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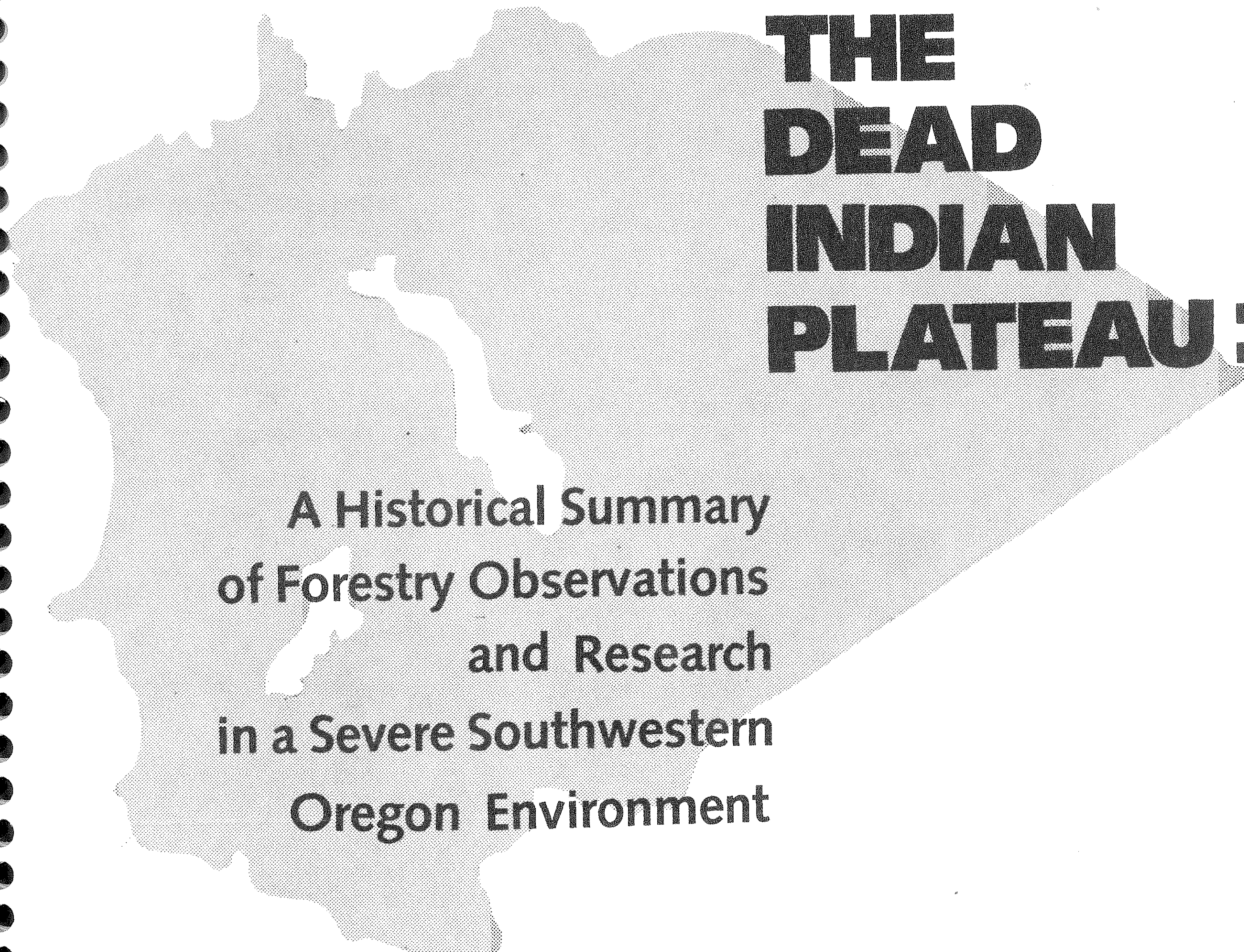

THE DEAD INDIAN PLATEAU:

A Historical Summary of Forestry Observations and Research in a Severe Southwestern Oregon Environment

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Abstract

The Dead Indian Plateau is a gently sloping area of 100,000 acres (40,000 ha) east of Ashland, Oregon. It is a valuable source of timber, but timber stands on the plateau often are difficult to regenerate after logging. Many people have been observing and studying these regeneration problems and other aspects of the Dead Indian Plateau for many years. This report is a summary of their observations, measurements, and conclusions.

Resembling a gigantic elevated saucer lying south-southwest of Mount McLoughlin, the Dead Indian Plateau has cold, snowy winters that alternate with hot, dry summers. Nocturnal freezes combine with gentle, often concave topography to produce serious frost damage in many places.

White fir constitutes the dominant tree species on much of the area, but a mixture of conifer species comprises most stands. Plateau forests are uneven aged; shrub density is low, but grasses and forbs are abundant and usually dense. These forests support large populations of rodents and deer.

Economic selection cutting on the plateau was succeeded by clearcutting shortly after World War II. Most attempts to regenerate these clearcuts were not successful, however, and various partial-cutting techniques have since been used--with varying degrees of success. A two-stage shelterwood system with underplanting seems necessary in most of the stands if the original composition is to be maintained.

Early research involved the pine beetle. Later, mistletoe and heart rot were also studied. Recent plantation trials involved overstory treatments, artificial shading, scarification, herbicides, species and stock trials, frost measurements, irrigation, and rodent caging. Indirect treatment with herbicide removal of the vegetation appears to be the best method for controlling gophers.

Work in progress includes amelioration of soil compaction, genetic studies, species trials, and continued research on gophers. Partial solutions are available for the three problems that seem to be most important in inhibiting regeneration: pocket gophers, frost, and the moisture stress produced by vegetative competition. None of these problems have been completely solved. Continued research and careful observation are appropriate and essential for progress in management on the Dead Indian Plateau.

KEYWORDS: Oregon (Dead Indian Plateau), history, regeneration (stand), management (forest).

Contents

Introduction

Approximately 10 miles (16 km) east of Bear Creek Valley and the city of Ashland, Oregon, the steep western extremities of the Cascade Range level out to form an extensive, gently sloping plateau. About 1854 some Rogue Valley settlers went to this area and found two or three deserted wigwams, in which were the bodies of two Indians--probably killed in a conflict between rival tribes (Brown 1960a). Since then, this area has been known as Dead Indian Plateau.

The plateau has been a valuable source of timber and rangeland for many years. Since World War II, however, its timber, grazing, wildlife, and recreational resources have been used at increasing rates by an expanding population. Gentle topography, an excellent road system, and nearby forest product markets should provide excellent opportunities for intensive forest management on the plateau. Unfortunately, intensive forest management is difficult on much of the area. Natural forest regeneration is often erratic, slow, or nonexistent. Growth is sometimes poor, and much of the timber is defective.

Many people have been observing, measuring, and studying the plateau and its problems for many years. Some of this work has been published, but much of it is scattered and difficult to obtain. Foresters working in the Dead Indian area should have easy access to knowledge gathered in the past as they manage the present forest resources. Researchers also should be aware of the past--repeating old experiments or seeking answers to questions that have already been answered is a waste of time, effort, and money. This report is a summary of past attempts to solve forestry problems on the Dead Indian Plateau.

LOCATION AND TOPOGRAPHY

The Dead Indian Plateau is bounded on the west by steep slopes descending to Bear Creek Valley and on the north by the precipitous slopes above Little Butte Creek and by Cox Butte, Burton Butte, and Buck Lake. Its southern boundary is generally considered to be the Green Springs Highway. No sharply defined eastern boundary exists, but it will be designated here as a line drawn from the south end of Buck Lake to Fredenburg Spring and Lincoln (fig. 1).

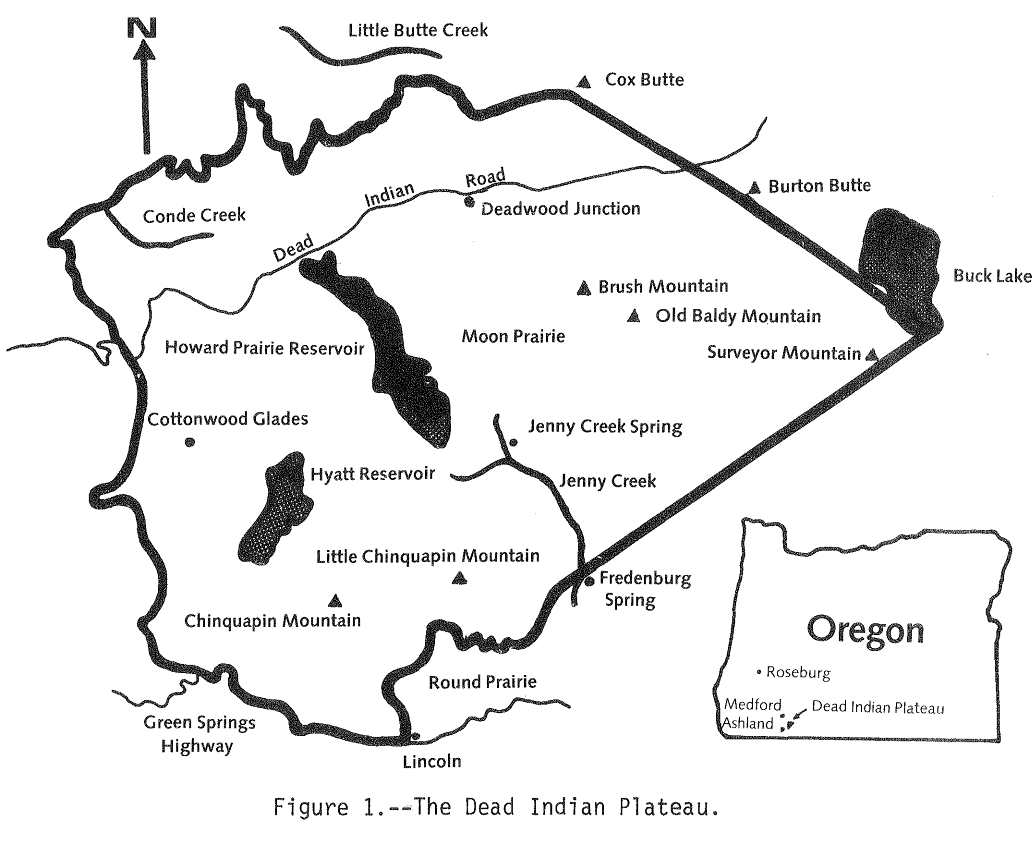

Figure 1.--The Dead Indian Plateau.

