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An Objective Aid for Forecasting the End of East Winds in the Columbia Gorge

by

D. John Coparanis

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AN OBJECTIVE AID FOR FORECASTING THE END OF EAST WINDS IN THE COLUMBIA GORGE (JULY THROUGH OCTOBER)

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I. Introduction

Many studies have been developed on east winds by fire-weather meteorologists of the Pacific Northwest, but relatively few have been written on the movement of the thermal trough from western to eastern Oregon. Both types of cases have one thing in common, i.e., a gradient or wind reversal. The importance of accurate forecasting of wind reversals in fire-weather cannot be overemphasized. In addition, there is the ever-present question to be answered, "What time will this wind shift take place?" This paper attempts to solve these problems as they apply to the Columbia Gorge. For this purpose, the assumption is made that any westerly gradient through the Gorge implies a west wind and any easterly gradient implies an east wind.

II. Forecast Problems

The forecast problems can be stated in two parts as follows:

Part I - GIVEN: An easterly sea-level pressure gradient between The Dalles and Portland, plus higher sea-level pressure in eastern Washington than at Portland at 1300 PST (July through October).

FORECAST: An easterly or westerly surface pressure gradient between The Dalles and Portland at 0400 PST the following morning.

By "higher sea-level pressure in eastern Washington" is meant that the majority of the reporting stations have a higher sea-level pressure than Portland.

Part II - GIVEN: At 1300 PST the decision that a westerly gradient will exist between Portland and The Dalles by 0400 PST the following morning.

FORECAST: The time this reversal will occur.

III. Selection of Cases

Ninety-two (92) cases were selected from 1962 - 1966, July through October, based on the above criteria. These comprise the developmental data.

Since 92 cases were selected on a surface-pressure distribution only, it turns out that with respect to the upper air, the majority of cases are associated with upper-air ridges, while a small minority are associated with troughs or closed lows. In other words, most of these cases apply during fair-weather days, but there are a few cases which are associated with cool, moist air masses. On the other hand, cases were eliminated which initially involved the approach of storm systems setting up easterly gradients through the Gorge. However, this did not preclude cases which involved the ending of an east wind regime by the approach of a surface frontal system.

It is interesting to note that only four of the 92 cases showed Eugene with higher sea-level pressure than Redmond at 1300 PST, while in 41 of 92 cases, Seattle reported higher sea-level pressure than Ephrata. The criteria established for choosing the 92 cases also established, in the majority of cases, that the thermal trough existed in western Oregon, but may or may not have existed in western Washington.

Seventy-two (72) percent of the cases occurred in September and October. As expected, this coincides with one of the maxima of east-wind frequencies in the Pacific Northwest as pointed out by Cramer (2).

IV. Development of Objective Aid - Part I

A particular pattern is required to maintain an easterly surface-pressure gradient through the Gorge with the thermal trough in western Oregon. This obviously entails higher pressure existing east of the Cascades. A scatter diagram (Figure 1) was set up to keep track of this pressure relationship using the algebraic difference between North Bend and Spokane (OTH - GEG) as the absicissa. For the ordinate, the surface-pressure difference between North Bend and Eugene (OTH - EUG) was followed to watch for the signs of a marine push from southwestern Oregon. Positive and negative numbers were used to denote onshore and offshore flow respectively. In Figure 1, the dots show an easterly gradient to exist through the Gorge the following morning at 0400 PST, while the x's show a westerly gradient to exist the next morning.

The scatter diagram (Figure 1) was divided into three areas based on the dependent data. These areas are marked "A", "B", and "C". If the case falls in area "A", an easterly gradient is forecast through the Gorge for the next morning at 0400 PST. If the case falls in area "C", a westerly gradient is forecast to exist through the Gorge the next morning at 0400 PST. Cases falling in area "B" or on the boundary lines are indeterminate and should be referred to Table 1.

