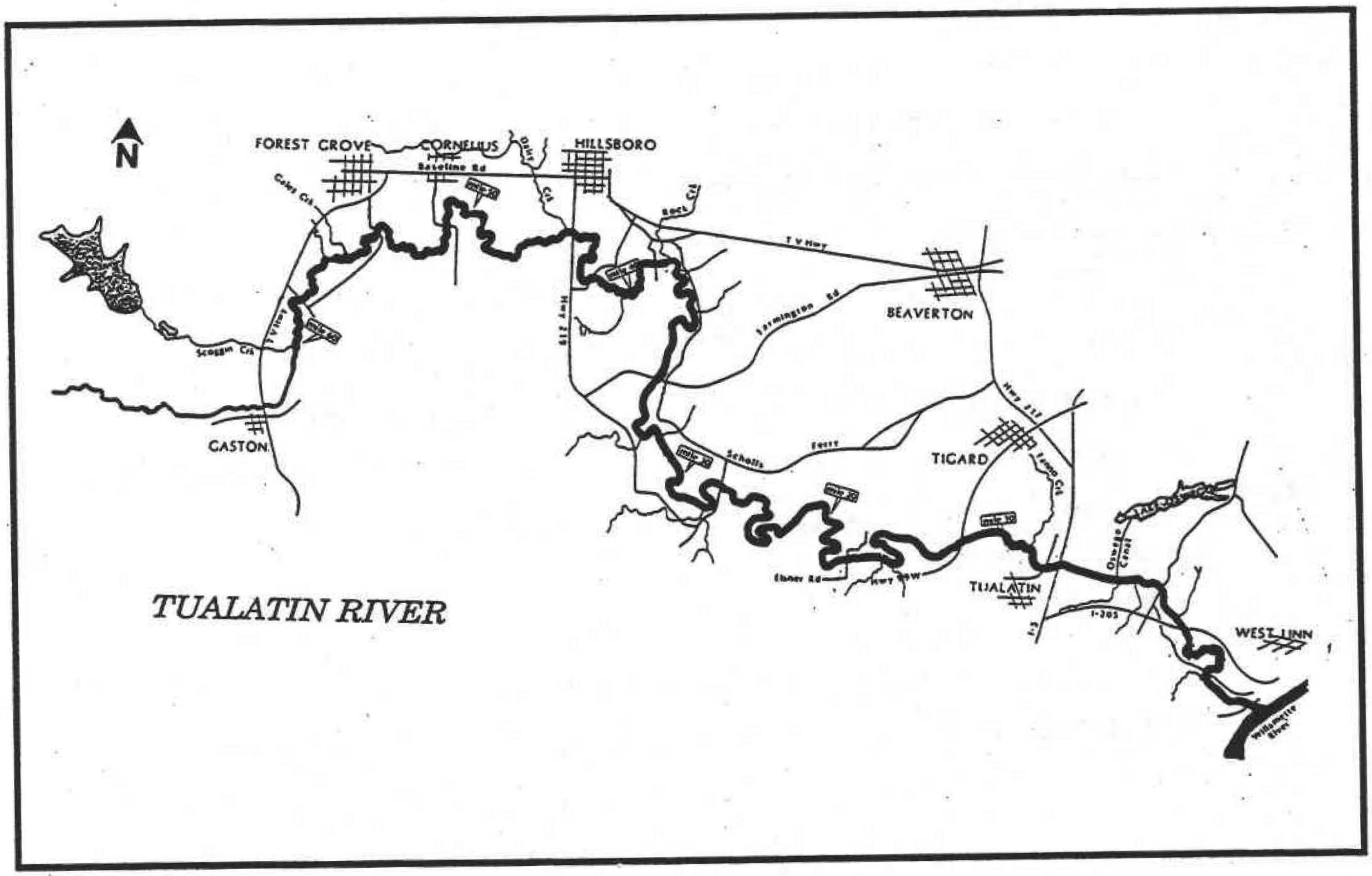
Estimating the Frequency and Quantity of Surface Runoff Within the Tualatin River Basin



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TUALATIN RIVER BASIN SPECIAL REPORTS

The Tualatin River Basin in Washington County, Oregon, is a complex area with highly developed agricultural, forestry, industrial, commercial, and residential activities. Population has grown in the past thirty years from fifty to over 270 thousand. Accompanying this population growth have been the associated increases in transportation, construction, and recreational activities. Major improvements have occurred in treatment of wastewater discharges form communities and industries in the area. A surface water runoff management plan is in operation. Agricultural and forestry operations have adopted practices designed to reduce water quality impacts. In spite of efforts to-date, the standards required to protect appropriate beneficial uses of water have not been met in the slow-moving river.

The Oregon Department of Environmental Quality awarded a grant in 1992 to the Oregon Water Resources Research Institute (OWRRI) at Oregon State University to review existing information on the Tualatin, organize that information so that it can be readily evaluated, develop a method to examine effectiveness, costs and benefits of alternative pollution abatement strategies, and allow for the evaluation of various scenarios proposed for water management in the Tualatin Basin. Faculty members from eight departments at Oregon State University and Portland State University are contributing to the project. Many local interest groups, industry, state and federal agencies are contributing to the understanding of water quality issues in the Basin. This OWRRI project is based on all these research, planning and management studies.

This publication is one in a series designed to make the results of this project available to interested persons and to promote useful discussions on issues and solutions. You are invited to share your insights and comments on these publications and on the process in which we are engaged. This will aid us in moving towards a better understanding of the complex relationships between people's needs, the natural environment in which they and their children will live, and the decisions that will be made on resource management.

ESTIMATING THE FREQUENCY AND QUANTITY OF SURFACE RUNOFF WITHIN THE TUALATIN RIVER BASIN

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INTRODUCTION

The Tualatin River Basin along the east side of the Coastal Mountains in Oregon is subject to a complex mixture of land uses. Approximately half the area is devoted to forestry production. The remainder is divided between agriculture and urban uses. In addition to this diversity in land use, there is a dramatic change in terrain from the upper forested areas to the flat basin floor where the river velocity becomes extremely slow.

During the summer months, there is relatively little rainfall in the Basin; high evaporation rates and generally dry soil profiles cause warm-season runoff to be rare. As a result, the flow in the Tualatin River consists of discharge from the upstream reservoir, groundwater inflow along the river and its tributaries, and effluent from the two major sewage treatment plants within the Basin. There are additionally several other point sources within the Basin; however, their total discharge is insignificant compared to the above sources. Groundwater inflow as used in this document includes any water flowing through the soil profile into a stream, including irrigation water that has been applied and infiltrated into the soil.

Estimating the frequency with which surface runoff enters the Tualatin River or one of it major tributaries is important in the selection of a pollution control strategy. The possibility of surface runoff-transported pollutants contributing to late summer elevated nutrient conditions in the lower reaches of the River requires that either there be surface runoff during the dry months or that runoff transported materials that enter the streams during the months of higher rainfall are stored in the stream and become somehow freed during the summer due to temperature change or some other phenomenon.

The purpose of this analysis is to determine the frequency of surface runoff from various land areas within the Tualatin River Basin during the various months of the year. Several variables determine whether precipitation in the Basin will cause runoff in the Tualatin River or its tributaries. This analysis assumes that the two most important variables are land use and soil moisture holding capacity. Various studies have been conducted in the past to explore these topics. The purpose of this paper is to organize that thinking and apply it to the Tualatin River Basin.

RAINFALL REQUIRED TO INITIATE RUNOFF

Runoff occurs when rainfall intensity exceeds the infiltration capacity of the surface onto which it falls. One of the most common methods for predicting runoff quantity is that developed by the U.S. Soil Conservation Service (U.S. Soil Conservation Service, 1964). That technique may be summarized as follows (Schwab et al., 1966). Surface runoff is predicted as follows:

$$Q = \frac{(I - 0.2S)^2}{I + 0.8S}$$

Where Q = direct surface runoff in inches

I = storm rainfall in inches

S = maximum potential difference between rainfall and runoff in inches.