The plateau occupies approximately 100,000 acres (40,000 ha). It includes townships 38 and 39 south, ranges 3 and 4 east, Willamette Meridian. Approximately half of T. 38 S., R. 5 E., and a small portion of T. 38 S., R. 2 E., are also included.

The western edge of the Dead Indian Plateau is approximately 5,200 feet (1 600 m) above sea level. This high western edge slopes downward on both sides--precipitously to the west and gently to the east. At Howard Prairie Reservoir, near the middle of the plateau, the elevation is only 4,500 feet (1 400 m). From Howard Prairie elevation gradually increases again to the east, and the elevation of Buck Lake is 4,900 feet (1 500 m). Like a gigantic elevated saucer lying south-southwest of Mount McLoughlin, the Dead Indian Plateau tends to be lower in the center than it is on the edges. This saucer, however, is not at all uniform. Large, rather gently sloping mountains rise above the general level in many places, and the southeastern portion is drained by a great crack--the steep-sided Jenny Creek drainage. Elevations range from 3,700 feet (1 100 m) at Lincoln to 6,300 feet (1 900 m) on the top of Old Baldy Mountain.

GEOLOGY AND SOILS

The high western portion of the Dead Indian Plateau is composed of Eocene and Miocene formations of the western Cascades. They are characterized by black andesitic lavas that include laboradorite, andesine, oligoclase, rhyolite, and basalt. Thin flows of these black lavas are interbedded with gray andesitic lavas, tuffs, breccias, and agglomerates. Younger, High Cascade formations of olivine basalt comprise the plateau surface east of the high western portion (Callaghan and Buddington 1938). Chinquapin and Little Chinquapin Mountains are pre-Mazama volcanoes (Williams 1942).

Soils of the Dead Indian Plateau were all developed from andesites and basalts. Along the western edge, where these volcanic parent materials are of Eocene and Miocene age, clay content of the soil tends to be higher than farther east--the 840 and 850 soil series have dense clay subsoils (deMoulin et al. 1975). Even in the east, however, most of the plateau supports soils with clay loam and loam subsoils. These are the 809, 810, 880, and 882 series of deMoulin et al. They were mapped as Pokegama, Woodcock, and Oatman series by Cahoon and Simonson (1969). Depth, color, and stone content vary considerably among these younger soils, but most are well drained and stony. Although serious erosion is not a problem on most of the plateau, soil compaction occurs in some areas.

CLIMATE

Climatic conditions on the plateau are severe. Cold, snowy winters alternate with hot, dry summers. Although the mean annual temperature at Howard Prairie Reservoir is a moderate 43.7°F (6.5°C), temperature fluctuations are extreme (meteorology Committee, Pacific Northwest River Basins Commission 1969). Temperatures at Howard Prairie varied from -20°F (-29°C) to 95°F (35°C) during the 1960-65 period. The mean annual precipitation of 34.4 inches (87.4 cm) is somewhat misleading. Total winter snowfall between 1960 and 1965 ranged from 142.5 to 218 inches (362 to 554 cm). In contrast, total precipitation in July was a meager 0.1 to 0.4 inch (0.25 to 1.0 cm). Although occasional summer thunderstorms occur, July is the driest and warmest month on the Dead Indian Plateau. December is the wettest month and January the coldest (Meteorology Committee, Pacific Northwest River Basins Commission 1969). Nighttime temperatures often drop below freezing, even during the summer months. These nocturnal freezes combine with gentle, often concave topography to produce serious frost damage in many areas (fig. 2).

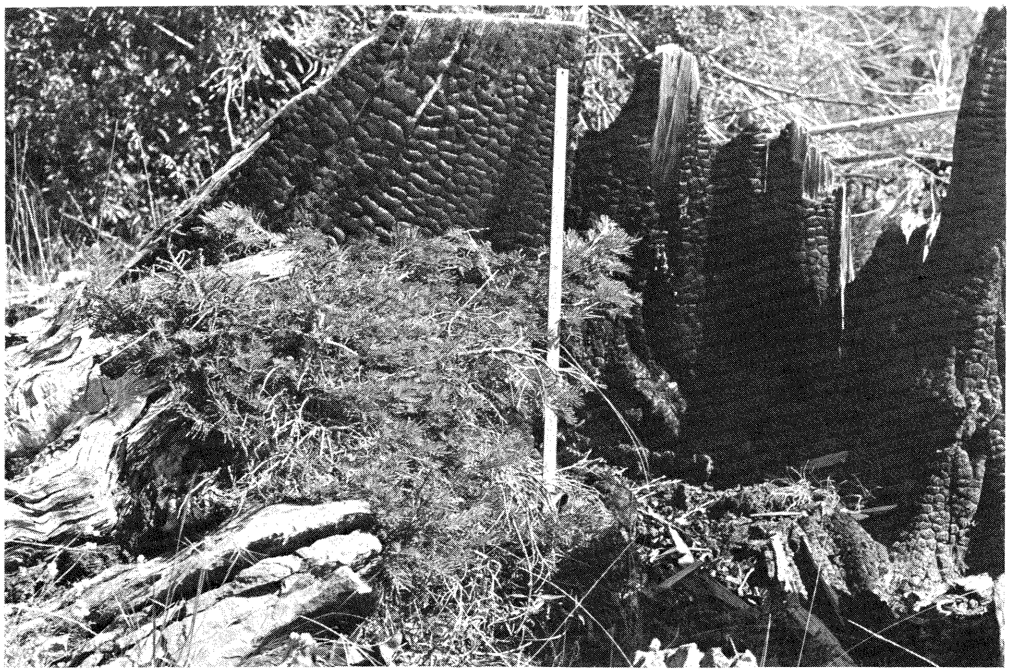

Figure 2.--Frost damaged white fir next to 50-inch (127-cm) diameter stump at Moon Prairie. Note flat fir top and adjacent meter stick.

VEGETATION

Vegetation on the Dead Indian Plateau generally resembles that of the mixed conifer zone described by Franklin and Dyrness (1973). White fir (*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.)[1/] is the dominant tree species in most plateau stands, and it forms nearly pure forests above 5,500 ft (1 700 m) in the west. Elsewhere, Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco) is nearly always well represented. Smaller quantities of incense-cedar (*Libocedrus decurrens* Torr.) and sugar pine (*Pinus lambertiana* Dougl.) often occur in the white fir-Douglas-fir mixtures. Ponderosa pine (*Pinus ponderosa* Dougl. ex Loud.) is sparsely scattered over much of the plateau, but is more evident toward the east. Shasta red fir (*Abies magnifica* var. *shastensis* Lemm.) occurs at high elevations; like ponderosa pine, it is most abundant on eastern portions of the plateau where it forms nearly pure stands above 5,500 ft (1 700 m). Western white pine (*Pinus monticola* Dougl. ex D. Don) is sometimes found with Shasta red fir, but it is never abundant. Although not present in the western and southern portions of the plateau except in local frost pickets, lodgepole pine (*Pinus contorta* Dougl. ex Loud.) is abundant in the northeastern portion. Pacific yew (*Taxus brevifolia* Nutt.) is occasionally present in the understory; and bigleaf maple (*Acer macrophyllum* Pursh), dogwood (*Cornus nuttallii* Aud. ex T. & G.), golden chinkapin (*Castanopsis chrysophylla* (Dougl.) A. DC.), Oregon white oak (*Quercus garryana* Dougl.), California black oak (*Quercus kelloggii* Newb.), and willows (*Salix* spp. L.) occur as occasional, minor components of the overstory. Although abundant at similar elevations elsewhere in southern Oregon, madrone (*Arbutus menziesii* Pursh) is absent on most of the Dead Indian Plateau and rare in the isolated areas where it does occur.