An antecedent condition to a marine push in western Oregon shows up in a comparison of the surface-pressure tendency relationship between Crescent City, California, and Pendleton, Oregon. When the algebraic difference between the 1300 PST pressure tendencies of Crescent City and Pendleton (CEC - PDT) is plus 1.7 mb or higher, the dependent data shows that a westerly gradient exists the following morning at 0400 PST through the Gorge (Table 1). As a result, the forecast rule adopted for cases falling in area "B" of Figure 1 becomes simply:

> When the 1300 PST pressure-tendency difference (algebraic) between Crescent City and Pendleton is greater than or equal to plus 1.6 mb, forecast a westerly gradient to exist the next morning through the Gorge at 0400 PST. When this difference is less than 1.6 mb, forecast an easterly gradient to exist the next morning through the Gorge at 0400 PST.

1300 PST CRESCENT CITY PRESSURE TENDENCY -
PENDLETON PRESSURE TENDENCY (MBS)

≤1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	≥2.0
●		●		●	●		X			X
●							X			X
										X
										X
										X
										X

Table 1 - INDETERMINATE CASES FROM AREA "B" OF FIGURE 1.

V. Skill Scores

Forecasts made for the 92 developmental cases are summarized in the following contingency table:

FORECAST

OBSERVED	East Gradient Next Day	West Gradient Next Day	Total
East Gradient Next Day	68	1	69
West Gradient Next Day	2	21	23
Total	70	22	92

Common Skill Score: .91
Percent Correct: 97

Table 2 - CONTINGENCY TABLE FOR DEVELOPMENTAL DATA

The objective forecast technique was tested against eight months of independent data. Specifically, the independent data used covered the months of July through October for the years 1960 and 1961. The results of 43 independent cases are summarized in Table 3:

OBSERVED	FORECAST: East Gradient Next Day	FORECAST: West Gradient Next Day	Total
East Gradient Next Day	29	1	30
West Gradient Next Day	3	10	13
Total	32	11	43

Common Skill Score: .76
Percent Correct: 91

Table 3 - CONTINGENCY TABLE FOR INDEPENDENT DATA

Ayer (1) recommended that Appleman's skill score be applied to two-category forecast systems. Appleman's skill score uses the climatologically most frequent occurrence in its computation. This is readily available in the contingency table. The results as they apply to the developmental data and the independent forecasts show Appleman's skill scores of .87 and .69 respectively.

VI. Development of Objective Aid - Part II

It was at first thought that a scatter diagram could be constructed to show the times that the gradient reversals took place through the Gorge. The intention was to draw isopleths of time on the scatter diagram. In all attempts where sets of sea-level pressure differences were used, a poor correlation was found with one of the sets. However, one set consistently showed good correlation, the difference in sea-level pressure between Portland and The Dalles (PDX - DLS).

A line of regression was computed to predict the number of hours from 1300 PST that a gradient reversal could be expected through the Gorge based on the pressure difference between Portland and The Dalles. Twenty-one cases were used from Figure 1, areas "B" and "C", reversals only. Figure 2 shows that the variates are negatively correlated, the correlation coefficient being -.86. The scatter about the line of regression was computed in order to increase the forecast potential of this tool.

The equation for the line of regression in its slope intercept form, $y = -3.8x + 0.7$, shows that the line does not intersect the origin. This is because the regression equation is developed from the available observed data. In practice, the line of regression should intersect the origin because of the physical relationship of the variables.

There were ten cases of independent data which involved correct west wind forecasts for the next morning through the Gorge. The timing of these wind shifts from 1300 PST was plotted as small triangles in Figure 2.

With respect to the developmental data, it is of interest to note that 95 percent of the Eugene-Redmond gradients reversed when the Portland-The Dalles gradient reversed. In 76 percent of the cases, the Eugene-Redmond reversal came later than the reversal through the Gorge. In 19 percent of the cases, this reversal came earlier.

VII. Conclusions

The objective aid for forecasting the end of east winds through the Columbia Gorge will be of value to most forecasters in the Pacific Northwest. The timing of the wind reversal will be especially helpful to fire-weather meteorologists who are forecasting for wildfires or controlled burns in the vicinity of the Columbia Gorge.