The Soil Conservation Service defines S as:

$$S = \frac{1000}{N} - 10$$

Where N = an arbitrary curve number varying form 0 to 100 (U.S. Soil Conservation Service, 1964).

By rearranging the above two equations, it is possible to calculate the required rainfall to produce a specific amount of runoff given the applicable Runoff Curve Number (RCN). Table 1 includes the result of those calculations.

The amount of rainfall in a particular storm required to initiate runoff is a function of the effective runoff curve number for that particular soil, its cover, its moisture content, and the extent to which erosion control measures have or have not been applied. Table 1 demonstrates the importance of RCNS in predicting the amount of rainfall required to produce runoff.

Runoff curve numbers elected as being representative of overall conditions in the Tualatin River Basin are presented in Table 2. These curve numbers are presented as a function of month as well as land use in an attempt to integrate the seasonality of the areas into this analysis. Clearly, less rainfall is required to initiate runoff during January when soil moisture is typically high, and evapotranspiration losses are lows, than during July when the soil surface has maximum storage capacity available and water consumption is high. It should be obvious that these curve numbers do not reflect all the individual land uses, but are presented as an indication of the likelihood that runoff will carry sediment or other suspended contaminants into the Tualatin system. Higher RCNS were selected for the cooler months to reflect both the lower evapotranspiration rate and the greater likelihood that there will have been rain the preceding day (thus reducing or depleting the surface storage capacity).]

By combining the information in Tables 1 and 2, it becomes possible to estimate the daily rainfall necessary to produce runoff from each of the major land use categories within the Tualatin Basin. As a basis for this discussion, runoff was defined as occurring whenever the predicted runoff was 0.10 inches from the 24 hour rainfall. The results of that combination of information is presented in Table 3. Thus, based on the frequency with which daily rainfall amounts can be expected during the various months of the year, the anticipated frequency of runoff from specific land uses can be predicted.

FREQUENCY OF RAINFALL TO INITIATE RUNOFF

Rainfall in the Tualatin Basin varies by year, season and by elevation. As an indication of that variability by month and by elevation, Tables 4 and 5 present the mean percentage of days during each month when rainfall exceed each of the identified threshold values. As an example, during 21 percent of the days there will be rainfall in excess of 0.48 inches at Scoggins Dam during February. During the same month, there will be rainfall in excess of 0.48 inches at Hillsboro only ten percent of the days.

INTERPRETATION

The information from Tables 3, 4, and 5 can be combined to predict the percentage of days that runoff can be expected from each oaf the major land uses within the Tualatin Basin. Those predictions are shown in Table 6. The urban and agricultural runoff frequencies were based on data form the Hillsboro weather station while the forestry data were based on observations at Scoggins Dam.

This information is helpful in interpreting summertime phosphorus concentrations in the Tualatin River and in planning pollution abatement measures in response to phorphorus related problems.

During the months of May through October, runoff from agricultural and forested lands is unlikely. Runoff from urban and otherwise impermeable land is greater but still less than once per month on the average.

During the high rainfall winter months when evapotranspiration is lowest, runoff from al of the Tualatin Basin land uses is frequent.

Although this analysis is helpful in evaluating the impact of runoff-carried phosphorus from the agricultural and forested areas on the phorphorus concentrations in the River, the question of amounts remains unresolved. The data do support the observation that changing land uses from agricultural and forestry to urban and other less permeable uses increases the frequency of runoff and hence changes both the hydrology and nutrient concentration of the River.

REFERENCES

Schwab, G. O., R. K. Frevert, T. W. Edminster, and K. K. Barnes. 1966. Soil and Water Conservation Engineering. John Wiley & Sons. New York, New York.

U. S. Soil Conservation Service. 1964. National Engineering Handbook, Hydrology, Section 4, Part I, Watershed Planning.

Table 1. Amount of rainfall required to produce various amounts of runoff as a function of Runoff Curve Numbers.

Runoff curve number	Amount of runoff, inches 0.01	0.10	0.25
100	0.01	0.10	0.25
97	0.011	0.29	0.49
95	0.037	0.39	0.61
93	0.069	0.48	0.73
90	0.122	0.61	0.89
85	0.225	0.83	1.15
80	0.346	1.05	1.43
75	0.489	1.30	1.71

Table 2. Proposed runoff curve numbers for use in the Tualatin River Basin to predict the rainfall necessary to cause runoff during the various months of the year.

Month	Impermeable urban areas	Permeable urban	Pasture	Row crops	Small grain	Forested
Jan	97	95	90	90	90	85
Feb	97	95	90	90	90	85
Mar	97	95	90	90	85	80
Apr	95	90	85	90	85	80
May	95	90	80	90	85	75
Jun	93	85	80	85	80	75
Jul	93	85	75	85	80	70
Aug	93	85	75	85	85	70
Sep	93	90	80	85	85	75
Oct	95	90	80	90	85	80
Nov	97	90	85	90	90	85
Dec	97	95	90	90	90	85

Table 3. Daily rainfall, inches, predicted to cause runoff from each of the major land use categories in the Tualatin River Basin for each of the months.

Month	Impermeable urban areas	Permeable urban	Pasture	Row crops	Small grain	Forested
Jan	0.29	0.39	0.61	0.61	0.61	0.83
Feb	0.29	0.39	0.61	0.61	0.61	0.83
Mar	0.29	0.39	0.61	0.61	0.83	1.05
Apr	0.39	0.61	0.83	0.61	0.83	1.05
May	0.39	0.61	1.05	0.61	0.83	1.30
Jun	0.48	0.83	1.05	0.83	1.05	1.30
Jul	0.48	0.83	1.30	0.83	1.05	2.03
Aug	0.48	0.83	1.30	0.83	0.83	2.03
Sep	0.48	0.61	1.05	0.83	0.83	1.71
Oct	0.39	0.61	1.05	0.61	0.83	1.05
Nov	0.29	0.61	0.83	0.61	0.61	0.83
Dec	0.29	0.39	0.61	0.61	0.61	0.83

Table 4. Percent of days during specific months when rainfall amounts can be expected to exceed certain amounts. Hillsboro, 1948-91.

	Rainfall amount, inches						
Month	0.29	0.39	0.48	0.61	0.83	1.05	1.30
Jan	24	19	15	11	6	3	2
Feb	19	14	10	7	3	2	1
Mar	16	10	7	5	2	1	0
Apr	7	4	3	1	0	0	0
May	6	3	2	1	0	0	0
Jun	6	3	2	1	0	0	0
Jul	2	1	1	0	0	0	0
Aug	3	2	2	1	1	0	0
Sep	6	4	3	2	1	0	0
Oct	12	8	6	4	2	1	0
Nov	23	17	13	8	5	3	2
Dec	25	19	15	11	5	3	2
Annual	12	9	7	4	2	1	1

Table 5. Percent of days during specific months when rainfall amounts can be expected to exceed certain amounts. Scoggins Dam 1973-85.

