TIMBER GROWING VERSUS GRAZING ON THE NON-FORESTED AREAS OF THE McDONALD FOREST

by

LYLE A. BAKER

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Table of Contents

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Introduction

Statement of Problem

According to G. A. Pearson (30) a comparison of timber and forage values on forest lands must consider, first, the need for timber and livestock products, both local and national; second, the returns from each in revenue to the landowner and to the public in the form of local industry and employment; and, third, the capacity of each resource to support profitable industry.

Public values of forest and range may be compared on two bases:

1. Direct products of the soil, as standing timber on one hand and standing forage on the other.

2. Industrial products, as lumber on one hand or meat and wool on the other.

It is the purpose of the author to use the first comparison listed. That is, to compare the value of growing timber with the value of raising forage for livestock on the non-forested areas of the McDonald Forest, and the objective is to determine to which use,

timber growing or grazing, these non-forested areas should be put.

Past and Present History of Forest

The McDonald Forest is a tract of forest land about seven miles north of Corvallis, Oregon. This area consists of 4,821 acres. It is used by the Oregon State College School of Forestry for a field laboratory and research area.

This tract of land has had a very interesting history. It was the primary intent of the pioneers coming into this area to use the land for agriculture. Few books carry a summary of land ownership and use since those first days of exploitation, and there are still fewer records for lands predominately forest in character.

The first private owner of property now included in the McDonald Forest was George E. Cole. He purchased an eighty-acre tract from the Office of Commissioned Control of the Oregon Territory in the year 1855. It was 1864 before any more of these properties passed into private ownership.

"From 1864 until the early 1900's by 80-, 120-, or 160-acre tracts the remaining properties now in this school forest passed into private ownership, final

transfer from public to private ownership transpiring in 1917" (2). Since the original date of purchase from the federal government a number of the properties have had as many as twenty title transfers.

In 1926 the first property was acquired by the School of Forestry at Oregon State College for use for laboratory and research purposes. In the fourteen years that have elapsed since the first acquisition, 4,821 acres have been obtained principally as a result of generous bequests by the late Mary J. L. McDonald.

"Land use practices, like ownership, have changed materially since the earlier days of private ownership. Speculation undoubtedly constituted the chief, if not the sole intent in ownership for the properties now included in this forest area when they originally passed from public to private control. But speculation was not a productive type of intent. The result was that little material returns accrued to the capital invested. There are evidences of the land having at times been used for grazing during these earlier days, but even this use was oddly enough, in at least one occasion, a forced use because of a prank of nature, for in this case unprecedented climatic conditions forced the felling of broadleafed trees for the forage supplied by leaves and succulent twigs. Later stages of private ownership saw the liquidation of timber capital from

the forested areas. In few instances did planned use, either intensive or extensive, follow on these properties after the removal of the forest wealth. On some of these areas, natural conditions were such that a new forest was reproduced, unheeded by the lack of assistance by man. A patch-work pattern of alternate timbered and cut-over areas was therefore the cover type when first the School of Forestry began acquiring these properties for school use." (2)

Conditions on this 4,821 acre area have been materially altered by the land use practices put into effect during the fourteen years that the School of Forestry has owned the land. All the timbered areas have been protected from fire. Their timber capital has been increased by thinnings and improvement cuttings. Many of the unstocked areas have been artificially restocked, the physiographic character of the area dictating whether restocking was to be pine or fir. Roads have been built from time to time so that now all parts of the area are accessible. Many trails have been constructed for protective as well as scenic purposes. Areas of outstanding scenic attractions have been marked and preserved. Meanwhile during this fourteen year period of planned forest use, other benefits have accrued to students and the college through the continued

use of the forested area for instruction and research purposes.

Topography, Soil, and Drainage

The topography of the McDonald Forest is typically that of the coast range. The round, rolling hills vary only several hundred feet in elevation from the lowest points on the forest. Most of the area has gentle slopes, not over 20-40 percent, but there are areas that are rather steep. It is on the southern part of the forest in Sections 7, 8, 9, 15, 16, 17, and 18 (see map) that most of the non-forested areas exist. This area was added to the McDonald Forest in 1938 and is known as the Jackson and Cockerham additions.

Some of the land included in the Jackson and Cockerham additions has been used for agriculture in the past. However, this is not its best use. The soil over most of the non-forested areas of the McDonald Forest is rather shallow. The top layer, which varies from one to two feet in thickness, is a dark brown clay loam. It is very fertile as is evidenced by the growth of trees on a large part of the area. Under this topsoil is a layer of yellow clay. It is very difficult for roots to penetrate this layer when it is dry, and

equally difficult for young trees to survive in periods of drought.

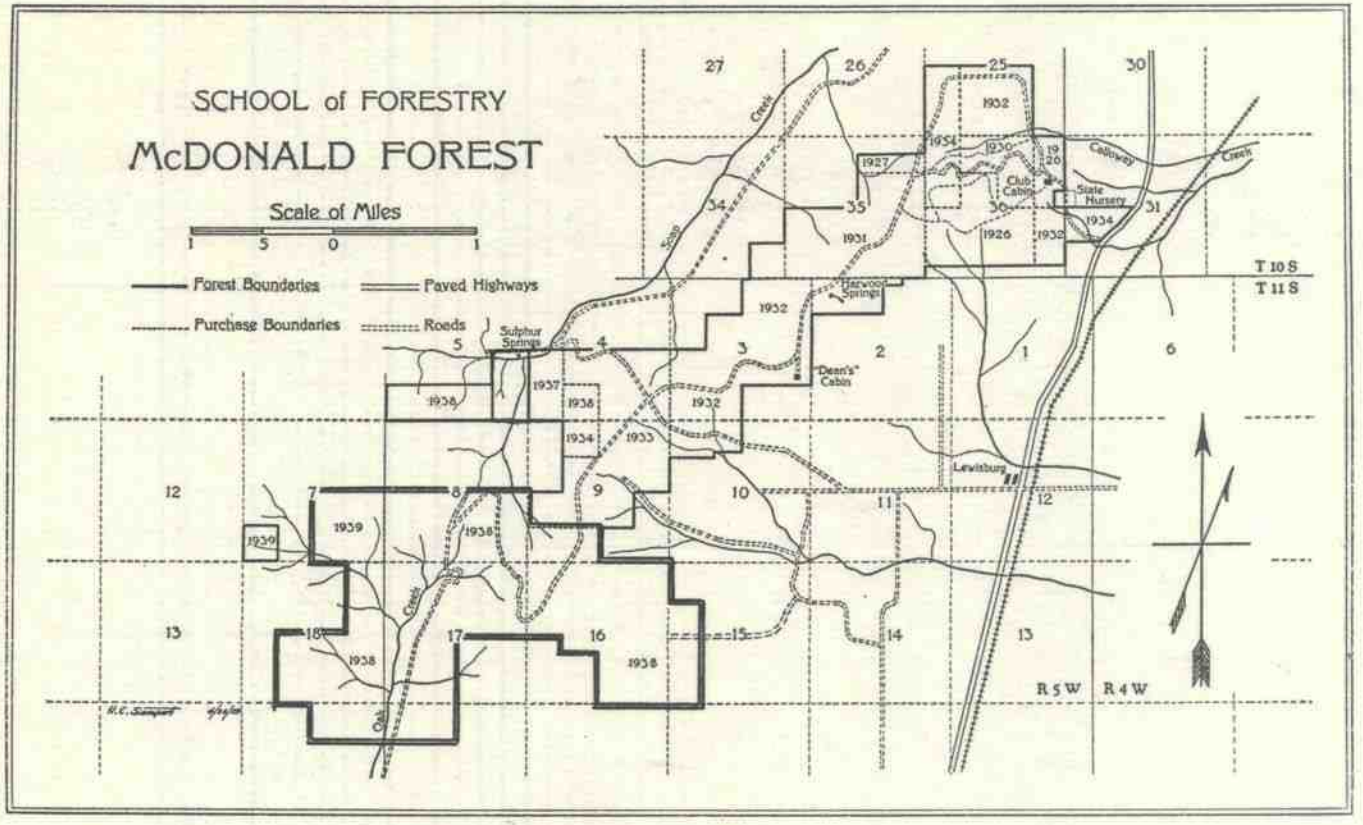
There are eight soil types in six series represented on the southern part of the forest. They are as follows: Olympic clay, Olympic clay (shallow phase), Olympic clay loam, Wapato silty clay loam, Cascade clay loam, Cove clay, Aiken silty clay loam, and Melbourne clay loam.