VIII. Acknowledgement

The author wishes to thank Mr. Harold S. Ayer for his helpful hints during the preparation of this paper, and to Scientific Services Division of WBWR for their technical review.

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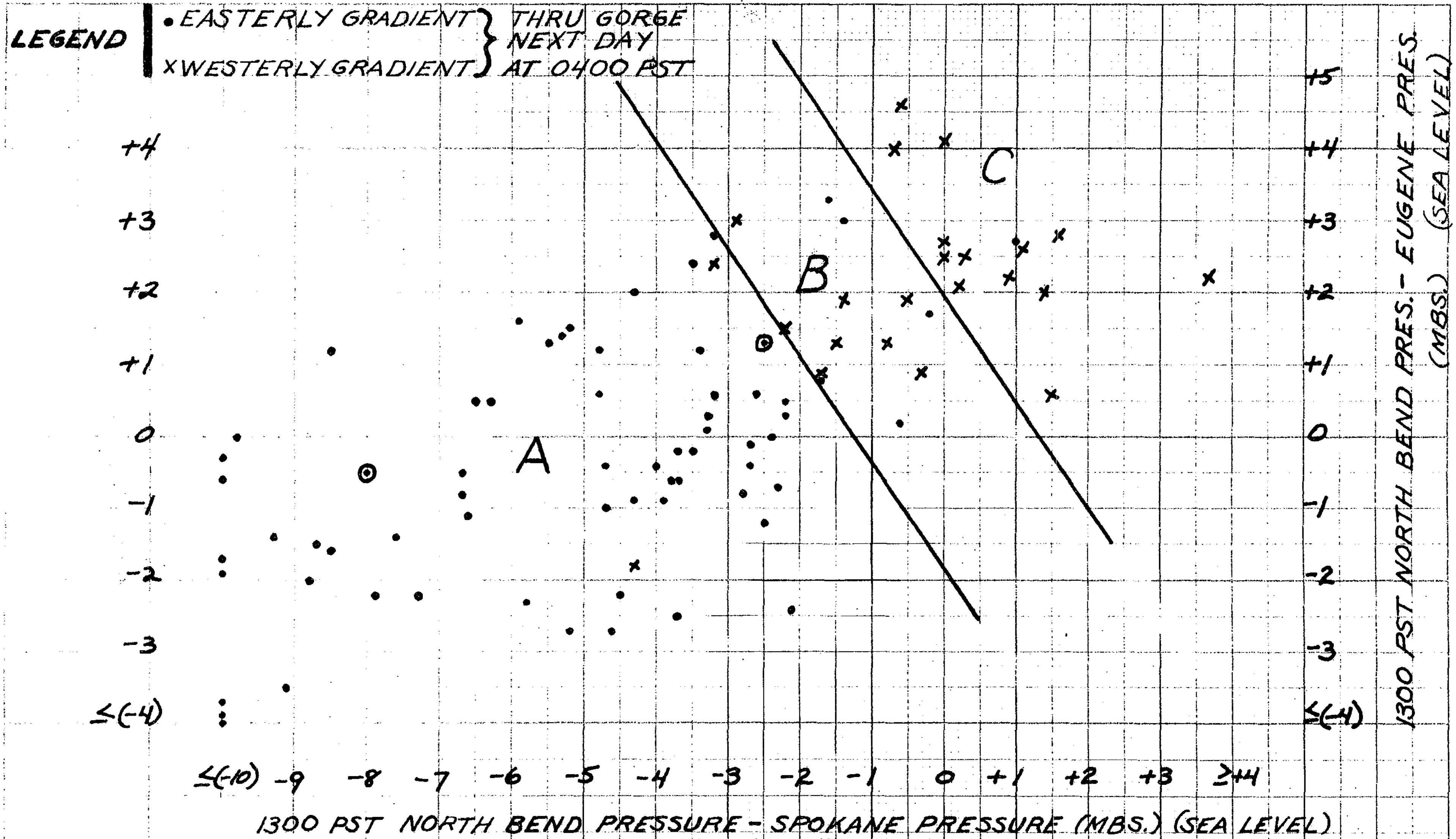