	Rainfall amount, inches						
Month	0.29	0.39	0.48	0.61	0.83	1.05	1.30
Jan	21	17	15	12	6	4	3
Feb	33	27	21	15	10	6	2
Mar	23	17	13	8	3	2	1
Apr	12	9	6	4	1	1	0
May	6	4	3	2	1	1	1
Jun	6	4	2	1	0	0	0
Jul	2	1	1	1	0	0	0
Aug	5	3	2	2	1	1	0
Sep	8	4	3	3	2	1	1
Oct	15	12	9	5	2	2	1
Nov	34	28	23	17	11	6	4
Dec	30	24	22	18	13	10	6
Annual	16	12	10	7	4	3	2

Table 6. Predicted percentage of days during which runoff can be anticipated from each of the land uses, Tualatin Basin, Oregon

Month	Impermeable urban areas	Permeable urban	Pasture	Row crops	Small grain	Forested
Jan	24	19	11	11	11	6
Feb	19	14	7	7	7	10
Mar	16	10	5	5	2	2
Apr	4	1	0	1	0	1
May	3	1	0	1	0	0
Jun	2	0	0	0	0	0
Jul	1	0	0	0	0	0
Aug	2	1	0	1	1	0
Sep	3	2	0	1	1	0
Oct	8	4	2	4	2	1
Nov	23	8	5	8	8	11
Dec	25	19	11	11	11	13

Table 7.

Number of Days Equalling or Exceeding Precipitation Thresholds

Scoggins Dam 1973-85

Threshold: .29 in.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1973				3	1	2	0	2	4	5	14	13	
1974	10	9	11	4	2	1	2	0	0	2	10	13	64
1975	12	10	8	1	1	0	1	3	0	9	10	9	64
1976	9	10	9	2	1	0	1	4	1	1	2	3	43
1977	1	4	6	0	2	2	1	2	4	4	11	9	46
1978	10	8	4	6	4	0	1	2	5	2	5	4	51
1979	3	14	3	3	3	1	0	1	4	9	9	12	62
1980	9	10	4	7	0	3	0	0	1	1	11	10	56
1981	3	8	5	4	3	3	0	0	5	8	8	13	60
1982	5	9	8	7	0	3	0	1	2	5	9	12	61
1983	11	14	13	3	1	2	3	2	0	2	20	10	81
1984	6	9	6	5	5	5	0	0	1	7	14	5	63
1985	0	7	7	1									
MEAN	6.6	9.3	7.0	3.5	1.9	1.8	.8	1.4	2.3	4.6	10.3	9.4	37.4
S.D.	4.1	2.7	3.0	2.3	1.6	1.5	1.0	1.3	2.0	3.1	4.6	3.6	29.1
SKEW	-.3	.2	.6	.2	.6	.5	1.2	.4	.2	.3	.3	-.7	-.3
MAX	12	14	13	7	5	5	3	4	5	9	20	13	81
MIN	0	4	3	0	0	0	0	0	0	1	2	3	0
YRS	12	12	12	13	12	12	12	12	12	12	12	12	11

Threshold: .39 in.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1973				3	1	1	0	1	3	5	13	13	
1974	8	5	9	3	0	1	1	0	0	1	7	9	44
1975	9	9	6	1	1	0	1	0	0	8	8	6	49
1976	9	7	5	0	1	0	0	3	1	1	2	2	31
1977	1	4	4	0	2	1	0	2	2	4	8	7	35
1978	10	7	2	4	3	0	1	2	3	1	4	4	41
1979	3	12	3	3	2	1	0	1	1	7	5	10	48
1980	8	8	4	7	0	3	0	0	0	1	7	10	48
1981	2	6	3	2	2	1	0	0	2	6	7	11	42
1982	5	7	7	6	0	1	0	1	2	4	8	9	50
1983	8	14	10	2	0	1	2	2	0	2	17	6	64
1984	2	7	3	3	4	4	0	0	1	5	14	4	47
1985	0	4	6	1									
MEAN	5.4	7.5	5.2	2.7	1.3	1.2	.4	1.0	1.3	3.8	8.3	7.6	29.0
S.D.	3.6	3.0	2.5	2.1	1.3	1.2	.7	1.0	1.1	2.5	4.3	3.3	22.6
SKEW	-.2	.9	.7	.7	.6	1.4	1.3	.5	.3	.2	.7	-.1	-.3
MAX	10	14	10	7	4	4	2	3	3	8	17	13	64
MIN	0	4	2	0	0	0	0	0	0	1	2	2	0
YRS	12	12	12	13	12	12	12	12	12	12	12	12	11

Scoggins Dam (cont.)

Threshold: .48 in.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1973				1	1	1	0	1	3	4	12	12	
1974	7	4	7	2	0	0	1	0	0	0	6	7	34
1975	8	6	5	1	1	0	0	0	0	6	5	6	38
1976	8	6	5	0	0	0	0	0	1	1	1	1	23
1977	0	3	4	0	2	1	0	2	1	1	6	7	27
1978	7	5	1	4	2	0	1	1	3	0	2	3	29
1979	2	7	3	2	1	0	0	1	1	5	3	9	34
1980	7	6	2	3	0	1	0	0	0	1	7	10	37
1981	1	4	1	1	0	1	0	0	2	6	7	11	34
1982	5	6	3	5	0	0	0	1	1	3	6	8	38
1983	7	13	9	2	0	1	1	1	0	2	15	5	56
1984	2	6	3	3	4	3	0	0	0	5	12	3	41
1985	0	4	6	1									
MEAN	4.5	5.8	4.1	1.9	.9	.7	.3	.6	1.0	2.8	6.8	6.8	23.0
S.D.	3.2	2.6	2.4	1.5	1.2	.9	.5	.7	1.1	2.3	4.2	3.4	18.2
SKEW	-.3	1.9	.5	.6	1.4	1.5	1.2	.6	.8	.2	.6	-.2	-.2
MAX	8	13	9	5	4	3	1	2	3	6	15	12	56
MIN	0	3	1	0	0	0	0	0	0	0	1	1	0
YRS	12	12	12	13	12	12	12	12	12	12	12	12	11

Threshold: .61 in.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1973				0	0	0	0	0	3	2	12	12	
1974	6	4	6	1	0	0	1	0	0	0	5	6	29
1975	7	3	3	0	1	0	0	0	0	3	4	6	27
1976	6	6	2	0	0	0	0	0	0	1	0	0	15
1977	0	2	3	0	1	1	0	2	1	1	6	7	24
1978	5	5	0	2	2	0	0	1	2	0	2	2	21
1979	1	4	2	1	1	0	0	1	1	4	1	5	21
1980	6	3	2	1	0	0	0	0	0	0	4	9	25
1981	1	3	0	1	0	1	0	0	2	3	5	8	24
1982	5	4	2	5	0	0	0	1	1	3	4	7	32
1983	5	11	6	2	0	0	1	1	0	0	10	4	40
1984	1	4	1	3	1	2	0	0	0	2	8	1	23
1985	0	2	2	0									
MEAN	3.6	4.3	2.4	1.2	.5	.3	.2	.5	.8	1.6	5.1	5.6	16.5
S.D.	2.7	2.4	1.9	1.5	.7	.7	.4	.7	1.0	1.4	3.5	3.5	13.5
SKEW	-.3	1.9	.8	1.4	.9	1.7	1.8	.9	.9	.2	.5	.0	-.1
MAX	7	11	6	5	2	2	1	2	3	4	12	12	40
MIN	0	2	0	0	0	0	0	0	0	0	0	0	0
YRS	12	12	12	13	12	12	12	12	12	12	12	12	11

Scoggins Dam (cont.)