Many shrub species occur on the plateau, but shrub density is

[1/] The source for scientific names of plants is Garrison et al. (1976).

notably low throughout most of the area. Wild rose (*Rosa gymnocarpa* Nutt.) and snowberry (*Symphoricarpos albus* (L.) Blake) are almost ubiquitous, but seldom abundant. Serviceberry (*Amelanchier alnifolia* Nutt.), creambush oceanspray (*Holodiscus discolor* (Pursh) Maxim.), gooseberries (*Ribes* spp. L.), Oregon boxwood (*Pachistima myrsinites* (Pursh) Raf.), thimbleberry (*Rubus parviflorus* Nutt.), and the Oregon grapes (*Berberis nervosa* Pursh and *B. aquifolium* Pursh) also are widespread but not abundant in most places. Blue elderberry (*Sambucus glauca* Nutt. ex T. & G.), pinemat manzanita (*Arctostaphylos nevadensis* Gray), and snowbrush ceanothus (*Ceanothus velutinus* Doug. ex Hook.) are locally abundant but not widespread. Shrubs of minor importance include greenleaf manzanita (*Arctostaphylos patula* Greene), California hazel (*Corylus cornuta* Marsh.), and squawcarpet (*Ceanothus prostratus* Benth.). Poison oak (*Rhus diversiloba* T. & G.) and whipple vine (*Whipplea modesta* Torr.) are absent.

In contrast to the shrubs, grasses and forbs are abundant and usually dense on the Dead Indian Plateau. Many species are present, but the herbaceous flora is somewhat less complex and varied than that of most southwestern Oregon areas. Grasses include the fescues (*Festuca* spp. L.), bromes (*Bromus* spp. L.), and wildryes (*Elymus* spp. L.) that are common in many clearcut areas on the Dead Indian Plateau. Beneath overstory canopies the most common herbaceous species are strawberries (*Fragaria* spp. L.), snowqueen (*Synthyris reniformis* (Dougl.) Benth.), starflower (*Trientalis latifolia* Hook.), Scouler bellflower (*Campanula scouleri* Hook. ex A. DC.), threeleaf anemone (*Anemone deltoidea* Hook.), starry solomonplume *Smilacina stellata* (L.) Desf.), and sedges (*Carex* spp. L.). Beargrass (*Xerophyllum tenax* (Pursh) Nutt.) is absent.

History

WILDLIFE

The abundant grasses and forbs on the plateau support large populations of rodents and deer. Rodents, including pocket gophers (*Thomomys* spp.), are particularly numerous on clearcut areas. Large rodent populations, however, apparently were present before clearcutting was begun. A 1917 grazing report indicated that "prairie dogs and gophers" were "doing considerable damage" in the Dead Indian area (Brown 1960a). Gophers probably have always been present on the plateau, but intensive trapping of fishers early in this century may have stimulated the growth of gopher populations by eliminating an important predator.[2/] Martens also probably preyed on gophers before trapping eliminated them from the Dead Indian area.

GRAZING

Grazing began many years ago on the plateau. Early access by road from the Bear Creek Valley may have contributed to this activity. Part of the area was accessible by road as early as 1850, and in 1870 the road was extended all the way to Pelican Bay on Upper Klamath Lake (Brown 1960a). Heavy grazing by sheep occurred on much of the Dead Indian Plateau from 1890 until 1940. Some grazing by cattle occurred during this period; cattle grazing increased after 1940 as the sheep were phased out.[3/] In 1913 Dead Indian was the most extensively grazed district on the Crater National Forest, and by 1917 the Cottonwood Glades and Conde Creek areas were reported to be overgrazed (Brown 1960a).

FIRE

Periodic fires probably increased the rangeland available for grazing by opening up the conifer overstory on some portions of the Dead Indian Plateau early in this century. A particularly severe fire occurred

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2/ Mark E. Lawrence (Medford District, BLM--retired), personal correspondence, 1978.

3/ Larsen, Lawrence P. 1975-1977. Field notes on file at the Medford District Office, Bureau of Land Management, Medford, Oreg.

in the drought year of 1910 when 2,300 acres (944 ha) burned in the Deadwood-Moon Prairie area (Brown 1960a). Part of this area burned again in 1917 (Hermann and Thomas 1963), and some of it still does not support trees (fig. 3). Fortunately, most of the plateau was not affected by these fires, and most burned areas either were not completely denuded or have since regenerated. Good cone crops for most species in 1928 probably contributed to forest regeneration in these old burns. Most species also had good seed crops in 1949, 1968, and 1971.[4/]

[4/] Larsen, Lawrence P. 1976. Klamath resource area silvicultural report. Preliminary draft on file at the Medford District Office, Bureau of Land Management, Medford, Oreg. 130 p.

LOGGING

The first timber harvesting operations on Dead Indian Plateau probably were begun early in this century with economic selection of the best old-growth trees (see footnote 4). These virgin old-growth stands contained 40,000 to 125,000 board feet to the acre, International 1/4-inch scale (360 to 1 130 m^3 per ha).[5/] A 1916 report on a fire situation stated that the timber was of inferior quality, however, and that the white fir was particularly defective (Brown 1960a). Large-scale logging operations apparently were

[5/] Lawrence P. Larsen (Medford District, BLM), personal communication, 1978.

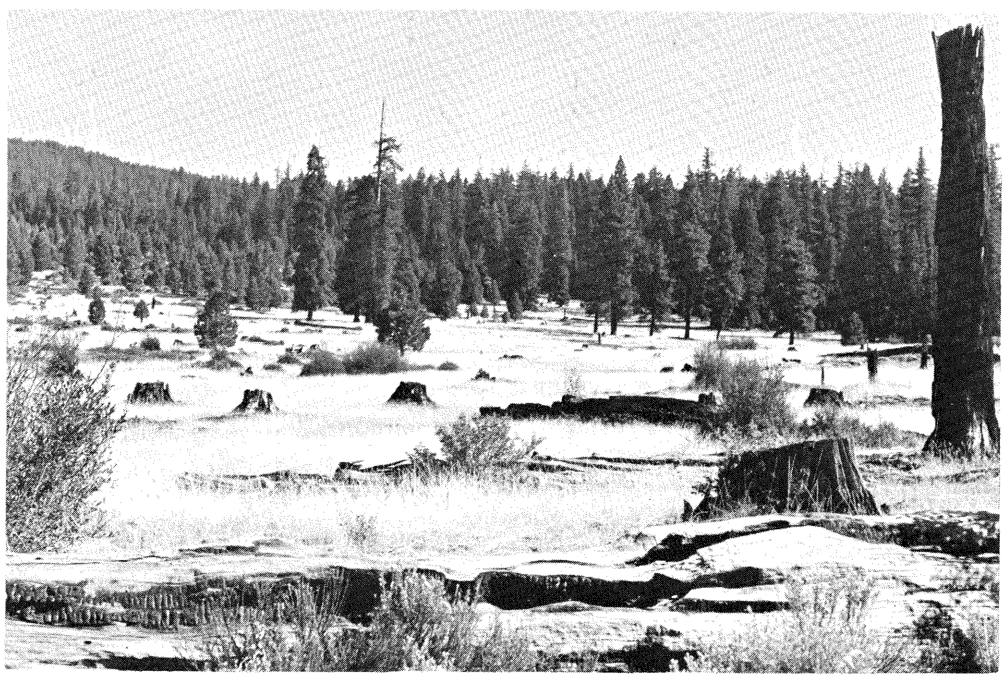

Figure 3.--The Moon Prairie burn in 1977. This area has been poorly stocked with forest regeneration since a 1910 fire and subsequent salvage operations removed the overstory.

not started until the beginning of World War II when selective harvesting using diameter limits was employed. Douglas-firs 24 inches (61 cm) or larger in d.b.h. and white firs 18 inches (46 cm) or larger in d.b.h. were cut (see footnote 4). Timber harvesting on Bureau of Land Management (BLM) land was begun in the early 1940's. National Forest timber sales on the plateau were made in 1943 (Brown 1960b).

Date of the first tree planting on the Dead Indian Plateau has not been determined, but available records indicate that it occurred after 1943. Thirteen acres near Dead Indian Road were planted with ponderosa pine in 1949 (Brown 1960b).

Logging gradually became less selective during the 1950's, and some cutover areas began to resemble "clearcuts thinly disguised by a veneer of poles" (see footnote 4). Small group selection cuts were tried at this time, and a few small clearcuts were logged in high-elevation Shasta red fir stands (Gratkowski 1958). Widespread clearcutting, however, was not started on most of the plateau until 1958 (see footnote 4). In 1958 both 20-acre clearcuts and seed tree cutting were attempted. Almost all the seed trees blew down by 1965 (see footnote 4). Clearcutting in small units was continued until 1963, but it proved to be as unsuccessful as the seed tree method (fig. 4). An intensive BLM reforestation program was started in 1958.[6] Nevertheless, less than half the BLM clearcuts in ranges 3, 4, and 5 east of township 38 south were satisfactorily stocked 12 years after cutting (see footnote 4). Most of these clearcuts were planted approximately three times after an initial 2- to 3-year delay to allow for natural regeneration that never occurred (Lawrence P. Larsen, personal communication, 1978).

[6] Lawrence, Mark E. 1963. Results and conclusions after 5 years of intensive reforestation in the Greensprings and Dead Indian areas. Memorandum on file at the Medford District Office, Bureau of Land Management, Medford, Oreg.

Figure 4.--A poorly stocked 15-year-old clearcut unit on the Dead Indian Plateau. Note the gentle topography and almost complete absence of conifer regeneration.

Regeneration difficulties probably caused both the Bureau of Land Management and the Forest Service to stop clearcutting on the Dead Indian Plateau in 1963. The Forest Service made only sanitation cuts between 1963 and 1970,[7] but BLM foresters continued to practice partial cutting after clearcutting was discontinued. They eventually introduced a three-stage shelterwood system that was applied until 1976, when a two-stage shelterwood system with underplanting was adopted. The Forest Service began shelterwood cutting on their Dead Indian lands in 1970 and began underplanting soon after (Alden Joy, personal communication, 1977). With the exception of a few large clearcuts established on nearby Weyerhaeuser land after 1974, little clearcutting has been done in the Dead Indian area since 1963.

