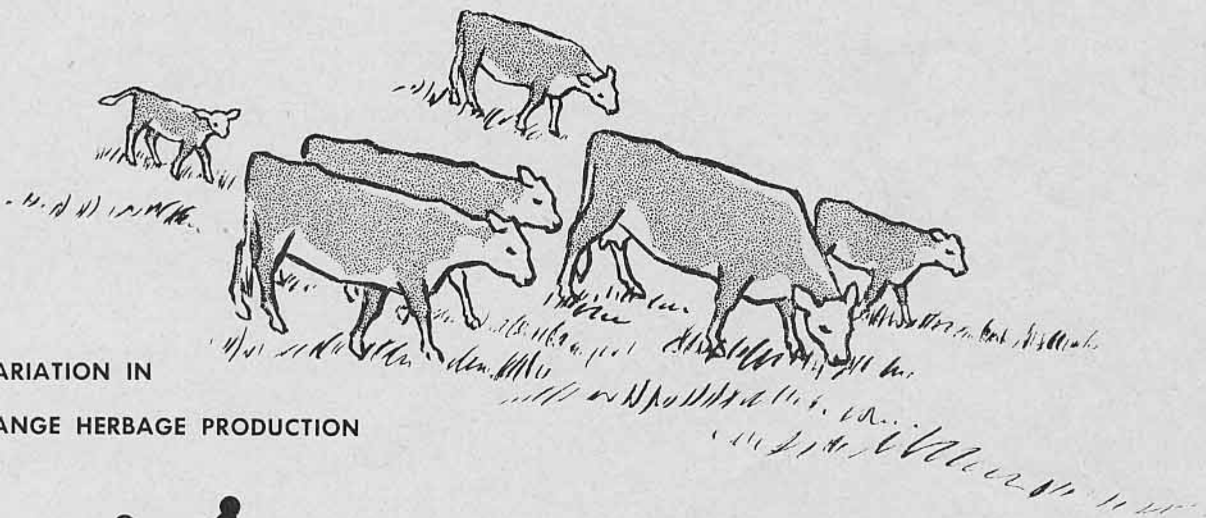
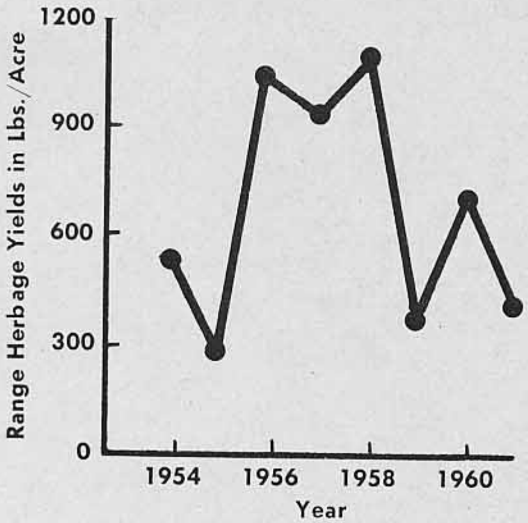
FORECASTING

RANGE HERBAGE PRODUCTION IN EASTERN OREGON



VARIATION IN RANGE HERBAGE PRODUCTION



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Forecasting Range Herbage Production In Eastern Oregon

Forrest A. Sneva and D. N. Hyder

With the advent of "barbwire" and the westward movement in the early 1900's, cattle on eastern Oregon ranges, as elsewhere in the West, could no longer "follow-the-grass" to stay on good feed. The consequence was that the land that remained would have to do. Cattle numbers would have to be balanced with feed supply.

Efficient use of our ranges has been a major consideration and concern of ranchers, technicians, and researchers alike. The difficulty of effectively using a widely fluctuating forage supply is recognized by all. The direction of management has been to balance stocking levels with normal range production. Present and future ranching economy, as well as range conservation, depends on a reasonable balance between stocking rates and normal forage production.

Stocking rates are calculated from estimates of range forage production. Estimates of stocking rates based upon yield samples taken in years other than normal years do not provide a reliable estimate for future years. Wide fluctuations in forage production from year-to-year not only discourage the best forage use each year, but have hindered reliable estimates of normal stocking rates from yield samples.