Threshold: .83 in.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1973				0	0	0	0	0	1	0	11	10	
1974	5	2	3	1	0	0	0	0	0	0	4	2	17
1975	3	2	1	0	1	0	0	0	0	1	1	5	14
1976	2	4	1	0	0	0	0	0	0	0	0	0	7
1977	0	1	1	0	0	0	0	2	1	1	2	7	15
1978	1	3	0	0	1	0	0	0	2	0	2	1	10
1979	1	2	1	0	1	0	0	1	1	2	0	4	13
1980	4	2	1	0	0	0	0	0	0	0	2	6	15
1981	0	1	0	0	0	1	0	0	1	3	3	6	15
1982	3	4	0	2	0	0	0	1	1	2	4	6	23
1983	3	8	3	0	0	0	1	0	0	0	5	3	23
1984	0	4	0	1	0	0	0	0	0	0	6	0	11
1985	0	0	1	0									
MEAN	1.8	2.8	1.0	.3	.3	.1	.1	.3	.6	.8	3.3	4.2	9.8
S.D.	1.8	2.1	1.0	.6	.5	.3	.3	.7	.7	1.1	3.1	3.1	8.6
SKEW	.4	1.2	1.0	1.8	1.2	3.0	3.0	1.7	.6	1.0	1.3	.2	.1
MAX	5	8	3	2	1	1	1	2	2	3	11	10	23
MIN	0	0	0	0	0	0	0	0	0	0	0	0	0
YRS	12	12	12	13	12	12	12	12	12	12	12	12	11

Threshold: 1.05 in.

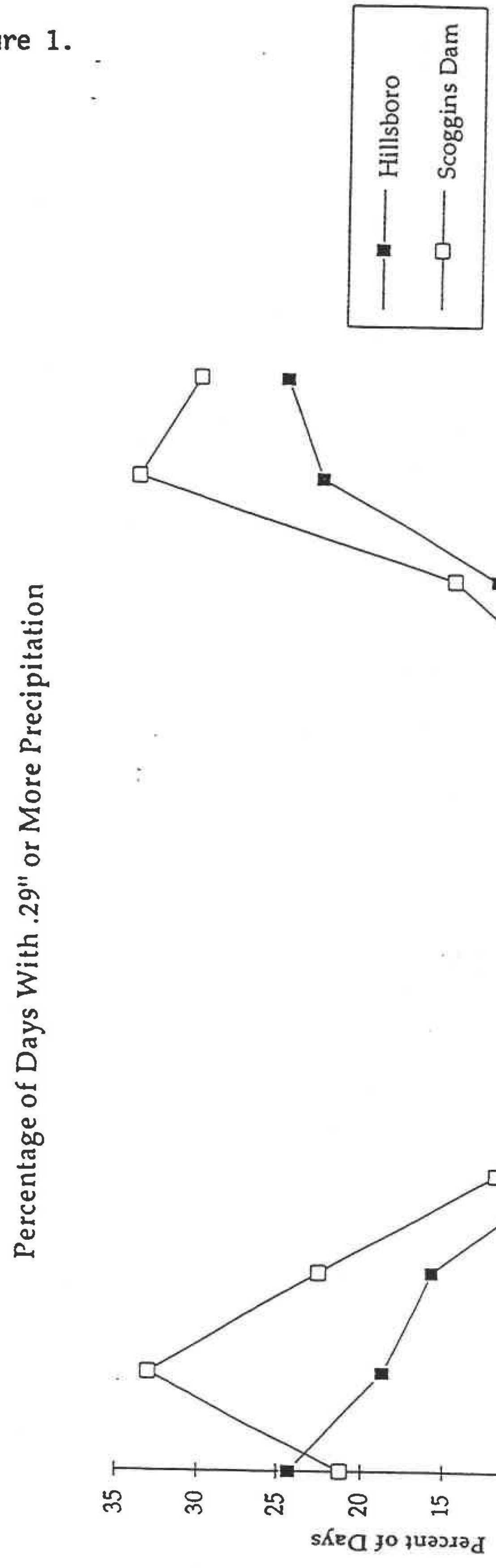
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1973				0	0	0	0	0	0	0	5	5	
1974	3	2	2	1	0	0	0	0	0	0	2	1	11
1975	2	2	0	0	1	0	0	0	0	1	0	3	9
1976	1	1	1	0	0	0	0	0	0	0	0	0	3
1977	0	0	1	0	0	0	0	2	0	0	1	7	11
1978	0	1	0	0	0	0	0	0	0	0	2	0	3
1979	1	1	0	0	1	0	0	0	1	2	0	2	8
1980	2	1	0	0	0	0	0	0	0	0	2	5	10
1981	0	1	0	0	0	1	0	0	1	1	2	6	12
1982	3	4	0	1	0	0	0	0	0	2	1	6	17
1983	2	4	3	0	0	0	0	0	0	0	4	2	15
1984	0	2	0	0	0	0	0	0	0	0	4	0	6
1985	0	0	1	0									
MEAN	1.2	1.6	.7	.2	.2	.1	.0	.2	.2	.5	1.9	3.1	6.1
S.D.	1.2	1.3	1.0	.4	.4	.3	.0	.6	.4	.8	1.7	2.6	5.7
SKEW	.3	.8	1.3	1.9	1.8	3.0	.0	3.0	1.8	1.1	.5	.1	.3
MAX	3	4	3	1	1	1	0	2	1	2	5	7	17
MIN	0	0	0	0	0	0	0	0	0	0	0	0	0
YRS	12	12	12	13	12	12	12	12	12	12	12	12	11

Scoggins Dam (cont.)

Threshold: 1.30 in.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1973				0	0	0	0	0	0	0	4	4	
1974	3	1	1	0	0	0	0	0	0	0	1	1	7
1975	1	0	0	0	1	0	0	0	0	0	0	2	4
1976	1	1	1	0	0	0	0	0	0	0	0	0	3
1977	0	0	0	0	0	0	0	1	0	0	1	6	8
1978	0	0	0	0	0	0	0	0	0	0	1	0	1
1979	1	1	0	0	1	0	0	0	1	1	0	1	6
1980	2	0	0	0	0	0	0	0	0	0	2	3	7
1981	0	1	0	0	0	0	0	0	1	1	1	2	6
1982	2	1	0	1	0	0	0	0	0	2	1	4	11
1983	0	1	1	0	0	0	0	0	0	0	1	1	4
1984	0	0	0	0	0	0	0	0	0	0	3	0	3
1985	0	0	0	0	0								
MEAN	.8	.5	.3	.1	.2	.0	.0	.1	.2	.3	1.3	2.0	3.6
S.D.	1.0	.5	.5	.3	.4	.0	.0	.3	.4	.7	1.2	1.9	3.6
SKEW	.9	.0	1.2	3.2	1.8	.0	.0	3.0	1.8	1.7	1.1	.7	.5
MAX	3	1	1	1	1	0	0	1	1	2	4	6	11
MIN	0	0	0	0	0	0	0	0	0	0	0	0	0
YRS	12	12	12	13	12	12	12	12	12	12	12	12	11

Figure 1.



Percentage of Days With .29" or More Precipitation
Hillsboro
Scoggins Dam
Percent of Days
35
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 2.