A brief description of each soil series follows. For a more complete description of each soil type found on the southern part of the forest the reader is referred to "Silvercultural Studies on the Jackson and Cockerham Additions to the McDonald Forest" by Herbert C. Sampert (34).

Olympic series: The soil in this series is a brown to rusty brown or reddish. The subsoil is brown and drainage is good.

Wapato series: This series is dark brown to dark grayish brown soil. The subsoil is drab to brown mottled. Drainage is poor.

Cascade series: The soil of this series is brown. It has a yellow brown to pale yellow subsoil, and a yellow to dull yellow mottled sub-stratum. The soil is friable in the deeper part. Drainage is good.


SCHOOL of FORESTRY
McDONALD FOREST
Scale of Miles
1 5 0 1
Forest Boundaries
Purchase Boundaries
Paved Highways
Roads
Sulphur Springs
Harwood Springs
"Deen's" Cabin
Club Cabin
State Nursery
Lewisburg
Caldway
Creek
T 10 S
T 11 S
R 5 W
R 4 W
1927
1930
1931
1932
1933
1934
1936
1937
1938
1939

Cove series: This series has dark brownish to black soil. The subsoil is black to drab mottled. This whole series is a heavy and impervious soil with poor drainage.

Aiken series: The soil in the Aiken series is not too pronounced reddish brown. The subsoil is red. Drainage is good.

Melbourne series: The soil of this series is brown to dark brown. The subsoil is yellow to brownish yellow mottled, and the sub-stratum is also yellow mottled. Drainage on this series is good.

Climate

The McDonald Forest is located in an area that receives about 40 inches of rainfall annually. However, most of the rain comes during the winter and spring. During the summer months of June, July, August, and September it is very hot and dry in this region. Though this has little effect on forest growth on areas adapted to forests, it does have an effect on establishment of seedlings.

Following is a table showing the rainfall and average temperatures for an average year of the ten-year period, 1929-1938, at Corvallis, Oregon, taken from U.S.D.A. Weather Bureau records (34).

Table I. Rainfall and Average Temperatures for an Average Year of the Ten-Year Period 1929-1938, at Corvallis, Oregon

Month	Temperature		Precipitation
	Max.	Min.	Inches
January	56	19	5.94
February	61	23	3.64
March	68	29	3.48
April	78	33	2.71
May	84	32	1.69
June	89	41	1.37
July	95	46	0.19
August	97	46	0.20
September	92	39	1.03
October	84	32	2.50
November	65	27	4.22
December	57	24	8.32
Total			35.29

Crops Raised on Area

Since most of the McDonald Forest is hilly, rolling country, timber is the most important crop grown on the area. Until recently, the non-forested areas were used for grazing sheep. It is these non-forested areas that are causing a land use problem now. The areas in question have been seriously overgrazed. Perhaps, with some management, grazing is the best use of the land.

Value of Land for Other Uses

It is possible that the land may have value for some other uses than those employed at present, but it is not probable. However, recreation could be developed to a greater extent than now exists on the area. Many trails and roads have been built on the area and already the Sulphur Springs area (see map) is being used by recreationists.

All the area included in the McDonald Forest is definitely unsuited for agriculture because of the topography and soil conditions noted earlier.

Timber Growing

Here is what H. M. Johnson (19) has to say regarding the importance of timber growing in this region. "The forests have been the backbone of industrial development of Oregon and Washington from the earliest period and are still the mainstay of industry and trade. The forest industries in these states furnish support, directly or indirectly, to roughly 40% of the population and account for about 60% of the industrial payroll, excluding agriculture."

The Timber Management Problem

Analysis of Local Social, Economic, and Industrial Conditions

Forest Industries: Since 1900 the lumber industry in this region has risen in importance, and it is now probably the most important industry in Benton County. The present Corvallis Lumber Mill was established prior to 1910 (23).

In 1936 there were 40 sawmills in Benton County. Twenty of these were constructed between 1935 and 1936. The total yearly capacity of these mills was 200 million board feet. This is figured on the basis of 300 working days and an average daily cut of 365 M. Seven

hundred men were employed in logging and milling (23).

Several well established mills are located adjacent to Corvallis. Timber on the McDonald Forest is readily accessible and could be sold to these mills. The distance logs would have to be hauled is less than 20 miles from the forest to these mills.

Other Industries: The two most important industries in Benton County, other than forest industries, are agriculture and livestock raising. The McDonald Forest is definitely not on agricultural land and so agriculture should not have any important effect on the future management plans of the non-forested areas. On the other hand, grazing and livestock raising are possible alternative uses to forestry, and must be taken into consideration in future plans.

The following table shows the importance of livestock raising in this county (23). From this table it can be readily seen that should the non-forested areas be used for grazing in the future, the possible source of sheep and cattle that can be grazed on the forest is right here in Benton County.

Table II. Statistics Concerning Land Use in Benton County, 1850-1935

Year	No. Milch Cows	No. Other Cattle	No. Sheep	No. Horses
1850	111	2,771	629	675
1860	3,138	6,005	6,588	3,188
1870	2,665	3,494	12,967	2,263
1880	2,860	3,752	26,759	3,300
1890	3,915	9,242	16,310	3,507
1900	3,765	6,242	25,314	3,817
1910	5,083	5,931	26,579	4,317
1920	8,064	2,630	20,998	4,497
1925	8,529	2,407	25,679	3,392
1930	8,906	2,190	37,962	2,684
1935			32,631	2,504

The Jackson and Cockerham additions have been used to quite an extent for grazing. This land was added to the McDonald Forest in 1938, and is one of the biggest problems on the whole forest. Sheep are still grazed on much of the area, and it has been grazed and burned over to such an extent that it is now in a seriously depleted condition.