Many people have asked, "Why does range production fluctuate among years so widely?" The answer, quite simple, is mainly the amount of water received on the land. This was true in the days of the buffalo; it is true today; and it will be true in the future unless some radical changes take place in our climate. *Precipitation fluctuation is the most important element that causes yearly fluctuations in range forage production. Therefore, precipitation can be used as an index of range herbage production.*

Dependence of range herbage production on precipitation has been evaluated at the Squaw Butte Experiment Station from data that was collected in Oregon, Idaho, and Utah. The relation obtained has been developed into a technique that may be used for estimating normal range production from a yield sample taken in any year and for forecasting annual range production in individual years. This bulletin tells how to use the technique on ranges in eastern Oregon and bordering areas in adjacent states. The relations involved have been described in greater detail in the *Journal of Range Management*, Vol. 15, pages 88-93, 1962.

Variation of Range Production With Precipitation

The cover picture illustrates how native bunchgrass yields on a 40-acre pasture fluctuated during the years 1953-1961 at the Squaw Butte Experiment Station. Similar sets of figures could have been obtained anywhere in eastern Oregon during that period. Studies elsewhere in the West on semiarid ranges indicate that 75 to 90% of the yield fluctuations among years can be attributed to variation in precipitation amounts.

The effect of precipitation on herbage yields—when yield and precipitation amounts are expressed in percentage of median amounts—is shown in Figure 1. This line provides a reliable means of estimating herbage yields from precipitation amounts. The line does not estimate directly in pounds per acre; rather, in percent of normal production. Percentage-production evaluations are necessary because 1 inch of precipitation is capable of producing as little as 10 pounds per acre on some ranges and as much as 100 pounds per acre on other ranges. Despite the differences in productivity among ranges, the study revealed that the response of herbage to changes in precipitation amounts was similar, and a common response line (as shown) adequately describes that response on the semiarid areas of the intermountain region.

Reliability of estimates

Other effects (such as distribution of precipitation, effectiveness of precipitation, temperatures, and quality of the preceding crop-year) also influence the yield of range grasses. In any one year, one or another of these effects or a combination of them, may affect herbage yield. On the average, these factors together account for less than 25% of the yield variation. Nevertheless, because they do influence herbage growth, yields forecast from crop-year precipitation amounts are not perfect.

The standard error of estimate for the data studied was 18.4%. Using this as a guide, and looking into the future, we would expect that in approximately ⅔ of the years the estimated yield will be within 18% of the true yield. These are reasonable limits of error and reliability, but there is need for improvement that will come

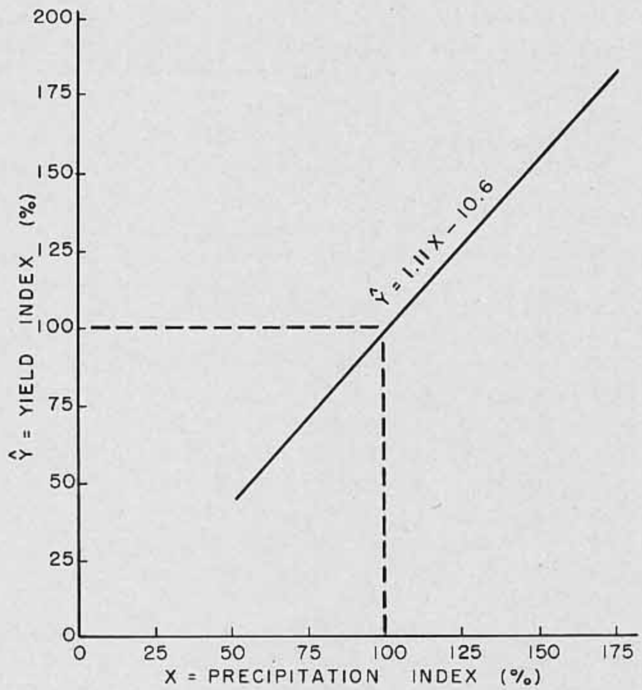

FIGURE 1. Herbage yield response to variations in precipitation.

when we are better able to measure and understand the influence of other factors upon yield.

Terms defined

1. *Crop-year precipitation* is that amount of precipitation received during the period September 1 to June 30. A crop-year is designated by the calendar year in which it terminates.

2. *Median precipitation* is that amount representing the long time normal for the crop-year as determined from weather records.