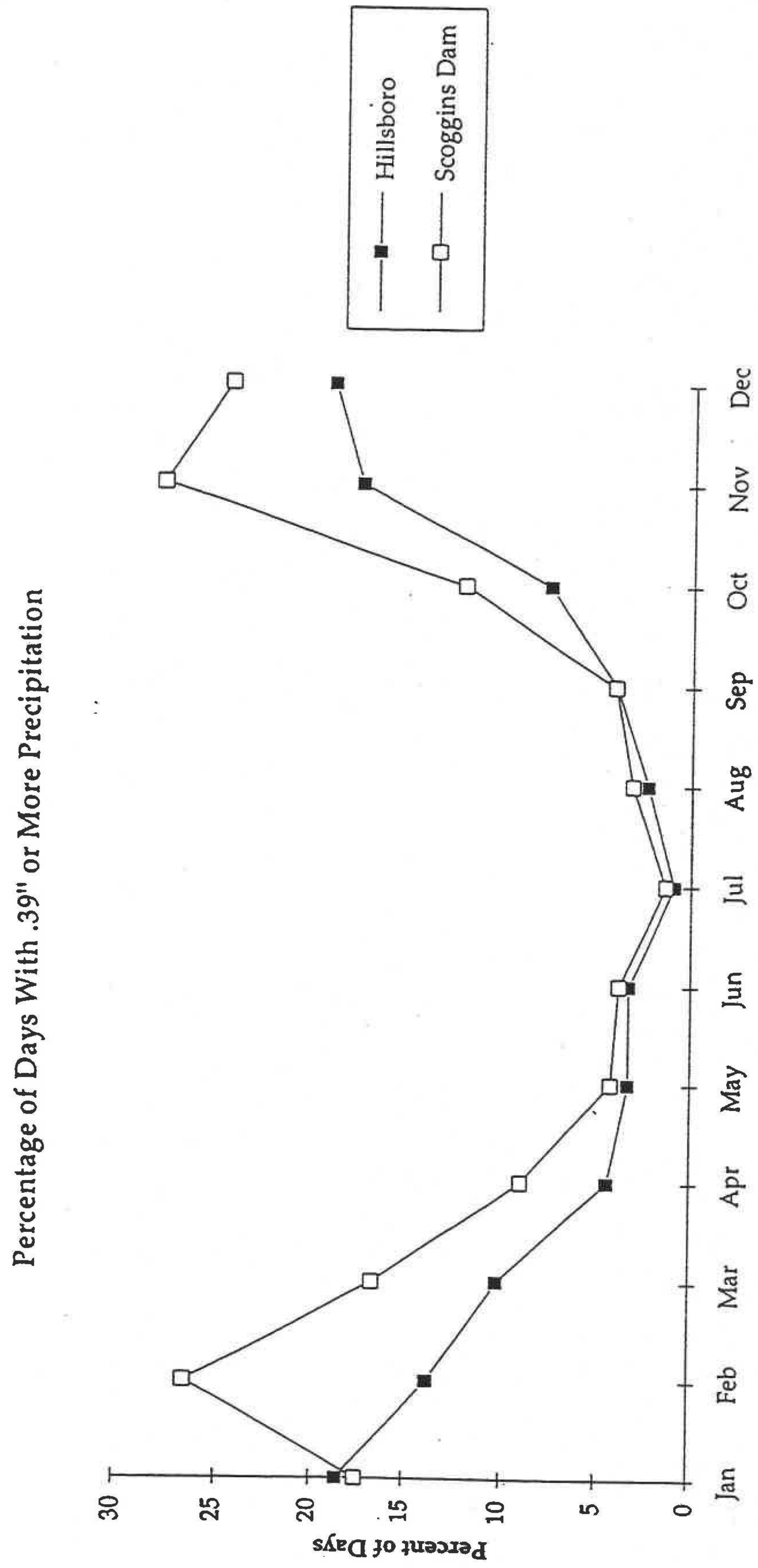

Percentage of Days With .39" or More Precipitation
Percent of Days
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Hillsboro
Scoggins Dam

Figure 3.

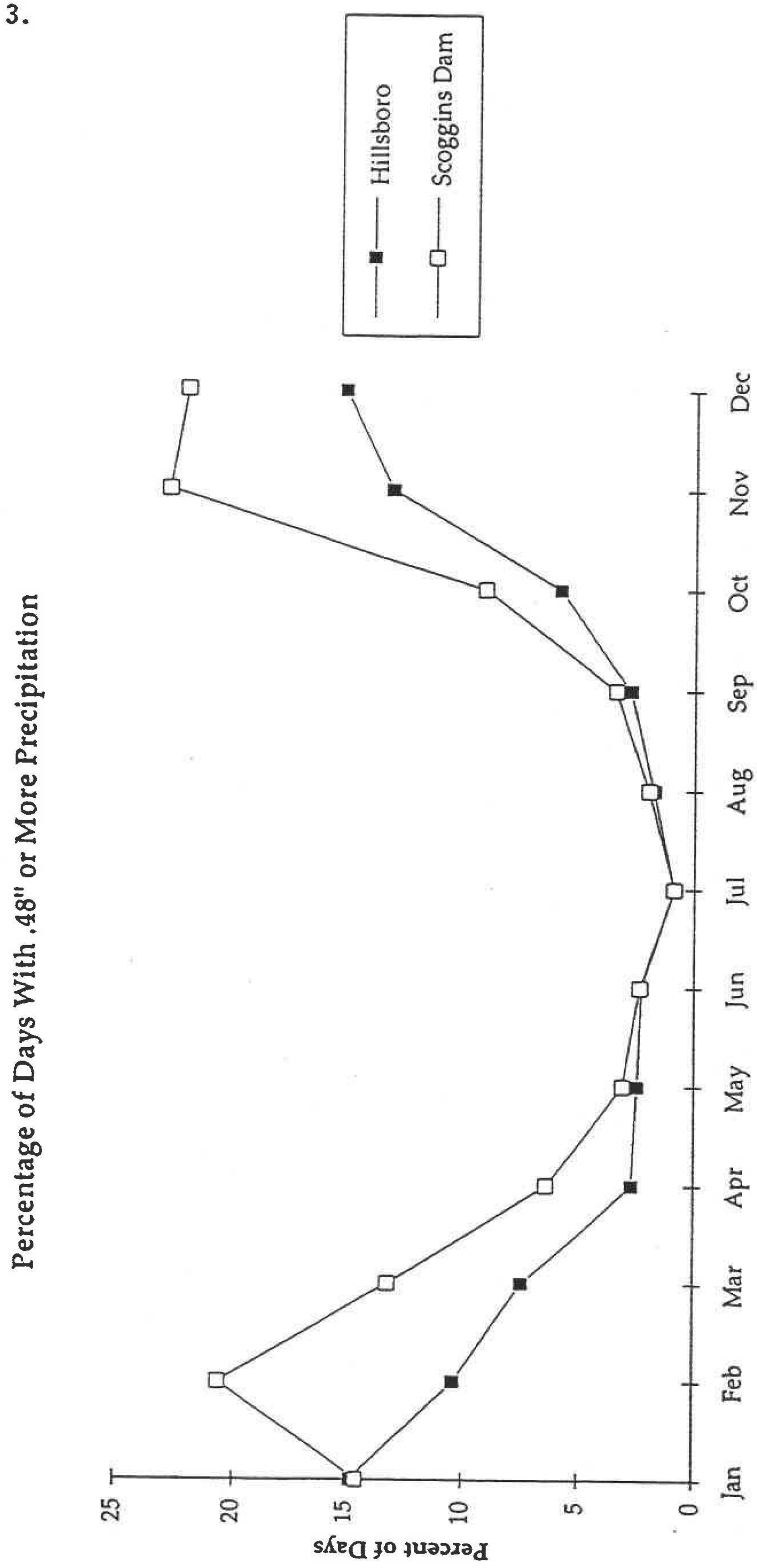
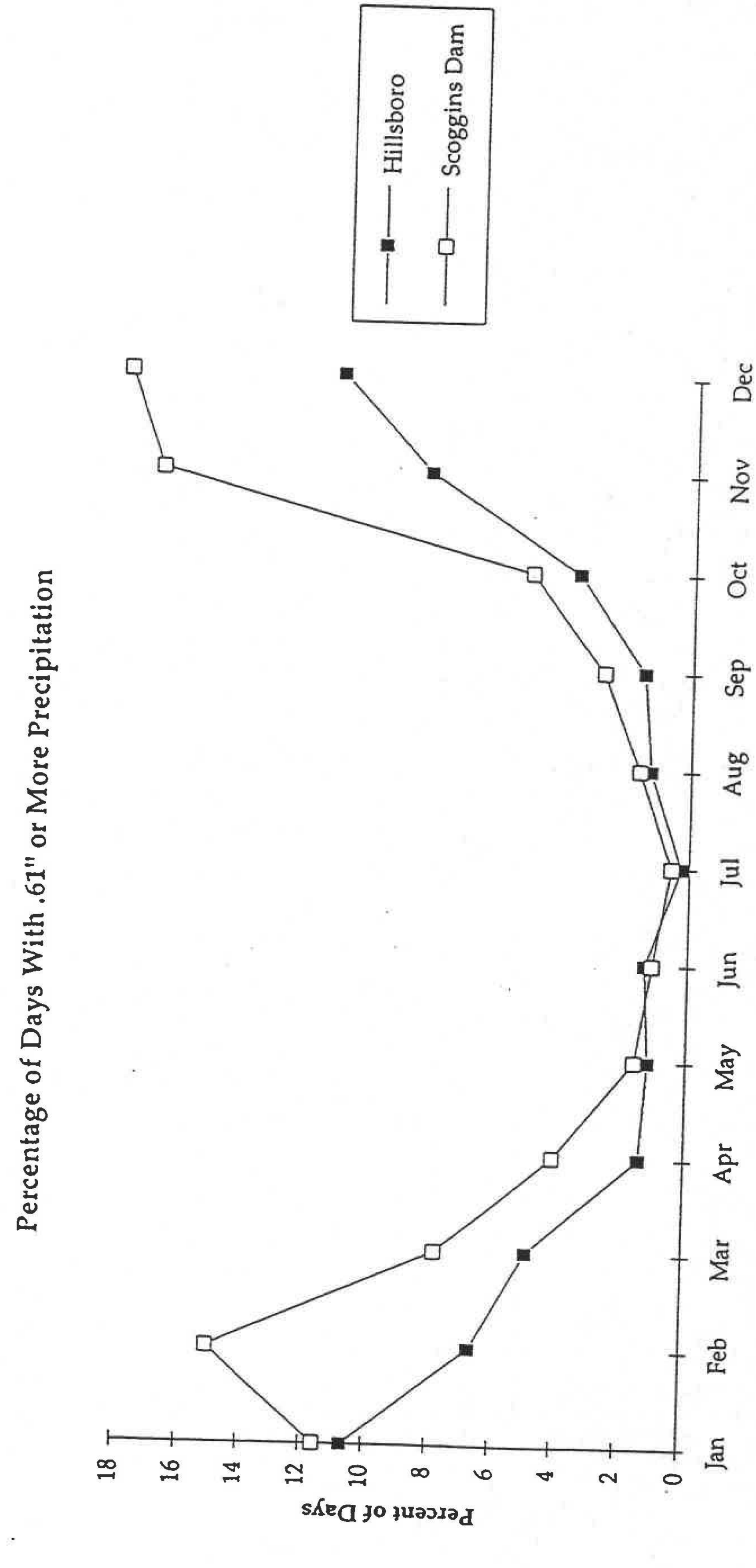