Population and Dependency: In 1938 nearly 3,000 acres of forest lands were cut over in Benton County. From this area a volume of approximately 57,000 M. board feet, log scale, was removed. Thus, in the future the logging industry should be quite promising. Longwood (23) has this to say regarding the future: "Depletion of the timber resources in western Washington and in the counties along the Columbia River indicate that the counties partially within the Willamette Valley will soon be supplying a sizable portion of the logs for the Portland mills."

Major Values Other than Lumber: About 25 percent of the area now in the McDonald Forest is considered at the present time as Douglas-fir sites IV and V (see table p. 16). The timber on much of this area is virgin growth, but due to the understocked condition of the original stand it is doubtful whether this timber could

be sold at a profit for use as lumber. Some other value must be assigned to this timber then. During the past few years the value has increased on Douglas-fir as cordwood. It is likely that this price will at least remain the same or even increase in the future. Thus, timber that cannot be sold as lumber could be sold as cordwood.

It is possible that a market can be found for any products sold from the McDonald Forest since this region is increasing in value as a lumber producing section. Mills are depending more and more on their supplies from the Willamette Valley. Then too, students are working continuously on such problems as exist on the McDonald Forest, and in the future, products from the forest should be of better quality because of this work. Increasing the quality of the products should also increase market possibilities.

Analysis of Forest Resources and Marketing Conditions

Some time has been spent in discussing the local social, economic and industrial conditions as they exist in this region, but in order to discover what relationship exists between timber growing and grazing, it is necessary to analyze the forest resources and other conditions as they are at present.

Forest Types: There are now some 4,800 acres in the McDonald Forest. The timbered areas are largely in the Douglas-fir type, both mature and immature. However, there are small areas of hardwoods throughout the forest. These are largely of Oregon Maple, Oregon White Oak, and Red Alder.

There are also large areas of cutover and grass-land types. The latter areas are, for the most part, confined to the southern end of the forest on the Jackson and Cockerham additions.

Much of the present stand of timber is virgin growth, and its condition is as well as can be expected from its past use. The original area was not heavily stocked, and so much of the timber is limby and of low quality. However, the largest percentage of the area has been classified as site III Douglas-fir or better, and so could grow high quality timber if properly stocked and managed.

Site Quality: McArdle and Meyer (25) state that the "various combinations of the physical characteristics of forest areas, such as soil, drainage, rainfall, temperature, altitude, slope, and aspect, result in different degrees of favorableness for tree growth. The combined effect of these characteristics on the stand is embraced in the term "site" or "site quality."

The 1939 Annual Cruise contains a table of the data obtained by Wallace Anderson, a former student at Oregon State College, of a site study of the McDonald Forest (1). This table has been slightly revised to fit the present acreage of the forest. The acreage and percentages of each site are roughly as follows:

Site	Acreage	Percent of Site
I	183	3.8
II	1,167	24.2
III	2,247	46.6
IV	1,118	23.2
V	106	2.2
	4,821	100.0

Transportation Facilities: Transportation facilities are very good for the marketing of timber products from the McDonald Forest. The Willamette River is within 20 miles of any part of the forest. A railroad is also located very near the east boundary of the forest running through the Willamette Valley to Portland.

A number of good truck roads have been constructed on the McDonald Forest, and it would not be more than a 20 mile haul by truck from any point on the forest to mills in Corvallis.

Marketing: At the present time there is a market for all types of products cut on the McDonald Forest. With the increasing importance of this region in future lumber production, it is reasonable to expect that there will be increased markets for products from the McDonald Forest.

Solution of Plan For Douglas-Fir

General: Any timber management plan should aim to attain maximum yields in both volume and quality of desired species on areas readily accessible to centers of consumption. Site, topography, and location are basic items of consideration. Selection of areas for management is also important.

Since the School of Forestry is already burdened with the non-forested areas on the McDonald Forest it is probably proper to proceed with such calculations as we can. The object, of course, is to decide to which use, timber growing or grazing, the areas should be put. The author decided to determine the expected returns from growing Douglas-fir and also Ponderosa pine on the non-forested areas.

Source of Data on Volumes: United States Department of Agriculture Technical Bulletin 201 by

R. E. McArdle and W. H. Meyer on "The Yield of Douglas-fir in the Pacific Northwest" has been used as a reference in determining volumes for Douglas-fir. Since the continued existence and prosperity of the lumber industry in the Northwest is dependent on the growth in immature stands, it is important to have definite information concerning the potential yields of these forest lands.

Planting: Planting is a very important item to be considered in future management plans for the McDonald Forest. This is especially true of the areas that are non-forested at the present time. All of these areas, if they are to be used for growing timber, will have to be planted in order to get a stand of timber on them. Douglas-fir and oak are gradually creeping into these areas at present but this method is much too slow from the management standpoint.

Planting costs can be kept at a minimum in planting the non-forested areas on the McDonald Forest since the Clarke-McNary nursery adjoins the forest on the east boundary. All the necessary planting stock, Douglas-fir and Ponderosa pine, can be acquired from this nursery.

Labor for planting the trees could be furnished by students in forestry at Oregon State College. In this way they would get practical experience in planting technique.

Some Ponderosa pine have been planted in the "Bald Spot" in the forest. From all indications shown to date they seem to do very well on that particular area, and there is reason to believe that they would do well on other non-forested areas in the McDonald Forest.

Douglas-fir seedlings have also been planted in a number of the non-forested areas. The percentage survival was not very high on the areas observed by the author. Seedling counts have been made on two areas located in Section 25, T. 10 S., R. 5 W. (see map on p. 6) to determine the percentage survival. On one area the survival was 32 percent and on the other area, 24 percent. This low survival can be attributed largely to the lateness of the season in which they were planted and to the inexperience of the men planting them. In the future, plantings should be reasonably successful if managed properly because most of the area has been classified as Site III, or better, for Douglas-fir, and these sites are considered as good areas to plant.

Rotation: The rotation may be defined as the number of years through which a forest is allowed to grow before it is cut and reproduced. In putting any area under management it is necessary to consider how long it will take to grow timber to the size needed for a particular product. That is, the rotation used will depend largely upon the market, size, species, and silvicultural method of treatment.

The largest percentage of the area included in the McDonald Forest has been classified as Site III Douglas-fir land. Should the School of Forestry decide to grow timber on the non-forested areas it would be most profitable to use the rotation that returns the largest mean annual income per acre. In other words, the rotation used should be a financial one.

Estimation of Costs and Yield at Rotation: The set-up for the McDonald Forest is somewhat different than for a private enterprise. The reason for this is that the McDonald Forest is state owned; and so, some costs do not enter into the plan of management. Taxes are an important item to be considered in a private enterprise. No taxes are paid to the state on state land. Thus, there are no taxes on the non-forested areas in the McDonald Forest. Neither does the cost of land have to be considered, since this

area already belongs to the state. These non-forested and brush areas total 1,042 acres.