3. *Median yield* is the amount of herbage expected with a median precipitation amount. Median yield is an estimate of normal range production for stable communities of native vegetation or seeded stands of well adapted species. Median yields predicted for ranges in poor or fair condition should be considered as temporary estimates that remain reliable for only a few years.

4. *Precipitation index* is derived by dividing a given crop-year precipitation amount by the median precipitation amount and expressing it as a percentage.

5. *Yield index* is derived by using the precipitation index and the relation shown in Figure 1 or by substituting the precipitation index value into the equation and solving for yield index. To simplify this calculation, a table of yield indices (Table 1, Appendix) has been computed for all precipitation indices within the range examined.

Estimating the Median Yield---Normal Range Herbage Production

Median precipitation amounts for U. S. Weather Bureau stations in eastern Oregon, and a few stations in adjacent states, are given in Table 2, Appendix. The first and third quartiles are also given in Table 2 because those amounts help us to recognize the distribution of precipitation fluctuations.

> "The median is a measure of central tendency based on position and is the value of the mid-item. The first quartile, Q_1, is the value of the item located one-fourth of the distance from the lowest item to the highest, and the third quartile, Q_3, is located at three-quarters of this distance. The quartiles are directly comparable to the median, which may be called the second quartile. The interquartile range is the difference between the values of the first and third quartiles ($Q_3 - Q_1$)."[1]

[1] Pearson, Frank A. and Kenneth R. Bennett, *Statistical Methods,* New York: John Wiley & Sons, 1942, page 37.

Step 1: Determine the median precipitation amount

For example, the crop-year precipitation amounts for the Fremont station in the years 1932 to 1957, arranged from low to high, are given in the table on page 5. The median precipitation amount is between 9.5 and 9.6 inches. We round off median amounts to the nearest even digit in tenths of inches, or 9.6 inches for Fremont. Averaging the middle 4 or 5 precipitation amounts is a good practice, especially for stations with a record shorter than 20 years. This averaging technique estimates a median amount of 9.6 inches for Fremont, and, unless climatic conditions change, the median will remain very near 9.6 inches as additional years are added to the record.

Precipitation amounts received at Fremont are further divided into quartile ranges. The low, or first quartile (Q_1) is 7.3 inches, but averaging the nearest 5 precipitation amounts gives a better long-time estimate of 7.6 inches. The third quartile (Q_3) is 12.0 inches, and averaging the 5 nearest amounts estimates a long-time value of 11.9 inches. Half of the years are included between the first and third quartiles. Compared to the overall range in precipitation amounts from 3.4 to 20.2 inches, the interquartile range from 7.6 to 11.9 (just 4.3 inches) is very small. Precipitation amounts in this narrow range have had an important influence on the development of soils and vegetation, and the median amount will promote a good healthy growth of resident native species. Therefore, we conclude that: *A median amount of precipitation of any range promotes normal herbage production.* Numerically, this median amount of precipitation is given a precipitation index of 100%, and the resulting amount of herbage produced is given a yield index of 100%. We need to estimate normal herbage production as a basis for long-time ranch planning.

Precipitation at Fremont, Oregon

Number of years of record	Crop year	Actual Precipitation	Precipitation median and quartiles
		Inches	
1	1955	3.4	
2	1933	5.5	
3	1939	5.5	
4	1934	6.5	
5	1935	7.3	
6	1937	7.3	
7	1949	7.3	7.6, (Q_1)
8	1947	7.8	
9	1944	8.2	
10	1932	8.5	
11	1950	8.6	
12	1936	9.5	
13	1948	9.5	
14	1954	9.6	9.6, median
15	1941	9.8	
16	1945	10.0	
17	1946	10.7	
18	1942	11.8	
19	1951	11.9	
20	1938	12.0	11.9, (Q_3)
21	1940	12.0	
22	1943	12.0	
23	1953	12.3	
24	1957	13.3	
25	1952	14.7	
26	1956	20.2	

Step 2: Sum current crop-year precipitation for the year

Current precipitation by months at all stations is published monthly and in an annual summary prepared by the United States Department of Commerce. The publication "Climatological Data" is compiled on a state basis and may be received by mail for a nominal charge. State offices of the United States Weather Bureau for the Great Basin states are listed on page 10.