Observations, Field Trials, and Research Studies

Several formal research studies have been established on the Dead Indian Plateau. In addition, many informal observations have been recorded by fieldworkers performing their management and administrative duties. Both sources of information were used in compiling this summary of investigative work accomplished on the plateau.

ENTOMOLOGY

The first formal research efforts in the area were accomplished by employees of the USDA Bureau of Entomology before World War I. Bureau entomologists from Klamath Falls organized a pine beetle control project at Parker Station, just east of the Dead Indian Plateau, early in 1912. As Parker Station was nearer to Ashland than to Klamath Falls, these entomologists moved to Ashland and established the Ashland Field Station in 1912.[8] Pine beetle surveys and research were conducted from this Ashland station. In addition, a considerable amount of research on cone and seed insects was accomplished from 1913 to 1917 by the entomologists stationed there (Keen 1958). Although not mentioned specifically, the Dead Indian Plateau probably provided much of the biological material used in this early research (Miller 1915, 1916).

Several significant contributions resulted from research on pine beetles on the plateau and around it. Studies by Ashland Station entomologists from 1915 to 1919 led to new proposals for control of beetles that were subsequently tested in several experimental projects.[9] Keen correlated ponderosa pine radial growth and numbers of beetle attacks in the Jenny Creek area between 1917 and 1926 and observed that vigorous tree growth resulted in resistance to attack by bark beetles (Miller and Keen 1960). Patterson studied artificial attraction of beetles and the use of solar heat as a control method in the same area during the summer of 1920. When this solar heat method and a more effective burning treatment were applied in southern Oregon and northern California from 1922 until 1925, a 27-percent reduction in losses caused by western pine beetles resulted.[10]

7/ Alden Joy (Ashland District, Rogue River National Forest), personal communication, 1977.

8/ Keen, F. P. 1972. Why the Ashland, Oregon station? Memorandum on file at Forestry Sciences Laboratory, Corvallis, Oreg. 3 p.

9/ Burke, H. E. 1946. My recollections of the first years in forest entomology. Mimeogr. On file at Forest Sciences Laboratory, Corvallis, Oreg. 37 p., illus.

10/ Keen, F. P. 1925. Analysis of results of control. Southern Oregon-northern California pine beetle control project 1922-1925. USDA Bur. Entomol., For. Insect Invest. Tech. Rep. 2, 21 p. On file at Forestry Sciences Laboratory, Corvallis, Oreg.

Southeastern and eastern portions of the Dead Indian area were surveyed annually for pine beetle damage after 1920.[11/][12/] Infested ponderosa pines probably were felled, peeled, and burned in T. 38 S., R. 5 E., and T. 39 S., R. 4 E., in 1924.[13/] After that, the men carrying out annual pine beetle surveys in and around the Dead Indian area recorded major beetle infestations in 1925-26, 1931, and 1934. The 1933 survey was conducted from a camp at Moon Prairie.[14/]

J. E. Patterson, an entomologist at the Ashland Field Station, utilized the construction of Green Springs Highway to study the influence of line slash on the spread of pine beetles to adjacent uncut timber (Patterson 1927). He found the slash to be very attrative to *Dendroctonus brevicomis*, and beetles from the surrounding timber were temporarily concentrated along the new highway. Brood mortality, however, was abnormally high in the slash and normal distribution of the beetle population resumed within a year. Infestation in the surrounding forests was not increased, and Patterson concluded that infestation by *D. brevicomis* may be disregarded when slash disposal is considered.

[11/] Jaenicke, A. J. 1921. Statistical data on the western pine beetle situation on the proposed southern Oregon-northern California control project. South. Oreg. north. Calif. proj., vol. A, No. 1. On file at Forestry Sciences Laboratory, Corvallis, Oreg.

[12/] Keen, F. P. 1923. Instructions for summer survey of 1923, southern Oregon-northern California pine beetle control project. On file at Forestry Sciences Laboratory, Corvallis, Oreg.

[13/] Keen, F. P. 1924. Working plan for fall work, 1924. On file at Forestry Sciences Laboratory, Corvallis, Oreg.

[14/] Keen, F. P. 1938. Report of pine beetle surveys of the Keno area, Klamath working circle. USDA For. Serv. Insect Lab., Portland, Oreg. On file at Forestry Sciences Laboratory, Corvallis, Oreg.

The Ashland Field Station was closed about 1925 (see footnote 8), effectively ending most entomological research in the area. Little research seems to have been conducted or recorded there during the next 15 years, and the Dead Indian apparently slept peacefully until the demands of World War II stimulated timber harvest on the plateau.

FOREST REGENERATION

Even during World War II, the initial light selection logging created no serious problems. Soon after the war, however, when regeneration failures began to be conspicuous, local foresters began to compare notes and set up field trials. Researchers eventually arrived after economic selection cutting was replaced by more intensive forestry practices.

A gradual awakening to some of the most serious regeneration problems has been well summarized by BLM forester W. F. Edinger (1973):

> In the true fir forest, on the Dead Indian Plateau south of Mt. McLoughlin, clear cutting was thought by many to be a way to convert old stagnant, uneven-age stands to a thrifty young forest. Over several years, these early cuttings did not reforest naturally. Plantings of true fir and Douglas-fir died. Ponderosa pine survived some of the time. Often, those that made it through the first summer succumbed to pocket gophers or grasshoppers. Sometimes heavy grass and sedge invasion prevented survival due to competition for moisture in summer.... Ground temperatures up to 140° proved lethal to volunteer and planted trees alike. Despite repeated planting and seed spotting, many of these clearcuts are still unstocked twenty years after cutting.... We have learned the lesson that hot, dry summers and low nutrient soils will not permit us to denude the landscape on the

Dead Indian unless we can somehow manage to make boards out of gophers, weeds, and elderberry bushes.

Even before extensive clear-cutting was begun, attempts to reforest areas denuded by nature in the Dead Indian area sometimes were accompanied by careful measurements of mortality. R. K. Hermann (Oregon State University) and H. Thomas (Rogue River National Forest) published some of these early observations (Hermann and Thomas 1963). In April 1951, a 5.2-acre (2.1-ha) ponderosa pine plantation was established on a portion of the 1910 Moon Prairie burn that reburned in 1917. The 2-0 seedlings were planted 7 feet (2.1 m) apart in 4-ft^2 (0.37-m^2) scalped spots. Part of this early plantation was fenced to keep out livestock, and the area was baited twice with strychnine-treated gopher bait 1 month after planting. A prolonged summer drought in 1951 apparently killed most of the seedlings, for survival was only 25 percent at the end of the first growing season. Subsequent mortality reduced survival in the plantation to 39 of the original 4,700 trees after 11 growing seasons--only 0.9 percent survived. Pocket gophers were the main cause of mortality after the first growing season. Hermann and Thomas observed that gopher damage on the Dead Indian Plateau varied with locality, but most occurred during the winter at high elevations where the snow was deep.

Although detailed records were not kept in every case, ponderosa pines were planted on many open sites during the middle 1950's (Alden Joy, personal communication, 1977). In some of these pine plantations, failure was as spectacular as that reported by Hermann and Thomas. In others, moderate to good survival produced pure young ponderosa pine stands. Unfortunately, most of this early planting stock originated from offsite seed sources. Therefore, most of the surviving plantations only served as nurse crops for natural regeneration. During this period, pine from offsite seed sources was deliberately planted as a nurse crop by the Forest Service at 5,200- to 5,700-foot (1 590- to 1 740-m) elevations in sec. 14, T. 38 S., R. 4 E. Natural regeneration subsequently came in successfully along the edges of the 20-acre (8.1-ha) clearcuts in which this technique was applied, but planting pine from offsite seed sources should be avoided.

Natural regeneration of Shasta red fir was surveyed by H. J. Gratkowski (1958), Pacific Northwest Forest and Range Experiment Station, on four small, high-elevation clearcuts north of Brush Mountain in 1955. Each was 12.5 acres (5.1 ha) in size, and all were cut and slash burned 2 years before the survey. Stocking ranged from 18 to 50 percent of the 4-milacre (0.0016-ha) plots measured--remarkably good for the Dead Indian Plateau. Gratkowski found unburned areas within the clearcuts much more heavily stocked than burned areas. He did not favor artificial regeneration of these high-elevation sites and recommended that clearcut size be limited to 15 to 20 acres (6.1 to 8.1 ha).

During the next few years (1959-62), several BLM silvicultural reports from the Dead Indian area noted that natural regeneration would occur under many partially cut stands if enough time were allowed (see footnote 4). The silvicultural reports also mentioned advance regeneration, often present in sufficient quantity to stock the future stand. Unfortunately, some of these reports were overly optimistic. A 1960 memorandum predicted that a north slope draw in NW1/4 sec. 11, T. 38 S., R. 3 E., could be successfully clearcut "...with the chance of reproduction coming in naturally fairly good," but the clearcut was still not stocked in 1975 (see footnote 4).

Forest Service foresters tried to supplement the natural seed crop in 1961 by helicopter-seeding 40 acres in sec. 3, T. 38 S., R. 4 E. The attempt was a complete failure (Alden Joy, personal communication, 1977). Reforestation problems on the Dead Indian Plateau and progress during the 1958-63 period were summarized in a BLM memorandum by Lawrence, who observed that frost heaving was bad and natural regeneration very slow.