At the present time there are no protection costs or logging costs to take into consideration. However, since the McDonald Forest now covers about 5,000 acres, it is likely that in the near future a protection charge will be made. Protection charges on other timberlands throughout Oregon amount to approximately 5¢ per acre. In determining the future income from the non-forested areas on the McDonald Forest a protection charge of 5¢ per acre has been made.

As for the logging costs, it is quite hard to determine these costs in order to project a cost into the future. According to Professor T. J. Starker, the average small operator in this region can log and haul timber to the mill for about $6 per M. In future management of McDonald Forest it would be most profitable to the school to hire small operators to log and haul timber from the area.

Growing stock to plant the non-forested areas on the McDonald Forest can be acquired from the Clarke-McNary nursery which is adjacent to the forest at $2.50 per 1,000 trees. The planting stock is 2-0 stock and is considered ideal for this region.

The planting cost is the biggest expense to be considered at the present time. Planting costs are

quite high in this region, amounting to between $7 and $8.50 per acre. These are average figures for planting on the national forests of western Oregon and were obtained from the Siuslaw National Forest Office in Corvallis. Trees are usually planted 8 x 8 feet apart. This makes a total of approximately 680 trees to the acre. For future calculations an average planting cost of $7.75 per acre will be used.

Interest charges on all investments amount to a relatively large sum over the rotation period. However, the original investment in growing stock and planting would have drawn interest if it had been put in a bank, so an interest charge must be made covering this amount during the first rotation. The interest rate is considered at 3 percent on the original investment; also on the annual protection charges.

Market Conditions: Log prices at present vary from $17 to $19 per M. for Red fir on the Columbia River market. These prices are slightly above the 1930 prices due to war conditions, but are considered to be fairly close to future prices. The following tables and figures show the average log prices for Red fir and Ponderosa pine in the Columbia River region since 1929.

Table III. Red Fir Log Prices in the Columbia River Region
1930-1939, incl.

Month	Year 1930	1931	1932	1933	1934
Jan.	$16	$13.50-14.50	$9.50-11	$8.50	$13-13.50
Feb.	15	14	10	8-9	13-13.50
March		12-13	10	8-8.50	12-14
April	12-14	12	7-9	8-8.50	13-14
May	12-14	12-12.50	8-9	8.50	13-14
June	14-15.50	10-12	8-8.50	9-10	13
July	14-15.50	12	8-8.50	11-11.50	12.50-13
Aug.	15-15.50	11-12	8-1.50	11	13
Sept.	15	10.50	7-8	12	12-12.50
Oct.	15	10-10.50	9	12	12
Nov.	15	8-10	8-9	9-13	11.50-12
Dec.	14-15	9.50-10	8.50	13	11.50-12
Average	$14.66	$11.56	$8.77	$10.15	$12.75

Average for 10 year period $12.50

(1) From The Timberman

Table III. Red Fir Log Prices in the Columbia River Region
1930-1939, incl. (Continued)

Month	Year 1935	1936	1937	1938	1939
Jan.	$11.50	$13.00	$14-15.50	$14-15	$13.50-14
Feb.	11-12	13-14	14-15	13	13.50-14
March	11.50	13-14	15-16	13	13.50-14
April	11-11.50	13-14.50	15-16	13	13-14
May	12	13.50-14.50	16-17	12.50	13.50-14
June	12.50	14	16-17	12	12
July	12-12.50	14	16-17	12	12-12.50
Aug.	12	13	15.50	12.50	12
Sept.	11.50-12	13	15-16	12.50-13	13
Oct.	11-12	13	15-16	12.50-13	14-14.50
Nov.	12-12.50	12.50-13	14-16	13-13.50	13.50-14.50
Dec.	12	12.50-13.50	14-15	13.50-14	13.50-14.50
Average	$11.83	$13.38	$15.52	$12.94	$13.33

Average for 10 year period $12.50

(1) From The Timberman

FIGURE 1. RED FIR LOG PRICES IN THE COLUMBIA RIVER REGION, 1930-39 INCL.