Step 3: Compute the precipitation index

The precipitation index is obtained by dividing total crop-year precipitation by the median amount and expressing the result as a percentage. For example, if total crop-year precipitation is 14.6 inches and the median amount for that particular station is 9.7 inches, the precipitation index is: 14.6 inches/9.7 inches x 100 = 151%.

Step 4: Sample range production

Reliable yield data must be obtained in at least one year to permit the estimation of median yield.

The number of samples needed to obtain a reliable estimate depends on the size of the area to be sampled, variability in production over the area, and plot size. Your local range technician can provide advice and assistance in sampling.

The procedure relates total or mature yields to precipitation; therefore, sampling should be done after grasses have reached their peak in yield. Generally, native range grasses on the Oregon high desert at 4,000 to 5,000 feet elevation have reached their maximum yield by the first of July.

Herbage yields are expressed in pounds per acre air dry (generally about 10-12% moisture content). Yield samples always need to be dried and the green weight corrected to air-dry weights. Oven-drying is preferred.

Animal-days-of-grazing or animal-unit-months (AUM's) *when stocking is proper,* can be used as a measure of forage production. However, since animals show preferences among species, which respond differently among years, a larger error in the estimate may be realized.

Step 5: Look up the yield index

With the precipitation index computed, we need only to turn to Table 1 at the rear of the bulletin. (Table 1 gives a yield index of 157% for a precipitation index of 151% for example.)

Step 6: Estimate normal range herbage production

For a given year, in which a yield sample has been obtained and the yield index computed, the estimate of normal herbage production (median yield) is obtained by dividing the yield in pounds per acre by the yield index in its decimal form. For example, assume the following results for a native range near Grizzly, Oregon:

Step 1—Grizzly's median precipitation amount is 12.9 inches (Table 2).

Step 2—In an assumed crop-year, actual precipitation is 8.4 inches.

Step 3—Therefore, the precipitation index is 8.4/12.9 x 100 or 65% of median.

Step 4—Herbage production, as sampled, is 600 pounds per acre air dry.

Step 5—The yield index for a precipitation index of 65%, as given in Table 1, is 62% or 0.62 in decimal form.

Step 6—Normal range production is estimated as 600/0.62 or 968 pounds per acre.

On this particular range the hypothetical rancher should be organized to depend on a normal range production of 968 pounds per acre; however, the operation must be flexible for adjusting to lower or higher yields for optimum use of the range.

Forecasting Range Herbage Production

After a normal range production has been estimated, you may subsequently forecast production in individual years.

Step 1: Determine the median precipitation amount

See Table 2.

Step 2: Sum current crop-year precipitation for the year

Since we are now forecasting, we do not have all of the precipitation that will occur through June 30. Therefore, we must assume some precipitation amounts for the months yet to come. For this purpose we use the median monthly amounts determined from past records. Median monthly precipitation amounts for each station have been determined for the months of April, May, and June and are presented in Table 3, Appendix. Crop-year precipitation amount is estimated by adding the amounts received and the median amounts for the months remaining.

Step 3: Compute the precipitation index

This is done as previously described.

Step 4: Look up the yield index

This is obtained from Table 1.

Step 5: Forecast current range production

The forecast of range production is now obtained by multiplying normal range herbage production (median yield) by the current season yield index in its decimal form.

Taking, in part, some of the data already given to illustrate procedure for estimating normal range production, let us assume that we wish to forecast the range herbage production on the Grizzly unit on April 1 of some year:

Step 1—The median precipitation amount is 12.9 inches (Table 2).

Step 2—In an assumed year, precipitation from September 1 through March 31 is 11.2 inches. From Table 3, Appendix, it is found that for the months of April, May, and June at Grizzly median precipitation amounts are 1.03, 1.14, and 1.68 inches, respectively. These monthly amounts added to the 11.2 inches already received estimate the crop-year precipitation amount of 15.0 inches.

Step 3—Thus, the precipitation index is 15.0/12.9 x 100 or 116%.

Step 4—The yield index for a precipitation index of 116%. (Table 1, Appendix) is 118% or 1.18 in decimal form.

Step 5—Finally, current range herbage production is forecast to be 968 x 1.18 – 1,140 pounds per acre. In other words, 118% of normal range production. The forecast can be improved at the end of April and May and the final forecast can be made after June 30. Estimates can be made in terms of animal-days-of-grazing or in AUM's, in the same manner as for herbage yields.