Figure 1. SCATTER DIAGRAM OF 92 DEVELOPMENTAL CASES

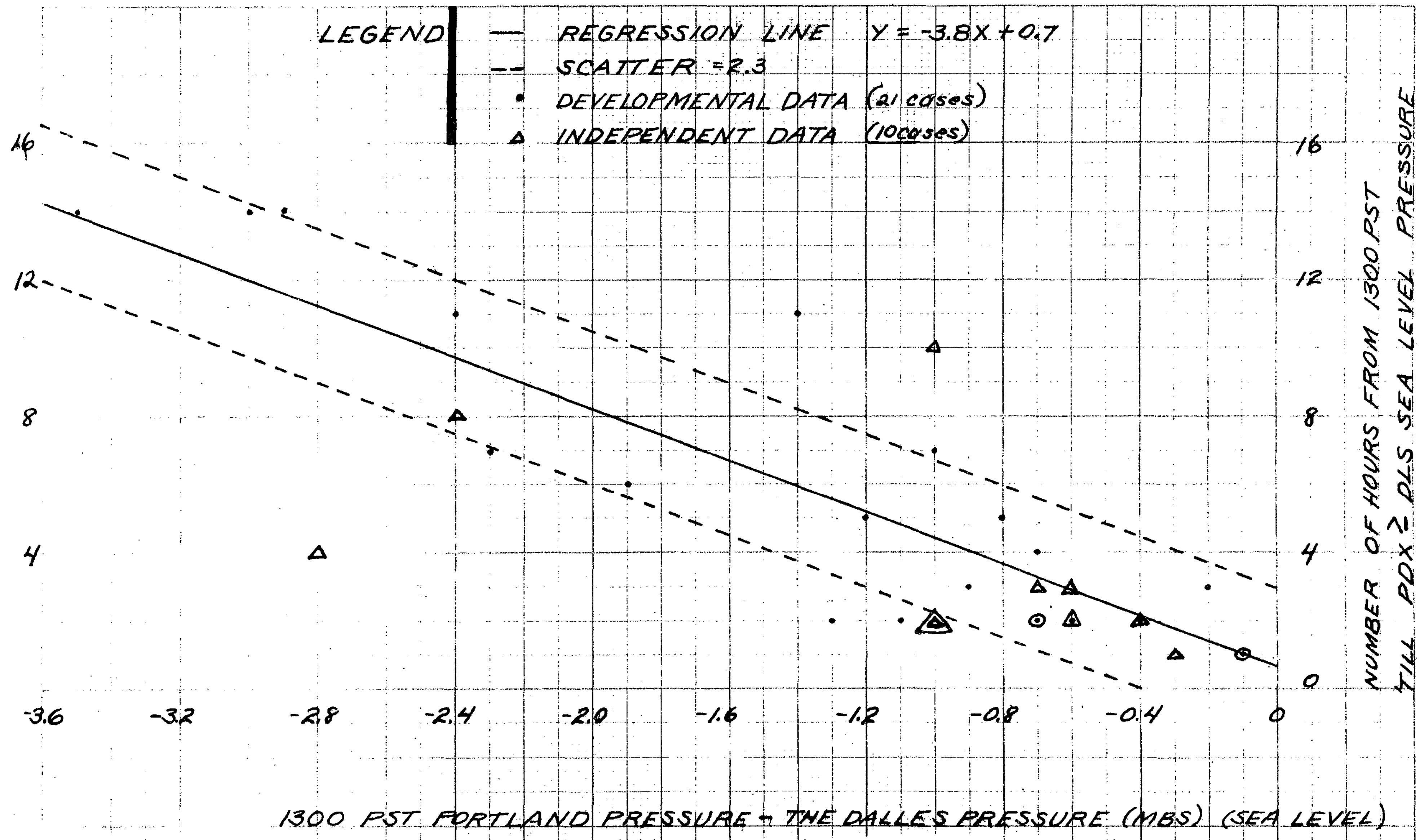

Figure 2.-Regression Line for Predicting Timing of Gradient Reversal or Equalization