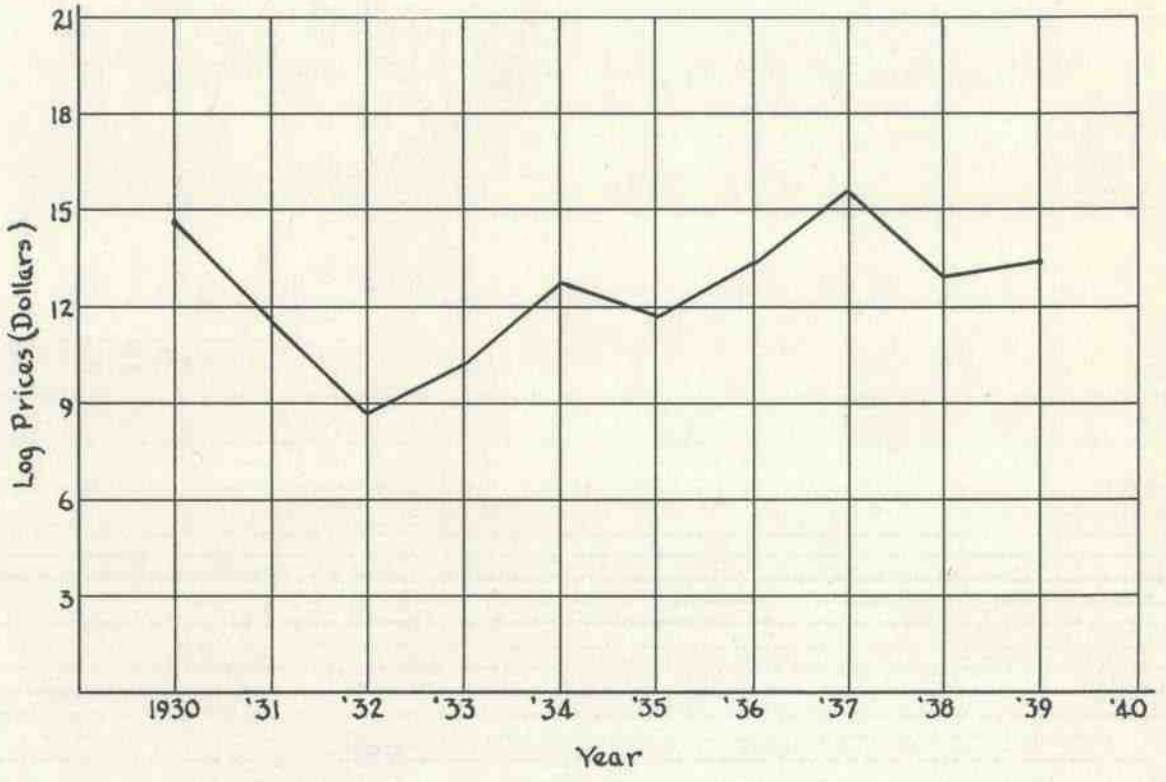


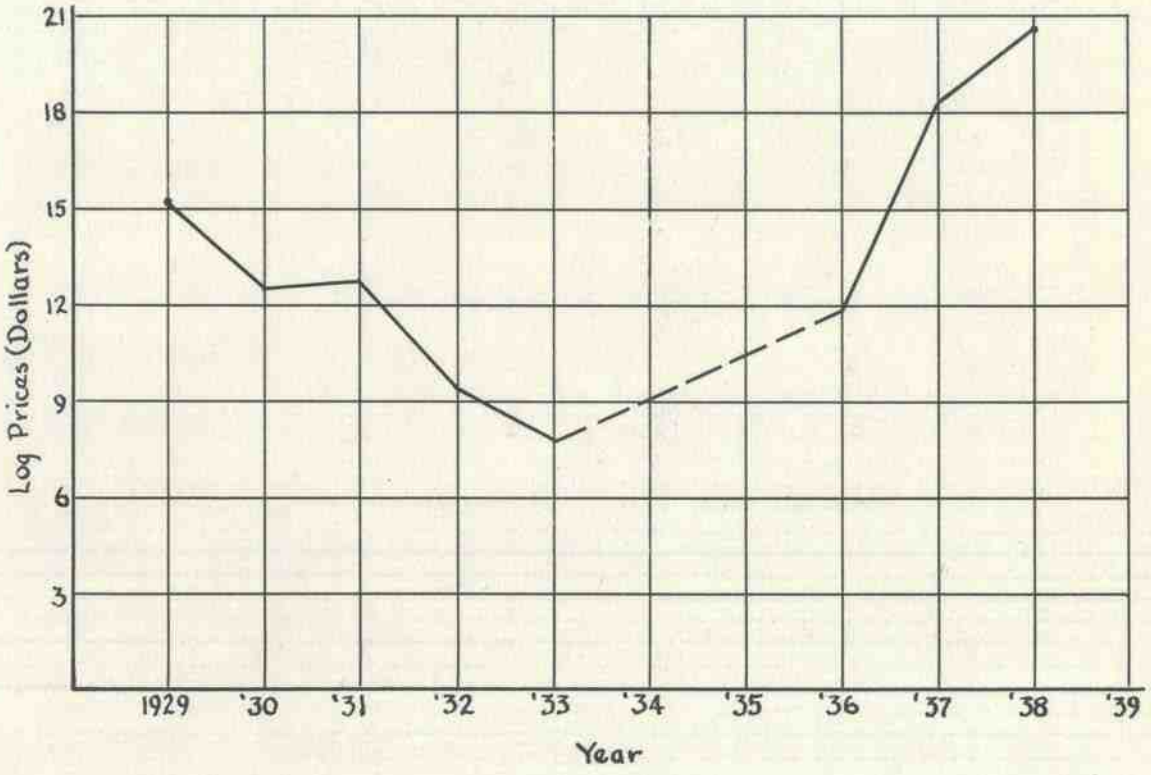
Table IV. Average Log Prices for Ponderosa Pine in the Columbia River Region 1929-1938, incl. (1)

Year	Ponderosa Pine Average Price	Ponderosa Pine Price Range
1929	$15.15(2)	$ 3.64-16.50(2)
1930	12.50	
1931	12.65(2)	6.00-15.50(2)
1932	9.30(2)	5.00-12.00(2)
1933	7.76	6.00-19.86
1936	11.85	7.00-20.00
1937	18.37	18.00-18.50
1938	20.55	19.80-21.78
Average	$13.50	

(1) From H. B. Steer

(2) State total

FIGURE 2. AVERAGE LOG PRICES FOR PONDEROSA PINE IN THE COLUMBIA RIVER REGION, 1929-38 INCL.



Fast growing second growth Douglas-fir is called Red fir. If the non-forested areas of the McDonald Forest are planted to Douglas-fir, they will be considered second growth forests. For this reason, the author has used Red fir log prices in future calculations.

Table III is made up of Red fir log prices on the Columbia River market as taken from the Timberman Magazine. The average log price for each year was determined by summing up the monthly figures and dividing by twelve. This arithmetical average was considered fairly accurate because the volumes sold each month was not listed in the magazine.

From Table III it can be determined that the average log price for Red fir is $12.50 per M. on the Columbia River market. Due to transportation charges between Corvallis and Portland there is a difference in price of logs at the local mills. In consulting the Corvallis Lumber Company, the author found that this price differential is approximately $3 per M. Therefore a price of $9.50 per M. has been considered as a fair price for Site III Douglas-fir logs in this report. This price has been assumed to be the same for logs regardless of period of rotation. That is, the value of $9.50 per M. was used in

calculating the returns at 70 years and also at 110 years. There may be a slight discrepancy in the final value, but no tables were available to show the difference in quality between logs grown on a 70-year rotation and logs grown on a 110 year rotation.

In order to determine what rotation would show the highest present value of the soil per acre, calculations were made for rotations of 70, 80, 90, 100, and 110 years. In the calculations below, a 70-year rotation has been used to illustrate the method of arriving at the net income per acre. According to the study made by McArdle and Meyer on the Douglas-fir in this region the volume (Scribner rule) on Site III Douglas-fir at 70 years is 35,200 board feet per acre (25). This volume is for trees 12 inches in diameter and larger.

Summarizing the above paragraphs, the rotation, costs, yield at rotation, etc. are as follows:

Rotation	70 years
Growing Stock	$1.70 per A.
Logging Costs	$6.00 per M.
Planting Costs	$7.75 per A.
Protection Costs	$ .05 per A. per year
Interest	3%
Log Price	$9.50 per M.
Yield at Rotation	35,200 b.f. per A.
Area (Non-forested and brush)	1,042 acres

Expected income at the end of 70 years is determined as follows:

Future value of a capital fund after a period of years is $Cn = Co(1.0p^n)$. Substituting we have

$$Cn = \$9.45(1.03^{70}) = \$9.45(7.91) \text{ or}$$

$$Cn = \$74.75$$

The $9.45 is the total of planting cost and cost of growing stock. The final value of $74.75 is the original cost of stocking the land and 3 percent compound interest over a 70-year period.

Since 5¢ per acre is paid annually as a protection cost, the future value of a terminable series of annual payments is found by substituting in the formula:

$$Cn = \frac{s(1.0p^n - 1)}{.0p}$$

$$Cn = \frac{.05(1.03^{70}-1)}{.03} = \frac{.05(6.91)}{.03} \text{ or}$$

$$Cn = \$11.52$$

Total income at 70 years = 35.2 M x $9.50 = $334.40

Logging costs = 35.2 x $6 = $211.20		
Other costs from above	=	86.27
Total costs		297.47
Net income per acre at 70 years		36.93

The present value of a single income is found by substituting in the formula:

$$Co = \frac{Cn}{.10p^n}$$

$$Co = \frac{\$36.93}{1.03^{70}} = \frac{\$36.93}{7.91} = \$4.67 \text{ per acre.}$$

The table below shows that a 70-year rotation will return the highest net income per acre. Therefore it is the rotation that should be used.