Ranchers, who do not have measures of herbage yield or records of stocking rates, will stop at Step 4, the yield index. Most ranchers are well acquainted with their grazing lands and have general knowledge about stocking rates in past years. In the example above, an estimate of 118% of normal or approximately 18% above normal gives assurance that current stocking rates can be about average or a little above. Should the year be estimated, say, at 60% of normal, however, it is quite obvious that the exact yield need not be known to conclude that range feed will be in short supply.

Selecting Appropriate Weather Recording Stations

The Great Basin region, of which eastern Oregon is a part, is notorious for its extreme variability in precipitation from year to year. This variability also exists from area to area in this region when we consider only current precipitation amounts in inches. However, since the eastern Oregon range receives general storm systems, the range, as a whole, is relatively dry or wet in any one year. Adjacent stations are, therefore, usually the most representative for any area, and generally the averaging of the precipitation indexes of adjacent stations is sufficient. A map of eastern Oregon (Figure 2, Appendix) delineates the areas represented by each current United States Weather Bureau station as determined by procedures set forth by Theissen.[1] Although this method of station selection is acceptable, it is not entirely adequate because it does not consider precipitation gradients. Another disadvantage is that a new drawing for an area is necessary whenever a new station is added to the network or an old station is eliminated.

[1] Theissen, A. H., "Precipitation Averages for Large Areas," *Monthly Weather Review*, Vol. 39, pp. 1082-1084, 1911.

Sources of Related Information

There are two other publications that are pertinent to the method given in this bulletin and may be useful in certain circumstances. They are: "Water Supply Outlook and Federal-State-Private Cooperative Snow Surveys" published on a state-wide basis and "Water Supply Forecasts for the Western United States." Information concerning the former can be obtained at county agents offices; whereas, the latter can be obtained upon request from the Chief, United States Weather Bureau, Washington 25, D. C.

Appendix

Table 1. Herbage yield indices for precipitation indices of 50-169%*

	Precipitation indices (Percent of median)									
	0	1	2	3	4	5	6	7	8	9
	Yield indices (percent of median)									
50	45	46	47	48	49	50	52	53	54	55
60	56	57	58	59	60	62	63	64	65	66
70	67	68	69	70	72	73	74	75	76	77
80	78	79	80	82	83	84	85	86	87	88
90	89	90	92	93	94	95	96	97	98	99
100	100	102	103	104	105	106	107	108	109	110
110	112	113	114	115	116	117	118	119	120	121
120	123	124	125	126	127	128	129	130	131	133
130	134	135	136	137	138	139	140	141	143	144
140	145	146	147	148	149	150	151	153	154	155
150	156	157	158	159	160	161	163	164	165	166
160	167	168	169	170	171	173	174	175	176	177

* Yield indices computed for precipitation indices shown from the regression equation $\hat{Y} = 1.11\ X - 10.6$, where X = precipitation index and $\hat{Y}$ = yield index.

Table 2. Median and quartile crop-year precipitation amounts for weather recording stations in eastern Oregon and adjacent areas*