Percentage of Days With .48" or More Precipitation
Hillsboro
Scoggins Dam
Percent of Days
0
5
10
15
20
25
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 4.



Percentage of Days With .61" or More Precipitation
Hillsboro
Scoggins Dam
Percent of Days
0
2
4
6
8
10
12
14
16
18
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 5.

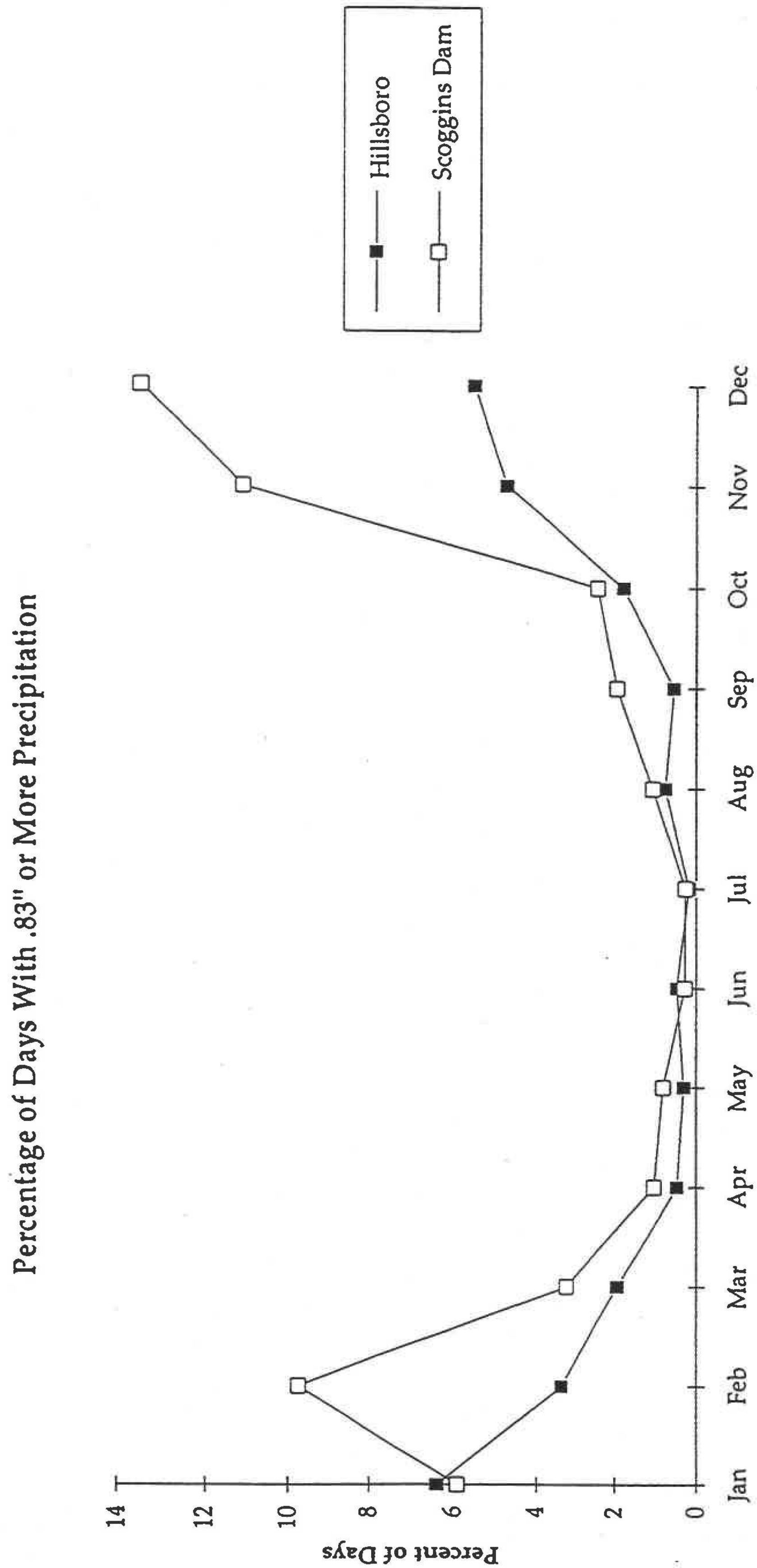

Percentage of Days With .83" or More Precipitation
Hillsboro
Scoggins Dam
Percent of Days
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 6.