Rotation (Years)	Net income per A. at Rotation	Present Soil Value
70	$36.93	$4.67
80	43.32	4.07
90	35.19	2.46
100	7.92	.41
110	-42.47	-1.64

Solution of Plan for Ponderosa Pine

General: As stated earlier in this manuscript, Ponderosa pine have been planted on the "Bald Spot" in the McDonald Forest. These were planted in order to carry on growth and race studies. None of these trees have yet reached 20 years of age, but the fast growth put on by certain races indicates a very good site for Ponderosa pine. According to Professor E. J. Starker, these areas can be considered as Site II or III for Ponderosa pine.

Source of Data: United States Department of Agriculture Technical Bulletin 630 by W. H. Meyer on "Yield of Even-aged Stands of Ponderosa Pine" has been used as a reference in determining site index and volumes for Ponderosa pine.

Rotation: As is the case with Douglas-fir, the rotation used will depend largely upon the market, size, species and silvicultural method of treatment. It is impossible as yet to determine exactly what site is indicated by the pine on the "Bald Spot". According to Meyer (27), site III has a site index range of from 85 to 98 and Site II has a site index range of from 99 to 112. In arriving at the value of growing Ponderosa pine on the area the board foot volume has been used for site index 100 and also for site index 110.

The author is aware of the fact that the log prices for Ponderosa pine are not on as sound a basis as the log prices for Red fir, but they are as accurate as can be found for Ponderosa pine growing on the west side of the Cascade Range. The log price established was used similarly to the established log price for Red fir. That is, the same value was used in the 60-year rotation as was used in the 100-year rotation.

This discrepancy in price due to quality of logs could not be determined.

Estimation of costs and yield at Rotation: As was previously stated under the plan for Douglas-fir, there are no taxes or land costs to be paid on the McDonald Forest since the land belongs to the state.

Protection costs, logging costs, cost of growing stock, planting costs and interest charges are assumed to be the same for Ponderosa pine as for Douglas-fir. That is, protection costs are 5¢ per acre; logging costs are figured at $6 per M.; growing stock from the Clarke-McNary nursery costs $2.50 per M.; planting costs average $7.75 per acre; and interest is figured at 3 percent on the original investments and on the annual protection charges.

Market Conditions: During the past few years the market for Ponderosa pine in the Columbia River region has increased. (See table on p. 25). This market should continue to increase in future years, and there should be a market for all products grown on the McDonald Forest.

The table and chart listed previously indicate the log prices and trend in prices for Ponderosa pine in this region from 1929 to 1938. The average price

paid for Ponderosa pine logs over this period was $13.50 per M. Transportation costs to Portland (about $3 per M.) should be deducted from this price in order to arrive at a local price. This will make the local log price $10.50 per M.

In order to determine what rotation would net the highest soil value to the School of Forestry, calculations were made for rotations of 60, 70, 80, 90, and 100 years. The volumes for site index 100 and site index 110 were used in each rotation. In the calculations below, a 70-year rotation has been used to illustrate the method of arriving at the net income per acre. According to Meyer (27), the volume (Scribner rule) for site index 100 on a 70-year rotation is 20,500 board feet per acre.

Summarizing the above paragraphs on Ponderosa pine, the costs, volume, yield at rotation, etc. are as follows:

Rotation	70 years
Growing Stock	$1.70 per acre
Logging Costs	$6.00 per M.
Planting Costs	$7.75 per acre
Protection Costs	$ .05 per acre per year
Interest	3%
Log Price	$10.50 per M.
Yield at Rotation	20,500 b.f. per A.
Area (non-forested and brush)	1,042 acres

Expected income at the end of 70 years is determined as follows:

Future value of a capitalfund after a period of years is: $Cn = Co(1.0p^n)$

$Cn = \$9.45(1.03^{70}) = \$9.45(7.91)$ or

$Cn = \$74.75$

The future value of a terminable series of annual payments is found by substituting in the formula:

$$Cn = \frac{a(1.0p^n-1)}{.0p}$$

$$Cn = \frac{.05(1.03^{70}-1)}{.03} = \frac{.05(6.91)}{.03} \text{ or}$$

$Cn = \$11.52$

Total income at 70 years = 20.5 M x \$10.50 = \$215.25

Logging costs = 20.5 x \$6 = \$123.00	
Other costs from above = 86.27	
Total costs	209.27
Net income per acre at 70 years	5.98

The present value of this single income is found to be $\frac{\$5.98}{7.91}$ or \$.76 per acre.

In arriving at a value for site index 110, a rotation of 60 years was used. The volume for site index 110 is 21,000 board feet per acre on a 60-year rotation. Substituting this volume in the table above results in the following income.

Total income at 60 years = 21 M x $10.50 = $220.50

Logging costs = 21 x $6 = $126.00

Other costs = 63.81

Total costs 189.81

Net income per acre at 60 years 30.69

The present value is $\frac{\$30.69}{5.89}$ or $5.21 per acre.

The tables below show that a 70-year rotation will show the highest present soil value per acre for Ponderosa pine on the non-forested areas using site index 100. Using site index 110, it can be seen that the highest present soil value is on a 60-year rotation.

Site Index 100

Rotation (Years)	Net income per A. at Rotation	Present Soil Value
60	$ 2.79	$ .47
70	5.98	.76
80	.38	.04
90	-17.91	-1.25
100	-49.43	-2.57

Site Index 110

Rotation (Years)	Net income per A. at Rotation	Present Soil Value
60	$30.69	$5.21
70	38.83	4.91
80	37.28	3.50
90	23.59	1.65
100	-5.78	-.30

The Range Management Problem

Market Considerations

General: Livestock production has always been an important industry in Benton County. The table on page 12 of this report shows how it has increased in importance from 1850 to the present. We can see by the table that the sheep industry has come to be most important. The amount paid for stock varies from year to year, but studies have been made as to the cost of producing sheep in this region (29).

Future Market Conditions: Market conditions for sheep raised in this region should continue to be as good or better in the future than they are now. Weather and range conditions are such that market lambs can be raised and put on the market before the lambs in eastern Oregon. Thus, farmers in the Willamette Valley should always have a market for lambs if they are properly managed.

Survey of Non-forested Areas

Carrying Capacity: The carrying capacity of any area is determined by making a range survey. Ed Geiger,

a graduate of 1941 at Oregon State College, is working on a range management plan for the McDonald Forest at the present time (1941). His range management plan covers the Jackson and Cockerham properties. It is this 2,003 acres that we are largely concerned with as very few non-forested areas are found on other parts of the McDonald Forest.

According to the survey, 961 of the 2,003 acres are already stocked with Douglas-fir. The remaining 1,042 acres are non-forested or covered with brush, weeds, and grass and can be used for grazing.

The carrying capacity of this 1,042 acres, according to Geiger, is about 55 animal units. If we consider five sheep as being equivalent to one cow, then the area will carry approximately 275 sheep under proper management. This figure is for year-around grazing.

Improvements Needed: Before any range management plan can be put into effect there are a number of improvements that will be needed on the area. The most outstanding improvements needed are boundary fences and drift fences. Men from the CCC Camp on the McDonald Forest are busily engaged in building boundary fences at the present time. No doubt these fences will be finished by the time the School of Forestry puts its range management plan into effect.