He also noted that "Borrow pits where the A horizon is removed frequently have good pine reproduction, which indicates that we may need to tear up the A horizon more or remove it" (see footnote 6). This observation was reinforced by William Stoate, an Australian working in northwestern California at that time. Stoate visited the Dead Indian Plateau and also suggested removal of the A horizon (Mark E. Lawrence, personal communication, 1977). This was tried shortly thereafter (1964-65) by terracing several clearcut areas along the Conde Creek access road (sec. 17, T. 38 S., R. 3 E.). Gophers killed the planted seedlings on these terraces, and the attempt failed. Several years later, BLM foresters tried to control gophers on the terraces by setting out baits with a tunnel builder, but efficient use of the machine was apparently prevented by rocky soil. Seedling mortality precluded any measurements at Conde Creek, but site deterioration may follow removal of the A horizon.

Seedling mortality also hindered the measurements of Richard K. Hermann, an Oregon State University researcher who set up several experiental plantations on the plateau during the middle 1960's. His initial ponderosa pine plantation was abandoned after 2 years when gophers caused losses of nearly 100 percent. A second study used artificial depressions ("shurfs") to trap moisture, three plowing depths, three species (ponderosa pine, Douglas-fir, white fir), and three stock types (2-0, 2-1, 2-2). Again, losses caused by gophers were so high (above 90 percent) that it was impossible to assess treatment effects. Despite these setbacks, Hermann established a third study in 1964. It involved southwestern Oregon Douglas-fir provenances planted in a fenced clearcut area near the Conde Creek access road (sec. 17, T. 38 S., R. 3 E.). He replanted this last area three times and finally gave up after the trees were consecutively destroyed by grasshoppers and gophers.

D. Minore (1971), Pacific Northwest Forest and Range Experiment Station, artificially shaded recently planted Douglas-fir seedlings north of Moon Prairie by piling logs and/or rocks around them in May 1968. After two growing seasons the survival of these shaded seedlings (60 percent) was significantly better than that of adjacent unshaded seedlings (10 percent) planted at the same time. Seedlings planted under the shade of living shrubs or trees also survived significantly better than those in the open. Shade was essential to survival of Douglas-fir seedlings on this hot, dry site.

Shade requirements probably are influenced by the abundant grass cover commonly found on the Dead Indian Plateau--a grass cover that may be considered either a bane or a blessing, depending on one's viewpoint and management objectives. A recent Pacific Northwest Forest and Range Experiment Station survey of regeneration on the Dead Indian Plateau showed conifer stocking to be poorer on grass-dominated sites than on sites dominated by herbaceous or woody vegetation.[15] Stein's comments are excellent summaries of the timber management viewpoint. "Development of grass is one of the quickest ways to render a site inhospitable to young trees. Once a site is lost to grass, establishment of trees requires extraordinary effort." He cites examples to show that the cattle which pasture on this grass compound the problem by trampling seedlings and damaging woody perennials that provide cover.

The cattle that trample seedlings also produce the beef needed by our growing population, however, and grazing may not always damage seedlings (Alden Joy, personal communication, 1977). Beef production should not be ignored when grass is considered on the Dead Indian Plateau. Range for deer and other wildlife benefits should also be considered. These factors were evaluated by Forest Service personnel in 1973 after

[15] Stein, William I. 1978. Regeneration outlook on Bureau of Land Management lands in the southern Cascades. Data on file at Forestry Sciences Laboratory, Corvallis, Oreg.

intensive site preparation eliminated the natural vegetation in many Ashland District stands. They decided that such site preparation resulted in unacceptable forage and wildlife conditions. Accordingly, the District began seeding grass after all shelterwood cutting operations.

Standard Forest Service operating procedure on the plateau from 1973 through 1977 was (Alden Joy, personal communication, 1977):

1. A two-stage shelterwood system was initially cut to leave 100-110 ft^2 of overstory basal area per acre (23-25 m^2/ha).
2. Brush-bladed tractors were used to pile brush, and the seed bed was ripped as soon as possible after the shelterwood cut.
3. A grass seed mixture was broadcast in the fall.
4. Douglas-fir and white fir bare-root seedlings were hoe-planted at 8- by 8-ft (2.4- by 2.4-m) spacing the following spring.

The grass seed mixture broadcast in the fall consisted of 50 percent orchard grass, 44 percent tall fescue, and 6 percent timothy or highland bent. It was applied at the rate of 16 pounds per acre (17.9 kg/ha) from 1973 through 1975. In 1976 and 1977 the amount was reduced to 15 pounds per acre (16.8 kg/ha), and only orchard grass was used. Orchard grass may be planted again in 1978; but only 4-6 pounds per acre (4.5-6.7 kg/ha) will be used, and grass seeding will be deferred until 1 year after tree seedlings have been planted.[16]

Bureau of Land Management foresters are not applying grass seed in the two-stage shelterwood operations they adopted in 1976. Indeed, in partially cut stands underplanted several years after cutting, one BLM forester believes that newly planted seedlings "don't stand a chance" without scalping or grass control (Larsen's field notes--see footnote 4). Larsen blamed improper seed sources, poor seedling condition after transport to the planting site, lack of adequate site preparation, and/or bad planting technique for the failure of more than half the areas underplanted by BLM foresters in the Dead Indian area during 1975. He observed little difference in the success of spring- and fall-planted Douglas-fir in these partial-cut plantations but found that white fir did best if lifted and planted in the spring.

Larsen's field notes contain many excellent observations and several astute conclusions. He limits the area in which severe regeneration problems occur to that portion of the plateau west of a line drawn from Deadwood Junction to Jenny Creek Spring, thence to the summit of Chinquapin Mountain, then south to the Green Springs Highway; but he notes that mountain summits east of that line have similar problems (gophers and other small rodents, insects, competing vegetation, and frost).

D. M. Williamson (1978), Oregon State University, studied frost and moisture to evaluate factors affecting the survival and growth of planted seedlings on the plateau. He also evaluated the effects of overstory canopy, cattle fencing, rodent caging, planting-stock species, and stock type during this study, which involved four experimental plantations established in 1975. They consisted of bare-root and container-grown seedlings of Douglas-fir, white fir, and ponderosa pine planted on four severe sites on the Dead Indian Plateau. Replicated gopher caging, cattle fencing, and irrigation treatments were applied on each site--half under the canopy of a partially cut stand and half in an adjacent open area.

After two abnormally wet growing seasons, Williamson concluded that frost and pocket gophers seemed to be the most important variables affecting survival and growth of all species and stock types. Average survival under the canopy (88.8 percent) was significantly better than survival in the open (36.4 percent). Minimum growing season

[16] William H. Harbaugh (Ashland District, Rogue River National Forest), personal communication, 1978.

temperatures under the canopy averaged 9°F (5°C) warmer than those in the adjacent open areas, and much less frost damage occurred there. Gopher caging improved survival in the open but not under the canopy--probably because of larger populations of gophers in the open. As expected, survival of ponderosa pine was better than that of Douglas-fir or white fir in the open. Under the canopy, however, survival of species did not differ, and container-grown Douglas-fir and white fir stock grew better than all other stock, regardless of species. Williamson concluded that the presence of an overstory canopy apparently is the single most important factor contributing to plantation success on the Dead Indian Plateau.

Where there is no overstory canopy, frost-resistant planting stock and/or gopher control seem necessary. Lodgepole pine appears to be even more resistant than ponderosa pine to summer frosts on the plateau, and Jeffrey pine seems to resist snow breakage better.[17] Snow breakage becomes increasingly important as elevation increases, and Forest Service foresters prefer to plant mixtures of Douglas-fir and white fir (and rust-resistant white pine when available) at high elevations, ponderosa pine at lower elevations around Howard Prairie Reservoir (Alden Joy, personal communication, 1977).

W. I. Stein (see footnote 15) surveyed natural and artificial regeneration at both high and low elevations throughout the Dead Indian area in 1973 and 1974 by sampling randomly selected partially cut and clearcut areas logged during the 1956-70 period. He found that total regeneration increased with the abundance of woody perennials and decreased with radiation index (a figure based on slope and aspect) on both partially cut and clearcut areas.

[17] Duane Kingsley (Rogue River National Forest), personal communication, 1977.

Regeneration of Douglas-fir and true firs decreased as ground cover increased in the clearcuts, but only true firs were adversely affected by ground cover in partial cuts (see footnote 15). Stocking ranged from 5 to 100 percent (average, 65 percent) in the 52 Dead Indian partial cuts sampled by Stein's Pacific Northwest Forest and Range Experiment Station survey crews. Approximately half their stocked 4-milacre (0.0016-ha) plots were dominated by advance regeneration. Stocking ranged from 0 to 75 percent (average, 33 percent) on the 16 clearcuts sampled, but only 4 were at least 50 percent stocked. Most of this clearcut stocking was established after cutting. Stein listed frost, vegetative competition, grazing, and gophers as the primary factors hindering the establishment and growth of forest tree seedlings on the Dead Indian Plateau. His survey data will soon be published.