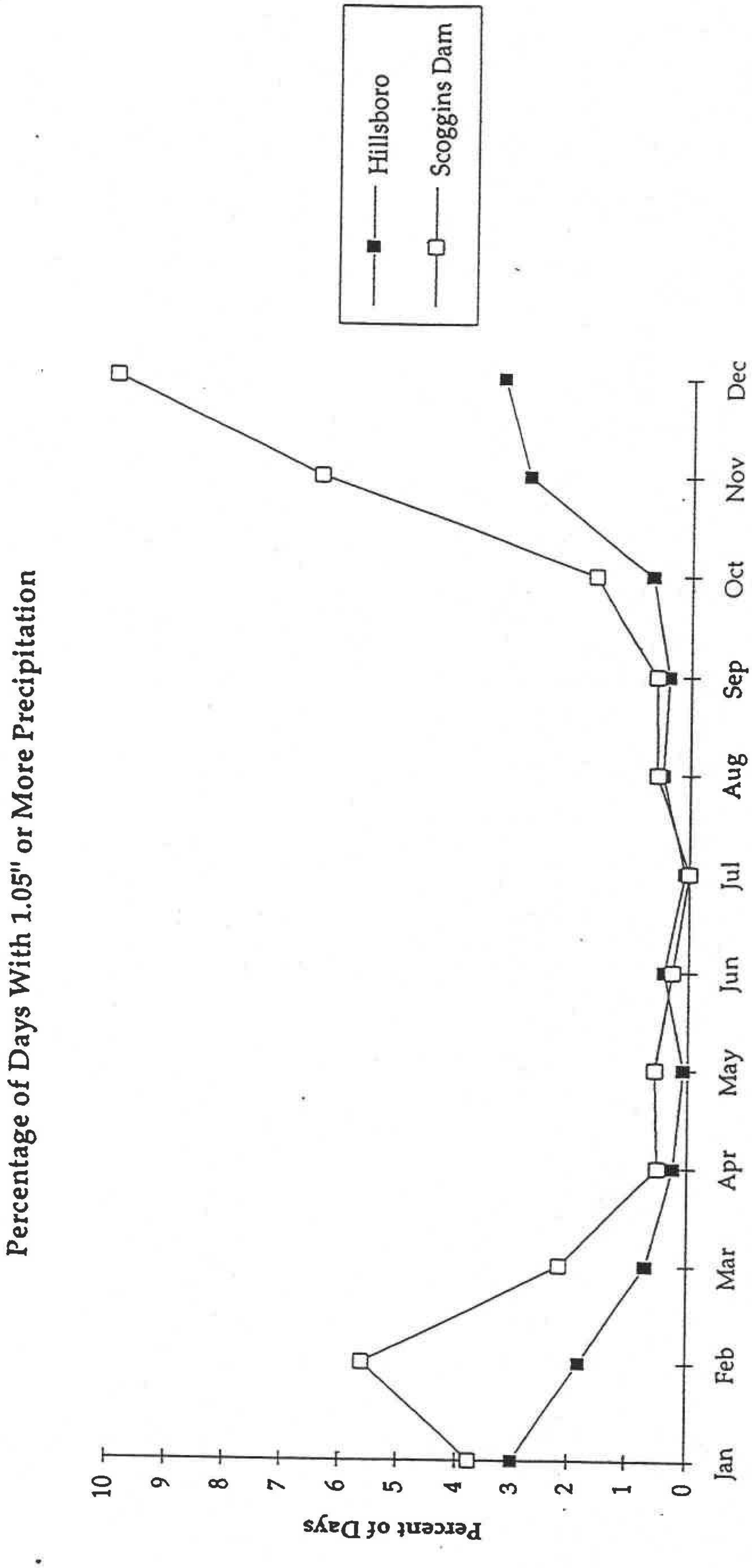

Percentage of Days With 1.05" or More Precipitation
Percent of Days
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Hillsboro
Scoggins Dam

Figure 7.

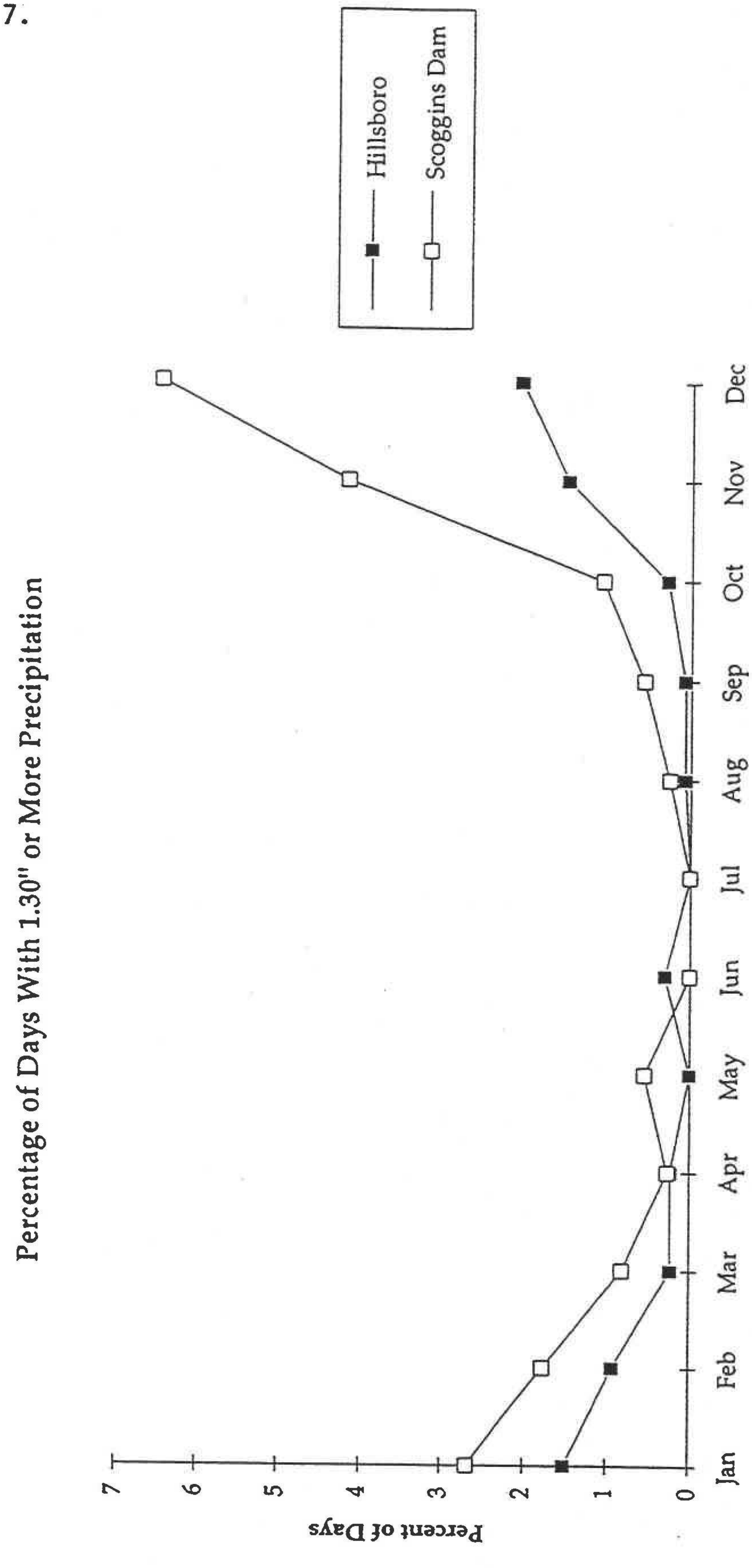

Percentage of Days With 1.30" or More Precipitation
Hillsboro
Scoggins Dam
Percent of Days
0
1
2
3
4
5
6
7
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 8.