Sheep tend to wander over an area quite readily, and if drift fences are not constructed at strategic points throughout the area the sheep will stray into the forested areas and cause damage to seedlings.

Effect on Land: Grazing has very definite detrimental effects on the land if carried to excess. Perhaps the first sign of overgrazing is the deterioration of the ground cover. The perennial bunchgrasses are gradually crowded out by annual grasses, weeds, and unpalatable shrubs. In this region the occurrence of St. John's Wort (Hypericum spp.) and Rose (Rosa spp.) are very sure signs of overgrazing. Much of the land in question in the McDonald Forest shows these signs of overgrazing. Thus, someplanting of grasses or restricted grazing may be necessary to bring these areas back to optimum conditions.

Once the ground cover on an area is broken the way is open for erosion to take place, and we have another adverse result of improper land use. Some areas on the Jackson and Cockerham properties have been so depleted of vegetation that gully and sheet erosion have taken place. During the past summer (summer of 1940) erosion control work was done on the Jackson place by the Fire Crew stationed at the McDonald Forest.

The most obvious indicators of overgrazing can be summarized as follows (18):

1. The predominance of annual weeds and grasses, a dense stand of such species and a lack of variety in the species.

2. The predominance of plants which have little or no value for any class of stock.

3. The presence of dead and partly dead stumps of shrubs; such as snowberry, currant, willow, serviceberry, and Oregon White oak.

4. Noticeable damage to tree reproduction, especially to Ponderosa pine or Douglas-fir reproduction on sheep range, and Aspen reproduction on cattle range.

5. Erosion and barreness, accompanied by a network of stock trails where formerly there was a cover of vegetation.

Only under proper management can these depleted areas in the McDonald Forest be brought back into production. This statement applies regardless of whether the area is planted to trees or leased for grazing. When Ed Geiger made the range survey of the Jackson and Cockerham additions he took into consideration the above indicators of overgrazing, and the carrying capacity he used allows for improvement of these conditions.

Solution of Problem For Sheep

Before any sheep are turned on to the McDonald Forest again a range management plan must be worked out. The objective of the author was not to work out this management plan, but to determine what was the best use of the non-forested areas and determine what income could be expected in the future from leasing the land for grazing.

Costs: Very few costs will have to be considered at this time if the non-forested areas in the McDonald Forest are used for grazing. As was stated earlier, the CCC are building the necessary fences. Since the land already belongs to the state, there are no taxes or other costs to be considered.

However, it is possible that over a period of years certain costs will have to be taken care of by the School of Forestry. Repairs and maintenance of fences will be necessary. Also, it may be necessary to do some seeding with grasses on areas that do not re-stock themselves readily.

Cost of Producing Sheep: According to O. M. Nelson (29) "there are two phases of the sheep industry found in Western Oregon. One is the production of commercial spring lambs for the butcher and the packer, and the

other is the production of pure-bred rams for the commercial flocks of Western Oregon and for the range herds of Eastern Oregon."

"The production of commercial spring lambs is an industry well adapted to Western Oregon farms. By far the largest number of sheep found in Western Oregon belong to this class. Pure-bred rams are mated to grade ewes and the ewes are wintered as much as possible on grass. The lambs are dropped early in the spring and are grown, fattened, and marketed by May or June at weights ranging from 70 to 80 pounds."

O. M. Nelson (29) gives three budgets for raising farm sheep in the Willamette Valley. Budget A shows that the annual expense of producing sheep in the Willamette Valley amounts to $9.96 per ewe. The annual income per ewe is $10.30. This makes a net annual income of 34¢ per ewe. The various expenses listed in budget A will vary from year to year depending on the system of management. Feeding is one of the biggest items, consisting of about 46% of the total expenses on each ewe, thus if the operator is able to get cheaper feed by leasing range land he will reduce expenses and increase the net annual income per ewe.

Protection: In order to get maximum returns from these non-forested areas at all times certain precautions

will have to be taken. The areas must be protected from fire, logging damage, and overgrazing.

D. C. Ingram (16) states that grazing "is one important method of reducing fire hazard and at the same time of converting into valuable animal products a secondary forest resource which, if left, becomes a liability." However, it is essential that correct grazing-management principles be put in effect. Ingram (16) also states that "moderate grazing use is not seriously inimical to forest regeneration and is more than compensated by the protection that it affords through reduction in fire hazard."

The method of logging or managing forest stands, especially the coniferous forests, has an important bearing on reproduction on the areas. Methods of cutting and logging should be such that the greatest net benefits in regulation of run-off, in maximum yields of usable water, and timber production are obtained.

Exploitive use of range and pasture lands will greatly reduce their utility for grazing. Overgrazing reduces the quantity of plant cover and the concomitant trampling compacts the soil. Various studies show that these effects modify the amount of run-off and increase erosion. Thus, protection will have to be given to all areas used for grazing so the areas do not deteriorate. This is especially important if the

areas are to be used for grazing for an indefinite length of time.

A plan of deferred and rotation grazing should work very well to increase the carrying capacity on the non-forested areas of the McDonald Forest.

Value of Grazing Sheep on the Non-Forested Areas

As was stated earlier, the carrying capacity of the non-forested areas of the McDonald Forest has been found to be approximately 275 sheep for the entire year. The next and most important item, then, is to decide what charge will be made per head to graze sheep on the area. The United States Forest Service charges 2½¢ per head per month to graze sheep on the national forests regardless of where located. However, this charge is for grazing on land that is back away from civilization, land that is relatively inaccessible, and land where few improvements are considered. This grazing charge was established after a survey was made on all the national forest land to determine its value for grazing.

Therefore, grazing on the national forests is not managed to return a profit to the government. For these reasons, the author believes a charge of 2½¢ per head per month for grazing sheep on the McDonald Forest is too low.

If the non-forested areas of the McDonald Forest are to be used for grazing, a charge must be made that will cover all maintenance and improvements and still return some profit to the School of Forestry. W. W. Gorton (10) has made a study on costs and grazing values on farm pastures in the Willamette Valley. In 1935 and 1936 Gorton found that private land owners were leasing their pastures for grazing at the rate of $1 per A.U.M. (Animal unit month). This study was made on hill pastures that are similar in physical characteristics to the non-forested areas of the McDonald Forest. Although the survey made by Geiger shows that the carrying capacity per acre of the non-forested areas on the McDonald Forest is not as high as for privately owned hill pastures, other conditions are similar. That is, the non-forested areas are accessible by road and trails, there are fences around the non-forested areas, and these non-forested areas are located in the same region as the privately owned pastures. Evidence seems to indicate that the head charge made for grazing the non-forested areas of the McDonald Forest should be about the same as that for grazing on privately owned pastures.