PATHOLOGY

A 1958 aerial survey of Douglas-fir dwarf mistletoe damage was conducted by Pacific Northwest Forest and Range Experiment Station pathologists. It included the Dead Indian Plateau and was summarized in a progress report.[18] Flying from north to south along section lines 2 miles (3.2 km) apart, the pathologists identified and mapped areas of light, moderate, heavy, and very heavy mortality. Acreages in each mortality class were determined from the aerial sketch maps. Ground surveys were subsequently accomplished to determine the diameters, mistletoe infections, and risk ratings of sample trees in the mapped areas. Although approximately 12 percent of the old-growth Douglas-fir trees in the Dead Indian area were heavily infected with dwarf mistletoe, no moderate, heavy, or very heavy mortality classes were mapped on the plateau.

Where mistletoe infections occur,

[18] Aho, Paul E., and Lyle N. Anderson. 1959. Douglas-fir dwarfmistletoe aerial survey, Rogue River National Forest, 1958. Office report on file at Forestry Sciences Laboratory, Corvallis, Oreg. 12 p.

the Forest Service now applies stand cleaning techniques to reduce or eliminate them. In clearcuts threatened by mistletoe, infected residual trees are killed, infected species are eliminated in surrounding stands, and susceptible plantation seedlings are often kept away from the adjoining uncut stand. In shelterwoods, infected species are removed in the first cut, species are mixed in the understory plantation, infected understory trees are eliminated during subsequent thinning operations, and the perimeters of plantations are protected.[19]

Other forest diseases are often less evident than mistletoe, but they can be just as destructive. Heart-rot fungi are particularly important in mature stands. P. E. Aho (Pacific Northwest Forest and Range Experiment Station) studied these organisms and their effects on the Dead Indian Plateau from 1966 until 1970. He found four to be most important: *Echinodontium tinctorium*, *Phellinus chrysoloma*, *Pholiota adiposa*, and *Hericium abietis*. Dissecting defective trees, Aho identified infection courts (branches and basal wounds), correlated hidden decay with visible defect indicators, and developed two methods for estimating defect in standing white fir trees in southwestern Oregon (Aho 1975). One method uses defect percentage tables based on d.b.h., age, and decay indicators. The second provides average length deductions below and above various indicators, with flat percentage factors for hidden defect. Defect indicators include conks, punky knots, wounds, scars, frost cracks, crooks, forks, mistletoe cankers, dead or broken tops, and dead vertical branches. Defect estimation techniques were summarized by Aho and Roth (1978).

Aho also identified nitrogen-fixing bacteria associated with fungi (Aho et al. 1974) and suggested an important role for these microorganisms in the decay process. Decay should have little effect on selection of future white fir rotation ages.[20]

RODENTS

Rotation ages become meaningless in areas where gophers destroy the seedlings before a stand can be established. Fortunately, not all areas are seriously affected. Larsen (see footnote 3) divided the problem of pocket gophers into three categories:

1. Light damage is usually found on clay soils or where brush is a rapid invader (e.g., Brush Mountain).
2. Moderate to heavy damage is common where grass constitutes the dominant invading vegetation after timber harvest (e.g., the Conde Creek and Moon Prairie areas).
3. Heavy to extreme damage is found in areas characterized by open glades with abundant lupine, yarrow, and wild pea (e.g., Cottonwood Glades and the summit of Surveyor Mountain).

Larsen believes that foresters "can live" with damage in the first category and can practice vegetative manipulation in the second but that they have few options other than buffer strips and limited direct control in the third category.

Direct control of gophers is laborious and expensive. Baiting is cheaper than trapping, but neither work well where gophers are present in surrounding areas. "The physical job of baiting runways 4 to 8 inches below ground surface over any large area with 50-70 gophers per acre is very demoralizing," and "...the unoccupied burrow systems are rapidly

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[19] Kingsley, Duane. 1978. Dwarf mistletoe control on the Rogue River National Forest in Oregon. Paper presented at the Dwarf Mistletoe Symposium, Berkeley, Calif., April 11-13, 1978, 5 p.

[20] Aho, Paul E. 1968. Defect in white and red firs on the Rogue River National Forest - 1968. A progress report on file at Forestry Sciences Laboratory, Corvallis, Oreg. 20 p.

reoccupied by invasion from adjacent populations" (see footnote 3).

Direct control of gophers is not always necessary. Deliberate plant community modification to reduce the gophers' food supply in cutover areas was initiated in 1970 by E. F. Hooven.[21/] He applied atrazine and 2,4-D to plots in sec. 4, T. 38 S., R. 4 E. This work was expanded in a 1972-76 study by Black and Hooven (1975, 1977) on eight unstocked, 20-acre (8.1-ha) clearcut units in sections 13 and 17, T. 38 S., R. 3 E. They applied four herbicide treatments:
(1) atrazine + simazine, (2) 2,4-D, (3) atrazine + simazine + 2,4-D, and (4) spot treatment with atrazine. The spot treatment was applied only once, after a 1972 planting. The other treatments were applied three times, in 1972, 1973, and 1974. Conifer seedlings planted in the fall of 1972 failed to survive, as did those planted in the fall of 1973. The treated plots were planted a third time in November 1974 in five-species clusters of ponderosa pine, incense-cedar, Douglas-fir, white fir, and lodgepole pine. A final five-species planting was accomplished in the spring of 1975. Gopher activity, seedling damage, herbaceous cover, and conifer mortality were monitored annually.

Black and Hooven (1975) also studied the treatment response of small mammal communities. In the clearcuts, these mammal communities contained the following principal species, in order of abundance:[22/] deer mouse (*Peromyscus maniculatus*), Great Basin pocket mouse (*Perognathus parvus*), long-tailed vole (*Microtus longicaudus*), yellow pine chipmunk (*Eutamias amoenus*), vagrant shrew (*Sorex vagrans*), golden-mantled ground squirrel (*Spermophilus lateralis*), and Townsend's chipmunk (*Eutamias townsendi*). Except for pocket mice and deer mice, diversity and abundance of small mammals were not markedly affected by herbicide treatment in the clearcuts. (Pocket mice increased and deer mice sharply decreased after herbicide treatment). In the surrounding partially cut stands, pocket mice were absent and deer mice were present in very low numbers. The red-backed vole (*Clethrionomys gapperi*) was abundant in the partial cuts, as was Townsend's chipmunk, but yellow pine chipmunks were absent or scarce.[23/]

A detailed report of the Black-Hooven research is being prepared for publication. In general, gopher damage to seedlings was reduced on areas treated with atrazine and simazine. Mortality of seedlings was least where all three herbicides had been applied together. Pines survived better than firs where grass was not controlled, but few seedlings of any species survived competition from uncontrolled grass.

SOIL MOISTURE

Seedling survival often depends on adequate soil moisture. Year-to-year variation occurs, but seasonal trends are evident every year. Larsen (see footnote 3) categorized these trends on the Dead Indian Plateau during "planting season:"

"November-December 10----Moisture only in top 3 inches" (7.6 cm).

"December 11-January 1----Moisture to 6 inches" (15.2 cm), "depending on snow and thaw conditions.

March, April, and May----Soil profile saturated.

May-June----Exposed level or south slopes drying rapidly to 3 inches" (7.6 cm).

21/ Edward F. Hooven (Oregon State University), personal communication, 1977. Mention of pesticides in this publication is for the information and convenience of the reader. Such use does not constitute an endorsement by the U.S. Department of Agriculture. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

22/ The source for scientific names for mammals is Larrison (1976).

23/ Black, Hugh C. 1973. Correspondence with W. R. Smith, Bureau of Land Management, Oregon State Office, June 25, 1973. On file at BLM, Medford District Office, Medford, Oreg.

"July----Beginning of drought.

August, September, and October----Soil like powder to 12 inches" (30.5 cm).

After finding high elevation sites where the soil was just as dry in the spring as in the previous fall despite deep soils and an adequate snowpack, Larsen concluded that freezing soil temperatures before the snowpack builds up can be serious deterrents to subsequent percolation and moisture recharge of the soil profile.

Soil moisture was studied on the plateau in 1965 by William E. Hallin (1968), a research forester from the Pacific Northwest Forest and Range Experiment Station. He sampled soil moisture content, moisture tension, and soil texture at 6-, 18-, and 36-inch (15-, 46-, and 91-cm) depths in three locations in a large cutover area "...to determine whether moisture depletion by vegetation was great enough to be a factor in planted tree mortality." Hallin removed vegetation from one 10-foot (3-m) square area with a hoe and used a tractor-pulled plow to furrow the second location; he left the third location undisturbed. Six inches (15 cm) below the surface, the undisturbed soil sample had 100 times more soil moisture tension than either the hoed or furrowed samples by the last week in July. At the 18-inch (46-cm) depth, moisture tension was approximately seven times greater in the undisturbed location. Soil moisture tension of approximately 15 atmospheres constitutes the moisture content at which permanent wilting occurs in most soils (Bonner and Galston 1952, p. 144). As soil at the undisturbed location reached a tension of 101.7 atmospheres at 6 inches (15 cm), moisture depletion by vegetation was great enough to affect mortality of planted trees in the sampled cutover. Hallin recommended planting or seeding immediately after harvest cutting, before competing vegetation becomes established. Alternatively, established vegetation could be removed or killed before establishment of forest regeneration is attempted.

COMPETING VEGETATION

Removing or killing the competing vegetation in Dead Indian clearcuts was accomplished in several ways during the 1964-70 period. With Hallin's help, the Forest Service set up a trenching program for Ashland District clearcuts. An AC-24[24/] tractor with construction ripper teeth and a double moldboard plow held in the ground by 1,400 pounds (635 kg) of hydraulic pressure were used to construct furrows 2 feet (0.6 m) deep and 3 feet (0.9 m) wide (Alden Joy, personal communication, 1977). After lying fallow for 1 year, the furrows were planted at an 8-foot (2.4-m) spacing. Snow collected in the furrows, and there was 38 percent more moisture in the furrows than under the adjacent grass when soils were sampled in July (Alden Joy, personal communication, 1977). The trenching operation cost approximately $40 per acre ($98 per ha) in 1965.

Approximately 600 acres (243 ha) were trenched in Forest Service clearcuts on the plateau. In addition, the Medco Company trenched some of their land in the area. Trenching succeeded where pocket gophers were not a problem. Unfortunately, most areas on the plateau are plagued by gophers. Baiting the trenched areas helped some, but gophers continued to cause severe damage until surviving furrow-planted trees were waist high on most sites. The furrowing apparently was completely successful only where gophers were not present in adjacent areas. In one of these successful areas (sec. 3, T. 38 S., R. 4 E.), alternate rows of lodgepole and ponderosa pines were planted in the trenches. Both species survived and grew similarly in this Forest Service trial (Alden Joy, personal communication, 1977).

24/ Mention of companies and products by name is for the information and convenience of the reader and does not constitute an endorsement by the US Department of Agriculture to the exclusion of other products which may be suitable.

A somewhat different method of removing vegetation was used by Boise-Cascade Company foresters during the late 1960's. They scarified many areas by blading off the grass in strips with a tractor. This scarification treatment apparently was successful in controlling grass, but gophers seem to have destroyed all the seedlings subsequently planted.

After this discouraging experience with scarification, Boise-Cascade foresters began using atrazine to control the serious grass competition in the Dead Indian area. Their initial preplanting spring applications often were unsuccessful. Snowpacks sometimes lingered until quite late in the spring on the plateau, and subsequent rainfall was insufficient to wash in the chemical after spraying could be done. Spraying atrazine after planting also seems to have been unsuccessful. Gophers probably ate the planted seedlings the following winter. Boise-Cascade now sprays with atrazine in the fall, then plants the sprayed areas 1 year after the following spring--successfully.

SITE CLASSIFICATION

Successful results obtained on one site often are not applicable to other sites on the Dead Indian Plateau. Soil variation may be responsible. In 1969 the Oregon State Water Resources Board published general soil map reports for the Klamath (Cahoon and Simonson 1969) and Rogue (Power and Simonson 1969) drainage basins. Including soil series descriptions as well as general soil series maps, these publications provided a general orientation for foresters comparing the soils on different parts of the Dead Indian Plateau. They also provided useful documentation for the observations of men like M. E. Lawrence, who had long noticed that regeneration problems were much less serious east of a soil change that occurs around the summit of Keno Road above Moon Prairie (Mark E. Lawrence, personal communication, 1977). More detailed soil maps were published by the Bureau of Land Management (deMoulin et al. 1975) and the Weyerhaeuser Company (Duncan and Steinbrenner 1975) several years later. Unfortunately, Weyerhaeuser's superb soil survey did not include all the Dead Indian Plateau.

A vegetation survey of the plateau was accomplished during the 1967-76 period by O. E. Hickman; although not published yet, it is a study of vegetative classification and geographical distribution of plant communities in the area.[25]

D. Minore and R. E. Carkin (1978), Pacific Northwest Forest and Range Experiment Station, studied vegetation, soils, overstory canopy, and natural regeneration in the Dead Indian area from 1973 through 1976. They measured 17 environmental variables, then used stepwise multiple regression analyses in relating them to postharvest natural regeneration on 55 partially cut areas. Total soil nitrogen, overstory canopy density, and vegetation were significantly correlated with natural regeneration stocking percent. The nitrogen correlation was negative--perhaps as a result of frost sensitivity induced by soil fertility. All other things being equal, optimum canopy density for natural regeneration was 60 percent. A vegetation index derived from the species present was well correlated with natural regeneration in the sample stands, and Minore and Carkin used it to separate the sites needing underplanting from those that did not. They concluded that 80 percent of the stands on the Dead Indian Plateau require underplanting.

Regardless of the management technique applied, some plateau areas are more difficult to regenerate than others. For example, comparison of the natural regeneration stocking recorded by Minore and Carkin (1978) with the soil series mapped by Cahoon and Simonson (1969) and Power and Simonson (1969) revealed several soil-regeneration relationships. Natural regeneration tended to be

[25] O. Eugene Hickman (Soil Conservation Service), personal communication, 1977.

poor on the Pokegama, (Ho), and (Ta) series. It was somewhat better on Woodcock soils, but Oatman soils seemed to have the best natural regeneration.

STAND AGE AND STRUCTURE

Data on stand age and structure were collected by Minore and Carkin in 1976 but not published in their 1978 research note. Overall, their age measurements on the plateau indicate that the mixed conifer forest on the Dead Indian Plateau is uneven aged; trees of every age are present in an age distribution reminiscent of the all-aged stands pictured in silviculture texts (fig. 5). With the exception of a few even-aged stands (e.g., the 50- to 70-year-old white fir-Douglas-fir stand on Chinquapin Mountain), individual sample stands also were uneven aged when considered as separate entities (fig. 6). The average within-stand age range was 301 years.

The uneven-aged nature of these forest stands indicates that most of them did not originate after severe fires or other catastrophes. Neither has regeneration been the result of particularly favorable climatic conditions. Almost every year, regardless of climatic fluctuation, a few seedlings seem to have become established. Regeneration on the Dead Indian Plateau seems to be a slow, steady process rather than a rapid, intermittent one. Under natural undisturbed conditions, the uneven-aged forest replaces itself slowly and evenly, perpetuating an unevenage distribution.

As one would expect when the understory trees experience varying degrees of suppression, age-diameter relationships are quite variable in the Dead Indian area. White fir poles, 4- to 6-inch (10- to 15-cm) d.b.h., varied from 45 to 134 years old in Minore and Carkin's measurements. Douglas-fir and incense-cedar did not vary as much but displayed a considerable age range within each diameter class. Surprisingly, all three species responded vigorously when released from suppression by stand thinning operations--at almost

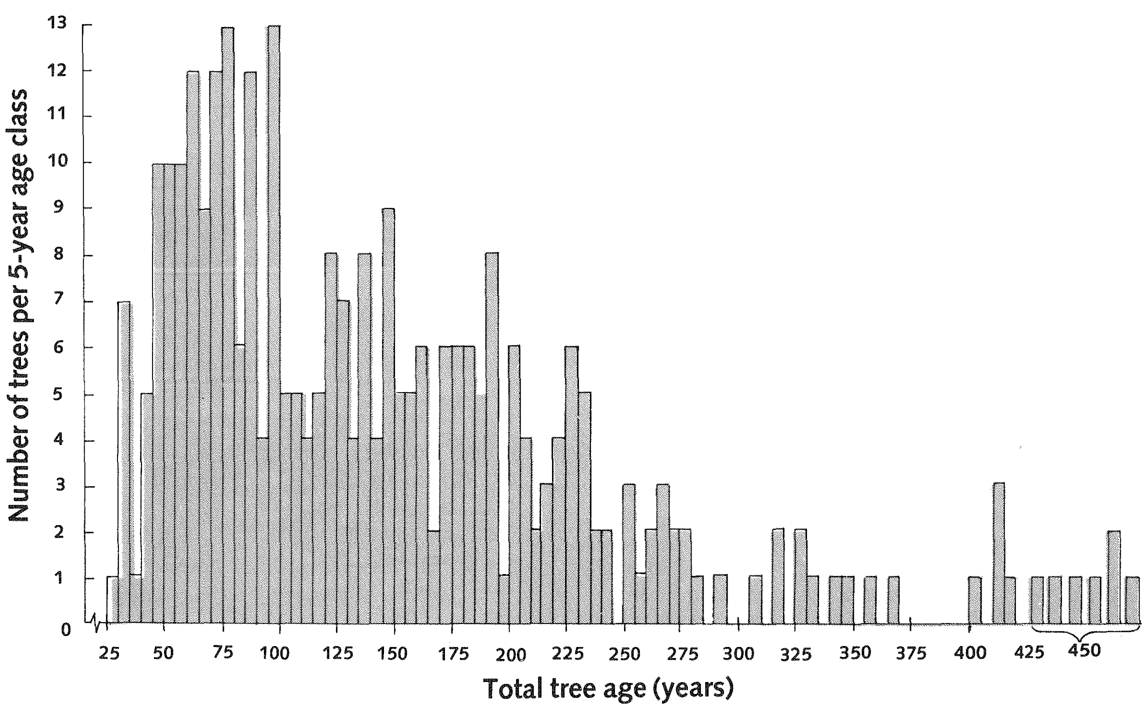

Figure 5.--Age distribution of 300 randomly chosen trees on the Dead Indian Plateau, all species.

Figure 6.--A typical uneven-aged mixed conifer stand after partial cutting. Tree ages vary even more than their sizes indicate.

all ages. Slow-growing, suppressed white firs, Douglas-firs, and incense-cedars up to 200 years old immediately formed much wider annual growth rings after surrounding trees were thinned by partial cutting. Trees of all ages--even large sawtimber trees--respond well to stocking reductions in the Dead Indian area.

