcut; invasion by seral forbs and shrubs was largely confined to spur roads, deck areas, and skid trails.

Figure 3.--Partial-cut study site.

METHODS

Temperatures were recorded during the 1967 and 1969 growing seasons at the center of 2-acre (0.81-ha) plots located at comparable midslope positions in each study site. Thermographs were placed 18 inches (45.7 cm) above the forest floor in small shelters similar to those designed by Hungerford (1957). The data were taken at the top of the shrub-herb understory primarily to supplement a companion plant succession study; temperatures at midbody height of standing animals would be expected to be slightly cooler and less variable. No statistical analyses were made because of sample size limitations, but the consistent thermal patterns in figure 4 suggest that reasonable comparisons between treatments can be supported.

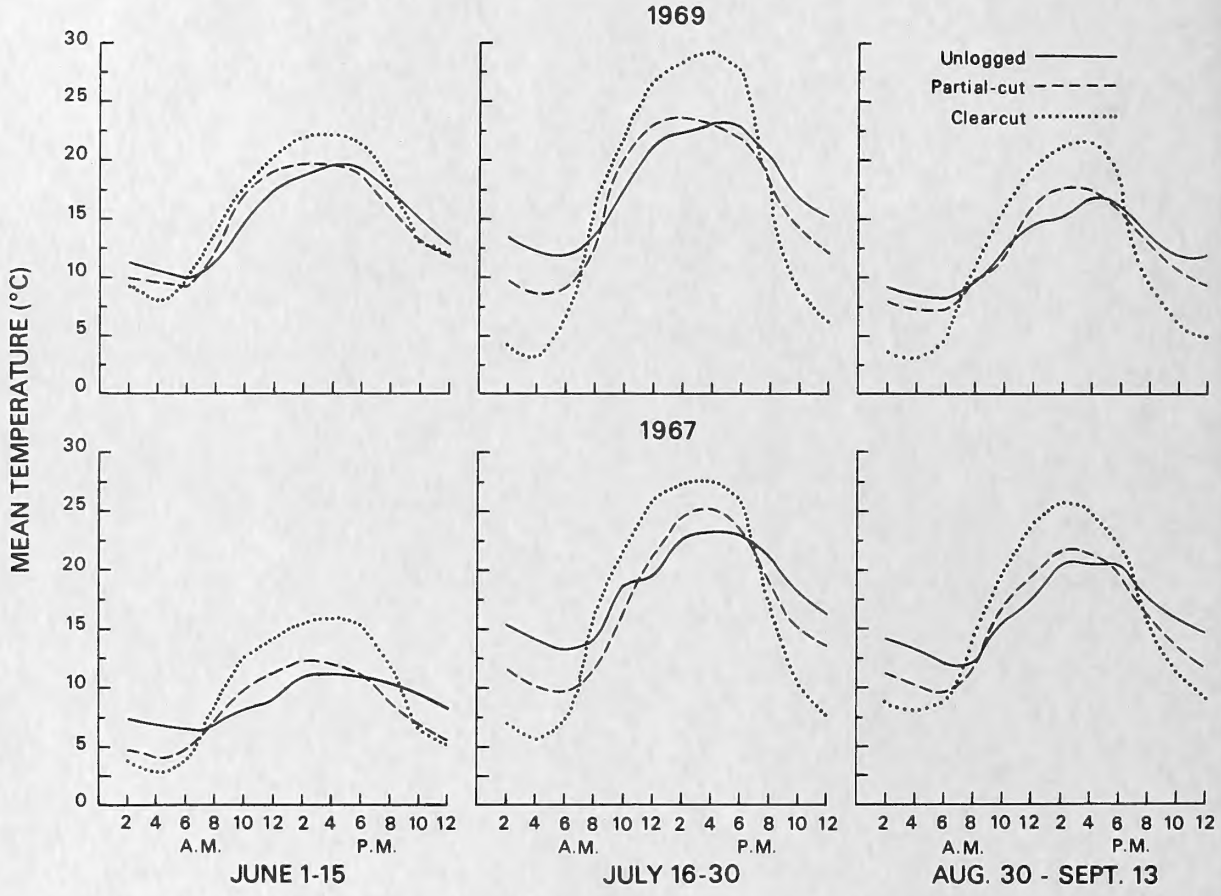

Figure 4.--Diurnal temperature profiles for unlogged, partial-cut, and clearcut mixed conifer forest, northeastern Oregon.

RESULTS AND DISCUSSION

Diurnal temperature patterns for representative early-, mid-, and late-summer periods are summarized in figure 4. Seasonal differences are clearly reflected. In early summer, average temperatures are cooler, with frequent periods of cloudiness and precipitation. As the summer progresses, the frequency of precipitation declines. Days are quite warm, but nocturnal temperatures drop quickly due to clear skies and low humidity. By late summer and early fall, daytime maximums are lower, and unsettled weather increases.

As figure 4 shows, the relationships between temperature profiles on the three sites were consistent throughout the seasons. Temperature extremes were greatest in the clearcut and least in the unlogged stand. Tree canopies of the timbered sites reduced both incoming and outgoing radiation, thereby moderating these environments. This effect was most pronounced during midsummer under clear skies; during early summer, differences were minimized by clouds which limited radiation loss.

The difference in canopy cover between the unlogged and partial-cut sites was relatively small, yet there was a noticeable difference in thermal regimes. Daytime temperatures in the partial-cut stand were warmer, but nocturnal temperatures were somewhat cooler than in the unlogged stand. Geiger (1965) explains that most of the radiation exchange in forests with unbroken canopies occurs at crown tops because the canopy prevents significant penetration by sun and wind. In logged or thinned forests, gaps in the canopy allow greater daytime heating and air circulation near the forest floor. Conversely, at night, heat radiated from the forest floor escapes more quickly to the open sky. Silvicultural prescriptions, such as the shelterwood or seed tree systems, that remove a much greater portion of the canopy would be expected to create environments with temperature profiles approaching that of the clearcut.

General observations indicate that old-growth mixed conifer stands of suitable size and distribution are a necessary component of elk summer range in northeastern Oregon. Edgerton (1972) reported that 5 years after logging, elk pellet group densities were highest in the clearcut and lowest in the partial-cut area. Forage was the obvious attraction in the clearcut. The adjoining unlogged area lacked preferred forage plants, and the presence of numerous well-used bedding areas and trails indicated that its primary value was concealment and thermal comfort for resting animals. The partial-cut stand provided neither optimum forage nor cover during this period.

Figure 4 suggests that the comparatively stable environment of unlogged stands is probably an important factor in habitat selection by elk. Thus, during cold, wet periods in the spring and fall, elk undoubtedly seek shelter in these stands to minimize loss of body heat. On warm summer days, cooler temperatures are the obvious attraction. This is confirmed by telemetry studies[3/] in an adjacent area which showed that during the summer, elk used clearcut areas at night but preferred the security and milder temperatures of dense conifer stands during the day. Movement of elk between habitats generally occurred during warming and cooling periods in the early mornings and evenings.

3/ Personal communication with R. J. Pedersen, Oregon Department of Fish and Wildlife, January 1976.

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