According to the U. S. Forest Service, prices paid for sheep during 1935 and 1936 were 53 percent and 75 percent, respectively, below the base price established in 1931. The 1941 price is still below the 1931 base,

being 85 percent ofthe 1931 price. Therefore, the rate of $1 per A.U.M. seems a reasonable charge to make for grazing on the non-forested areas of the McDonald Forest, because even though the 1941 prices for sheep are still below the 1931 base, they are above the prices paid for sheep in 1935 and 1936 when this rate of $1 per A.U.M. was used. This value is for one cow month or five sheep months. The author has therefore used a grazing fee of 20¢ per sheep month in arriving at future values.

W. W. Corton (10) also found in his study that maintanance and improvement costs amount to 18¢ per acre per year on hill pastures. This is the cost used by the author in making the computations below.

A summary of the carrying capacity, grazing fee, interest, etc. is as follows:

Carrying capacity	275 sheep
Grazing fee	20¢ per sheep month
Interest	3%
Maintenance & Improvement Costs	18¢ per A. per year
Area	1,042 acres

Expected income or value of leasing land to grazing is as follows:

Income per month = 275 x 20¢ = $ 55.00

Income per year = $55 x 12 = $660.00

The area that can be used for grazing totals 1,042 acres. Thus, the gross annual income per acre is $\frac{\$660}{1,042}$ or 63¢. Subtracting the maintenance and

improvement cost of 18¢ per acre per year from the 65¢ gives a net annual income of 45¢ per acre. To make these figures comparable to those for Douglas-fir a rotation of 70 years was used. The net income per acre at 70 years is found by substituting in the formula:

$$Cn = \frac{a(1.0p^n-1)}{.0p}$$

$$Cn = \frac{.45(1.03^{70}-1)}{.03} = \frac{.45(6.91)}{.03} \text{ or}$$

$$Cn = \$103.65$$

The net income per acre at 70 years is thus found to be $103.65. The present value of this income is $\frac{\$103.65}{7.91}$ or $13.10 per acre.

W. W. Gorton (10) found in his study that hill pastures on private lands were worth about $13 per acre. The above figure of $13.10 per acre seems to compare favorably with Gorton's findings inasmuch as the lower carrying capacity of the non-forested area of the McDonald Forest is offset by the taxes paid on private land.

Summary

The objective of this study was to determine to which use, timber growing or grazing, the non-forested areas of the McDonald Forest should be put. Values have been determined for growing Douglas-fir and Ponderosa

pine on the non-forested areas. Returns have also been determined for grazing sheep on the non-forested areas.

The McDonald Forest is located about seven miles north of Corvallis, Oregon. At the present time there are 4,821 acres included in the forest. This area has had a very interesting history. Originally, speculation was the chief intent of ownership but practices resulted in misuse rather than proper land use.

Land use practices have been changed materially in the fourteen years since the land has been under the ownership of the School of Forestry. Roads and trails have been constructed, areas have been artificially restocked, and thinnings have been made. Also, many benefits have accrued to students through the continued use of the forested area for instruction and research purposes.

Topography of the McDonabd Forest is typical of this region. That is, the area consists of round, rolling hills with small relatively level areas in between. The soil is rather shallow and infertile in spots, especially on the southern part of the forest on the Jackson and Cockerham additions where the problem areas exist.

The McDonald Forest is located in an area that receives avout 40 inches of rainfall annually.

The two main uses to which the McDonald Forest has or can be put are timber growing and grazing. Part of the area is used for recreation but this is a subordinate use of the land.

The forest industry is a very important industry in this region. A large percentage of the people are dependent on forest industries as a means of livelihood. Agriculture and livestock raising are also important industries in Benton County.

Future indications are that the counties within the Willamette Valley will soon be supplying a large portion of logs to the mills in this region. Since transportation facilities on the McDonald Forest are very good there should be a market for all forest products produced.

For growing Douglas-fir on the non-forested areas of the McDonald Forest the assumptions were as follows: Rotation, 70 years; growing stock, $2.50 per M.; logging costs, $6 per M.; planting costs, $7.75 per acre; protection costs, 5¢ per acre per year; interest 3 percent; log price, $9.50 per M.; and yield at rotation, 35,200 board feet per acre. The total area is considered as Site III for Douglas-fir. Results of the above computations show a net income of $36.93 per acre in 70 years for growing Douglas-fir on the non-forested areas. This amounts to a present value of $4.67 per

acre. A 70-year rotation was found to be the rotation that showed the highest present value of the soil per acre.

In determining the value of growing Ponderosa pine, the entire area was assumed to fall between Site II and Site III. The values were determined by using the board foot volumes for both site index 100 and site index 110. Other assumptions made were as follows: Rotation, 70 years; growing stock, $2.50 per M.; logging costs, $6 per M.; planting costs, $7.75 per acre; protection costs, 5¢ per acre per year; interest, 3 percent; log price, $10.50 per M.; and yield at rotation, 20,500 board feet per acre for site index 100. Expected income at the end of 70 years is $5.98 per acre. This amounts to a present value of 76¢ per acre. The highest present value of the soil was found to be at 70 years for site index 100.

For site index 110, the highest soil value per acre was on a 60-year rotation. The volume for site index 110 is 21,000 board feet per acre. Expected value at the end of 60 years is $30.69 per acre, and the present value is $5.21 per acre.

A range survey was made on the Jackson and Cockerham additions by Ed Geiger. The carrying capacity, according to this survey, is approximately 275 sheep on year-around grazing. The area is not suited to grazing by cattle.

Improvements needed on these non-forested areas before either a grazing or timber management plan can be put in effect are boundary fences. Before a grazing plan is put into effect it will be necessary to build some drift fences. Also, it may be necessary to seed some small areas to grass.

To determine the value of using the non-forested areas for grazing, it was estimated that a charge would be made of 20¢ per head per month for sheep. Grazing 275 head of sheep on the area for twelve months brings an annual return of $660 on 1,042 acres. This amounts to a gross annual return of 63¢ per acre. Maintenance and improvement costs amount to 18¢ per acre per year. Subtracting 18¢ from 63¢ gives a net annual return of 45¢ per acre. In 70 years, at 3 percent interest, this amounts to $103.65 per acre. The present value of this net income is $13.10 per acre. A 70-year period was used so the final value could be compared with the value for growing Douglas-fir on the non-forested areas.

Conclusions

1. The non-forested areas on the McDonald Forest present a very distinct management problem. Land use practices in the future should be such that the most profitable use is found for these areas without causing

any deterioration to take place.

2. The forest industry is very important in this region and benefits will accrue to a larger number of people by growing timber on the non-forested areas of the McDonald Forest.

3. Douglas-fir can be grown on the non-forested areas of the McDonald Forest to show a present value for the soil of $4.67 per acre.

4. Ponderosa pine can be grown on the non-forested areas to show a present soil value of 76¢ per acre for site index 100, and $5.21 per acre for site index 110.

5. The non-forested areas have a year-around carrying capacity of 275 sheep if properly managed. Leasing the land for grazing shows a present soil value of $13.10 per acre.

6. Apparently, leasing the non-forested areas for grazing shows the greatest present value to the soil. However, assurance of this value from grazing depends upon rigid enforcement of a range management plan.

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