Station	First quartile	Median	Third quartile
	Inches	*Inches*	*Inches*
Adrian	7.0	8.3	9.6
Antelope 1N	10.1	12.1	14.1
Arlington	7.4	8.6	9.6
Baker KBKR	8.0	9.6	11.4
Bend	9.5	11.0	12.8
*Beulah	8.4	10.2	12.4
*Burns	9.1	10.6	11.9
*Chemult	20.7	24.0	28.2
Chiloquin	14.0	16.8	19.6
Clear Lake Dam, Calif.	11.0	13.2	15.3
Condon	9.9	11.8	13.7
Cove	18.8	21.6	24.9
Danner	9.3	10.8	12.3
Dayville	8.8	9.8	12.0
Dufur	9.4	11.2	13.1
Echo	8.6	9.8	11.1
Enterprise	9.6	11.6	13.8
Fort Bidwell, Calif.	12.6	14.2	15.9
*Fossil	12.0	13.8	15.9
Fremont	7.6	9.7	11.7
Friend 1W	14.2	15.2	17.9
Gerber Dam	16.1	18.3	20.2
Grand View	6.0	7.3	8.7
Grizzly	11.1	12.9	14.7
*Halfway	16.8	19.1	23.4
Harney Branch	7.4	9.0	10.5
*Harper	6.7	8.1	9.6
*Hart Mountain	8.0	8.9	10.8
Heppner	10.7	12.4	14.2
Hermiston 2S	7.0	8.6	9.1
Huntington	8.0	10.2	12.4
Ione 18S	11.1	12.7	14.3
*John Day	13.0	15.1	17.0
Joseph	13.0	14.9	17.0
Keno	16.1	18.4	20.8
Kent	8.7	10.4	12.0
Klamath Falls 2SSW	11.6	13.7	16.0
LaGrande	16.9	19.3	21.7
Lakeview	12.0	14.6	16.0
*Lower Hay Creek	7.7	9.0	10.3
Madras	7.2	8.9	10.3
*Malheur Refuge Hdqs.	7.0	8.2	9.2
Mikkalo 6W	7.6	9.1	10.8
Milton-Freewater 4NW	11.5	13.3	15.3
Minam 7NE	17.1	20.8	23.7
Continued	*Inches*	*Inches*	*Inches*
Morgan	7.6	9.1	10.6
Moro	9.8	11.1	12.7
*Nyssa	7.5	8.9	10.6
*Ochoco R.S.	15.4	17.8	20.5
Owyhee, Nevada	12.6	13.6	15.7
Owyhee Dam	6.5	8.0	9.5
Paisley	7.4	9.2	11.1
Paradise Valley, Nevada	7.3	8.2	10.0
*Pendleton W.B.-A.D.	12.2	13.8	15.5
Pilot Rock 1SE	11.0	12.7	14.4
*Plush 6SE	6.1	7.6	8.5
Prairie City R.S.	12.0	13.4	14.8
*P Ranch Wildlife Ref.	9.0	10.8	12.1
Prineville 4NW	8.1	9.3	10.6
Redmond	6.6	8.1	9.6
*Richland	7.7	9.7	11.7
Rock Creek	17.7	19.3	21.7
Round Grove	14.8	16.6	18.5
*Seneca	9.2	10.9	12.0
*Sheaville, Idaho	9.8	11.6	13.0
Sheldon, Calif.	9.0	11.1	12.0
*Squaw Butte	8.6	11.0	12.1
Swan Falls Power House, Idaho	6.4	7.4	8.3
The Dalles	11.2	13.2	15.2
*The Poplars	7.4	9.1	10.6
*Three Creek, Idaho	10.1	12.4	13.6
Tule Lake, California	7.6	10.3	11.8
Ukiah 1NE	15.2	16.3	18.5
Umatilla	6.2	7.7	9.1
*Unity	8.3	9.8	11.5
Union	10.7	11.8	13.5
Vale	6.4	8.4	10.5
Valley Falls	9.8	11.8	13.7
Wallowa	14.0	16.7	19.3
Warm Springs Res.	6.1	7.5	9.0
Wasco	9.5	11.1	12.5
Weston 2SE	16.3	18.5	21.0
*Wickiup Dam	14.5	18.3	21.3

* Data used to determine the median and associated quartiles values were obtained as recorded in **Climatological Data** by the U. S. Weather Bureau for the states involved. The values were developed from that portion of record available for the crop-years 1932 through 1957. Missing monthly data were computed according to U. S. Weather Bureau procedure; however, if more than 3 months of any crop-year contained missing data, the year was deleted. Stations bearing the asterik* did not record several years during the 1932-1957 period, and estimated values for those years were included. Values were estimated on the basis of the average deviation of 2 adjacent stations from like-period means.

Table 3. Median monthly precipitation amounts for eastern Oregon stations and adjacent area stations for April, May, and June*