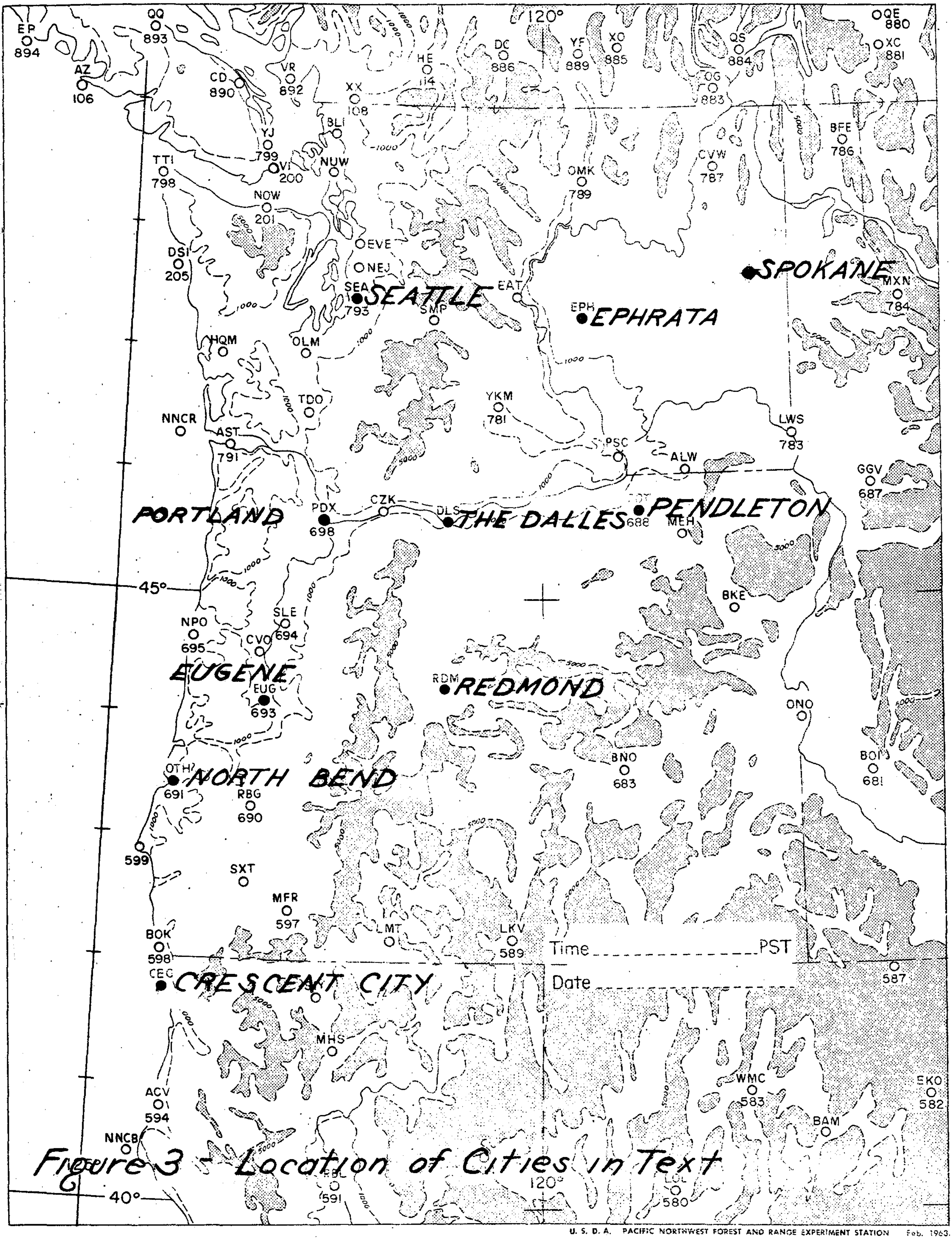

Figure 3 - Location of Cities in Text

U. S. D. A. PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION Feb. 1963.