Variability in age-diameter relationships could produce diameter distributions that are more uniform than age distributions (young and old trees might have similar diameters). To find out, I constructed a frequency distribution for 1,736 sample diameters tallied on the plateau during 1976 (fig. 7). If a curve is plotted over the bar tops shown in figure 7, an inverted J shape is produced--a shape almost identical to that presented in textbooks as the theoretical distribution of diameter classes in a managed uneven-aged selection forest. Similar diameter distributions result when individual species are considered separately.

Some of the regeneration difficulties experienced by forest managers on the Dead Indian Plateau may result from applying even-age management techniques and expectations to an uneven-aged forest. Where acceptable natural regeneration is anticipated and underplanting is unnecessary, the uneven-aged stands probably should be maintained by selective cutting.

WORK IN PROGRESS

Tractor logging often creates a compaction layer 4 to 6 inches (10 to 15 cm) below the surface of some loose, structureless soils west of Moon Prairie. Farther east, the soils tend to have more structure and are less subject to significant compaction.[26] Seedling roots pene-

[26] Observations of S. Shade (Medford District, BLM), as recorded by L. Larsen (see footnote 3).

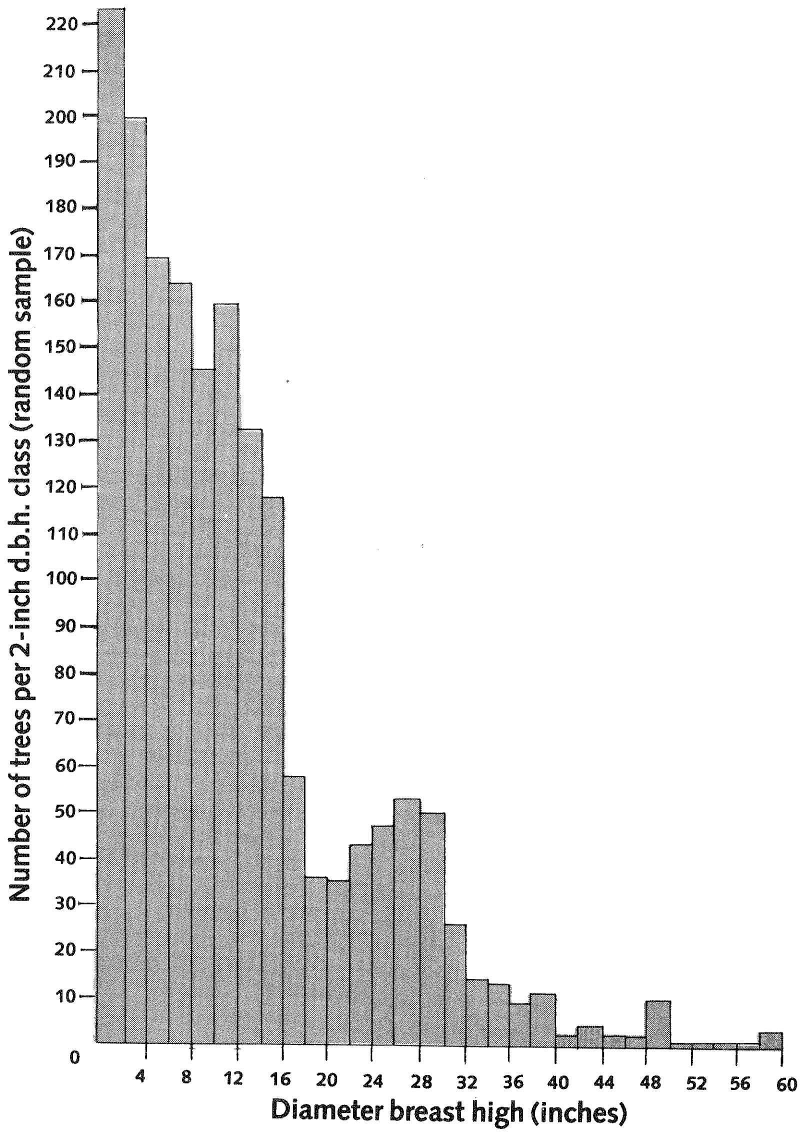

Figure 7.--Diameter distribution of 1,736 sample trees on the Dead Indian Plateau, all species.

trate compacted layers with difficulty, and these layers constitute a deterrent to regeneration. Attempting to ameliorate this condition, the Bureau of Land Management tractor-ripped portions of the previously terraced Conde Creek area in 1977. Results have not been evaluated.

Lodgepole pine plantations may soon be evaluated by Boise-Cascade foresters. Apparently, they hope to reforest frost pockets with the frost-tolerant lodgepole, then get natural regeneration of other species under the resulting cover. The Boise-Cascade foresters have obtained lodgepole pine seeds from plateau sources and are now growing their own planting stock.

Seed collection began on the plateau in 1976 for a study of Douglas-fir breeding zones in southwestern Oregon--a cooperative study involving BLM, Oregon State

University, and the Pacific Northwest Forest and Range Experiment Station.[27] Elevation, latitude, distance from the ocean, aspect, slope, shade profile, vertical distance from the drainage bottom, and vertical height of the major slope on which it is located were recorded at each collection site. The purpose of the study is to provide a practical guide for use in moving seed and for delineating seed zones. This 10- to 12-year study will involve the establishment and monitoring of plantations in 120 locations.

Although most Weyerhaeuser Company research is concentrated in locations east of the plateau, company researchers established several small ponderosa pine-white fir species trials on the Dead Indian Plateau in 1975.[28] A Weyerhaeuser-Boise-Cascade cooperative study near Conde Creek involves the testing of strychnine-oat gopher baits encased in plastic sacks to prevent moisture deterioration.

Conclusions and Recommendations

Several generations of careful observation and research have shown that it is difficult to secure satisfactory forest regeneration on most of the Dead Indian Plateau. Although limiting factors vary among individual sites and differ from year to year, three negative influences seem to be responsible for this poor regeneration: pocket gophers, frost, and the moisture stress produced by vegetative competition. Partial solutions have been devised for each of these problems, but none of the problems have been eliminated.

As normally practiced, clearcutting produces severe regeneration problems on the Dead Indian Plateau. Even small clearcuts remain poorly stocked for years. Intensive site preparation to remove all competing vegetation followed by efficient gopher control and the planting of carefully grown ponderosa pine planting stock of local origin seems to be succeeding where applied by Weyerhaeuser foresters east of the plateau. Their techniques probably would work just as well throughout the Dead Indian area wherever pine monoculture is desired. Replacing the native white fir-Douglas-fir mixed conifer forests with pure ponderosa pine might create unforeseen problems, however, and to attempt large-scale forest type conversion now would probably be unwise.

The many old, unstocked clearcuts on the Dead Indian Plateau should be restored to productive forest stands before any new forest type conversions are attempted. Repeated applications of herbicides (simazine, atrazine, and 2,4-D) to control competing vegetation and reduce the gopher population, followed by the planting of a frost-tolerant tree species (e.g., lodgepole pine) seems to be the best available method. Subsequent gopher baiting may be necessary on some sites. Where frost-sensitive trees are planted in these open clearcuts, additional cover (artificial shading, nurse crops, etc.) should be provided.

Cover is available under partially cut stands. Natural regeneration is rapid in a few of these stands, and an initial cut that leaves an overstory canopy of 60 percent should result in abundant understory seedlings. As an overstory of 60 percent is difficult to remove all at once without damaging established regeneration, individual tree selection and the maintenance of an uneven-aged stand may be desirable in these rapidly regenerating stands. They may be identified before cutting by examining the vegetation and referring to the vegetation index published by Minore and Carkin (1978). Unfortunately, natural regeneration in most Dead Indian stands is too slow to be practical. Underplanting is necessary if a new stand is to be established

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[27] Campbell, Robert K. 1977. Delineation of breeding zones for Douglas-fir in southwestern Oregon. Study plan on file at Forestry Sciences Laboratory, Corvallis, Oreg. 9 p.

[28] David Russel (Weyerhaeuser Company), personal communication, 1977.

in a reasonable time period. Container-grown white fir and Douglas-fir planting stock seem appropriate for these underplanting operations.

Continued research and careful observation are essential for progress in forest management on the plateau. Our present knowledge, though useful, provides as many questions as it does answers. For example, we now know that an overstory canopy of 60 percent probably is optimum for natural regeneration, but we do not know the minimum overstory cover that is required to prevent frost damage to underplanted seedlings.

Any overstory canopy cover, optimum or minimum, has to be removed sooner or later. Can this be done without eliminating the understory regeneration? If so, how and when? The initial shelterwood cut and subsequent removal of the overstory will probably compact the soil. Will this soil compaction reduce site quality? If it does, what can be done to prevent or reduce the compaction?

With or without soil compaction, what species or species combinations should be managed on the variety of sites available to the Dead Indian land manager? Which will produce the most timber? Should grazing and timber production be combined on the same multiple use areas or separated? If combined, how can they best be coordinated to produce both beef and boards?

All the above questions should be answered, but they certainly do not constitute a complete or final list. A final list is nearly impossible, for future problem solving will produce further questions. The process, like life, is an unending cycle of temporary setbacks and new beginnings. Viewed in this light, the Dead Indian Plateau seems to have been poorly named. Characterized by controversy, struggle, and achievement, it is an area with many lifelike attributes. If past and present observations, field trials, and research studies are used as criteria, the plateau is not dead but very much alive.

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