Station	April	May	June
	Inches	*Inches*	*Inches*
Adrian	0.73	0.85	0.62
Antelope 1N	0.93	1.03	1.09
Arlington	0.45	0.41	0.55
Baker KBKR	0.89	1.10	1.42
Bend	0.46	0.74	1.06
Beulah	0.72	1.15	1.10
Burns	0.62	0.72	0.76
Chemult	1.11	1.65	0.75
Chiloquin	1.02	1.15	0.72
Clear Lake Dam, Calif.	0.92	1.36	1.05
Condon	0.82	1.06	1.35
Cove	2.23	2.47	2.57
Danner	1.00	1.14	0.89
Dayville	0.88	1.45	1.20
Dufur	0.59	0.58	0.74
Echo	0.72	0.57	0.66
Enterprise	1.18	1.43	2.17
Fort Bidwell, Calif.	0.96	0.94	0.69
Fossil	1.00	1.25	1.56
Fremont	0.45	0.83	0.81
Friend 1W	0.63	1.12	0.67
Gerber Dam	1.34	1.45	1.30
Grand View	0.56	1.24	0.58
Grizzly	1.03	1.14	1.68
Halfway	1.88	1.92	1.70
Harney Branch	0.65	0.61	0.82
Harper	0.64	0.70	0.63
Hart Mountain	0.72	1.84	1.62
Heppner	1.17	1.09	1.38
Hermiston 2S	0.54	0.55	0.68
Huntington	0.70	0.60	0.68
Ione 18S	1.05	1.05	1.60
John Day	1.41	1.98	1.62
Joseph	1.82	1.93	2.44
Keno	0.92	1.20	0.75
Kent	0.85	0.81	1.01
Klamath Falls 2SSW	0.86	1.05	0.84
La Grande	1.92	1.65	2.06
Lakeview	1.00	1.34	0.99
Lower Hay Creek	0.55	0.88	0.95
Madras	0.51	0.77	0.75
Continued			
Malheur Refuge Hdqs.	0.50	1.04	0.71
Mikkalo 6W	0.62	0.82	0.85
Milton-Freewater 4NW	1.08	1.18	1.26
Minam 7NE	1.76	1.84	1.97
Morgan	0.62	0.50	0.90
Moro	0.72	0.68	0.72
Nyssa	0.64	0.82	0.62
Ochoco R.S.	1.25	1.44	1.70
Owyhee, Nevada	1.57	2.22	1.37
Owyhee Dam	0.58	1.00	0.62
Paisley	0.53	0.82	0.83
Paradise Valley, Nevada	0.61	0.80	0.56
Pendleton W.B.-A.D.	1.01	0.89	1.08
Pilot Rock 1SE	1.19	1.12	1.11
Plush 6SE	0.39	0.82	0.98
Prairie City R.S.	1.16	1.27	1.58
P Ranch Wildlife Ref.	0.94	1.65	1.36
Prineville 4NW	0.69	1.02	1.11
Redmond	0.34	0.65	0.97
Richland	1.06	1.66	1.23
Rock Creek	1.45	1.64	2.30
Round Grove	1.21	1.65	1.05
Seneca	0.92	0.56	0.83
Sheaville, Idaho	1.29	1.44	0.85
Sheldon, Calif.	0.88	0.98	1.13
Squaw Butte	0.58	1.25	1.10
Swan Falls Power House, Idaho	0.72	0.68	0.88
The Dalles	0.47	0.42	0.41
The Poplars	0.38	1.42	1.01
Three Creek, Idaho	1.35	1.85	1.52
Tule Lake, California	0.66	0.91	0.64
Ukiah 1NE	1.36	1.41	1.93
Umatilla	0.48	0.53	0.64
Unity	0.59	1.19	1.06
Union	1.40	1.69	1.63
Vale	0.72	0.84	0.63
Valley Falls	0.89	1.23	1.23
Wallowa	1.48	1.43	1.92
Warm Springs Res.	0.48	0.59	0.91
Wasco	0.64	0.64	0.58
Weston 2SE	1.87	1.43	1.66
Wickiup Dam	0.84	1.23	1.28

* Data to derive monthly median precipitation amounts for the stations listed were obtained from *Climatological Data* for the states of Oregon, California, Idaho, and Nevada. Median determination was obtained by taking the mean of the middle 4 or 5 values of arrayed data.

Table 4. Future use record

Station.................................... Median precip.....................

Year*	Monthly precipitation (inches) Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Crop-year precip.	Precip. index	Yield index
											(Inches and tenths)	%	%
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* Crop years are identified by the calendar year in which they terminate.

Location of State Offices, U. S. Weather Bureau

OREGON

State Climatologist
Weather Bureau Office
321 Custom House
Portland 9, Oregon

CALIFORNIA

State Climatologist
Weather Bureau Office
557 Federal Office Building
50 Fulton Street
San Francisco 2, California

UTAH-NEVADA

State Climatologist
Weather Bureau Airport Station
Salt Lake Municipal Airport
Salt Lake City 16, Utah

IDAHO

State Climatologist
Weather Bureau Airport Station
Box 1718
Boise, Idaho

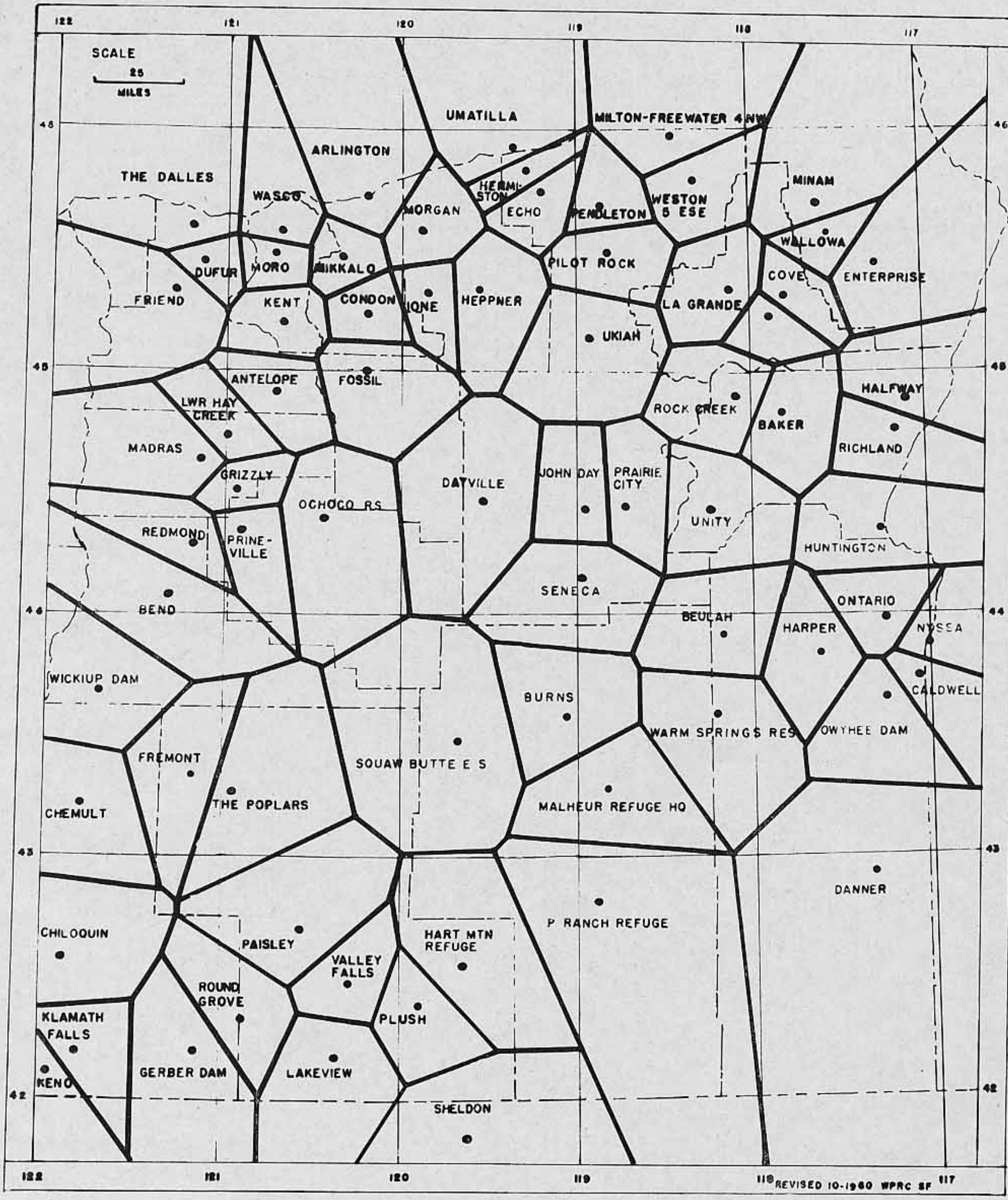

FIGURE 2. Theissen grid of eastern Oregon.

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Oregon State University

Corvallis