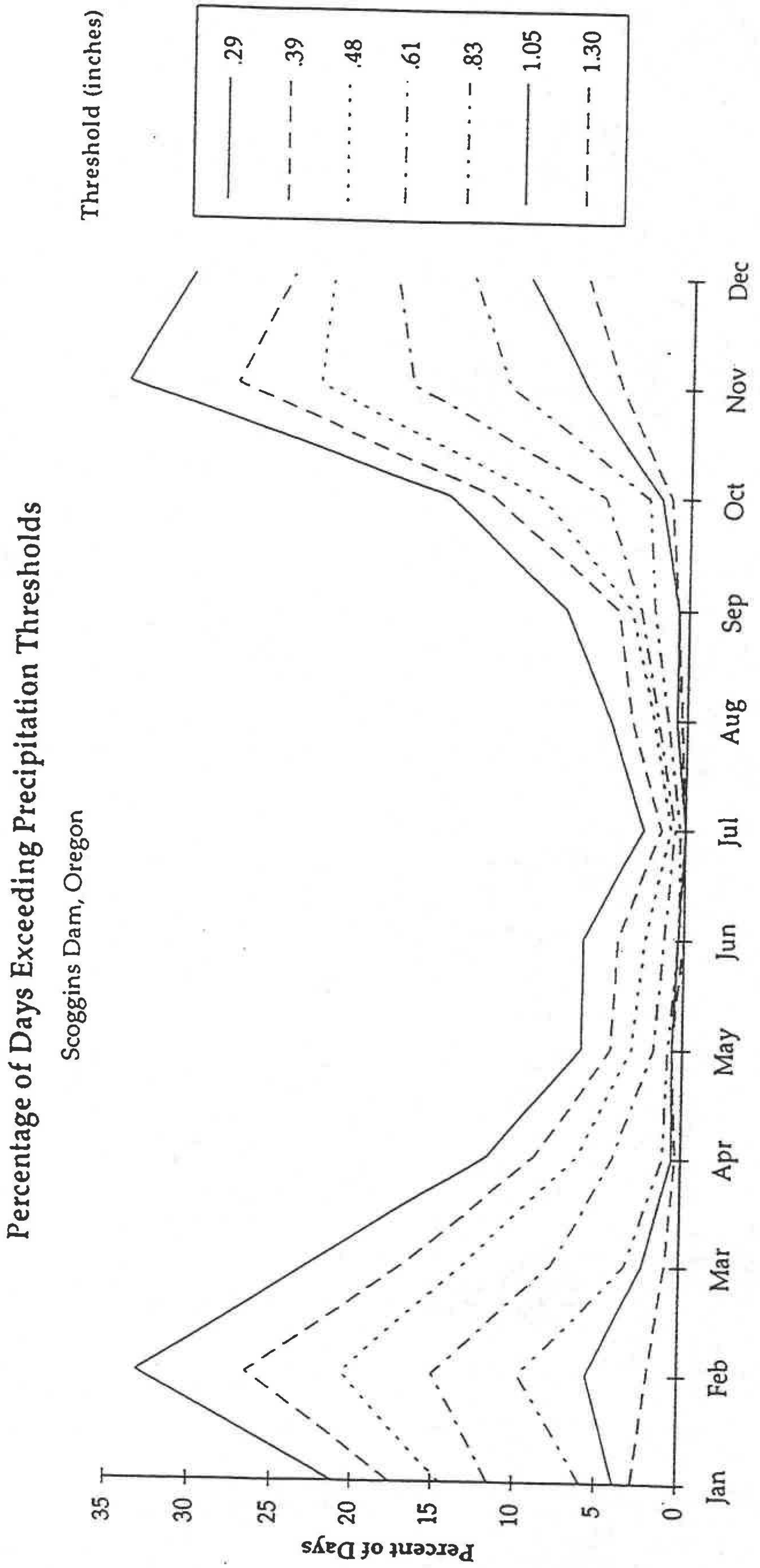
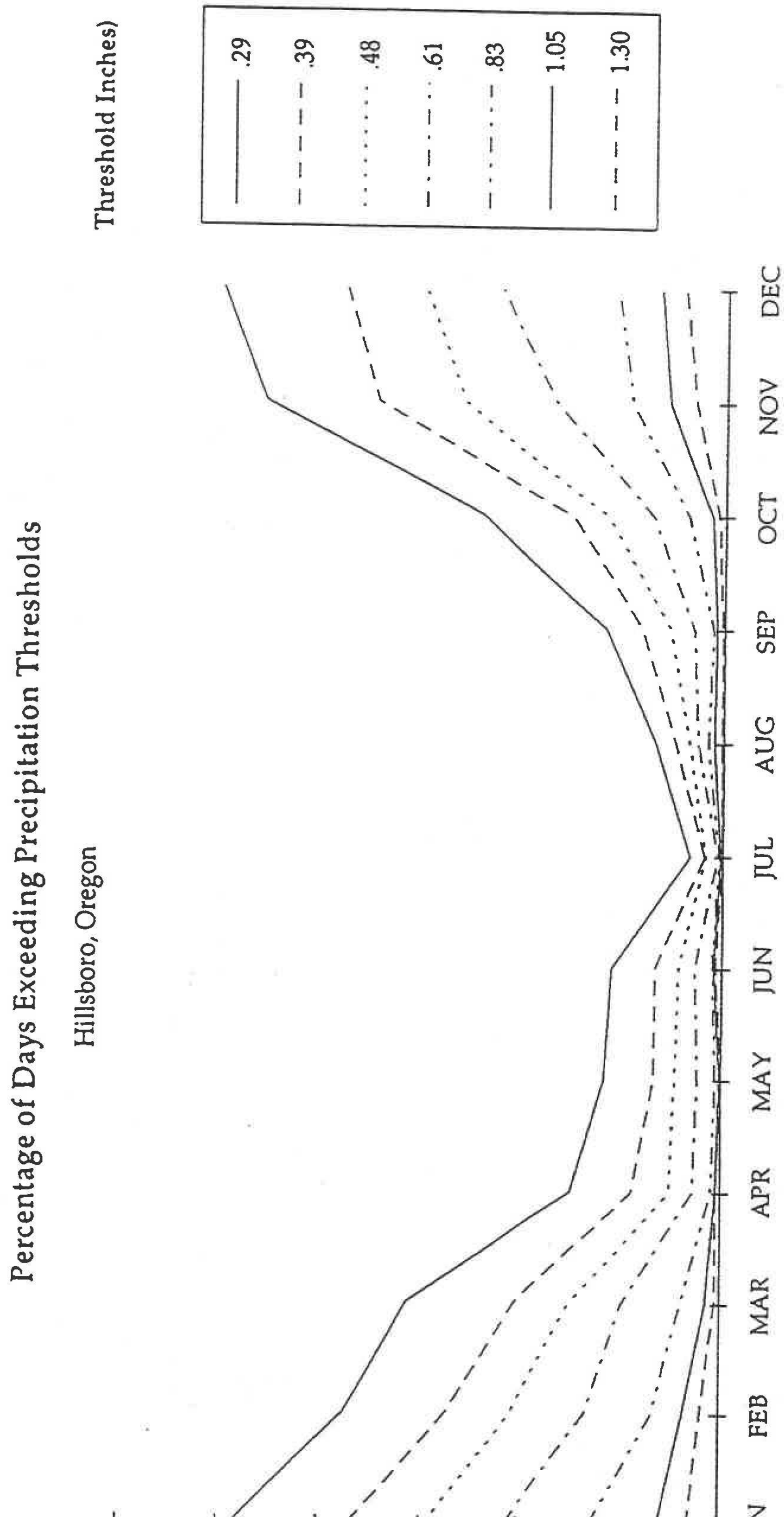

Percentage of Days Exceeding Precipitation Thresholds
Scoggins Dam, Oregon
Threshold (inches)
.29
.39
.48
.61
.83
1.05
1.30
Percent of Days
0
5
10
15
20
25
30
35
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 9.


Percentage of Days Exceeding Precipitation Thresholds
Hillsboro, Oregon
Threshold Inches)
.29
.39
.48
.61
.83
1.05
1.30
Percent of Days
0
5
10
15
20
25
30
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC