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UNITED STATES DEPARTMENT OF THE INTERIOR

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WATER RESOURCES DIVISION

ANALYSIS OF WATER LEVEL DATA FOR EVERGLADES NATIONAL PARK, FLORIDA

By

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Prepared by the

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TABLE OF CONTENTS

ILLUSTRATIONS

TABLE

OFR-FL-72-004
USGS- 72-054

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ABSTRACT

Stage-duration curves were developed for five gaging stations in Everglades National Park, Florida. Four of the five curves show similar characteristics with an increase in the slope when the water level is below land surface. Monthly stage-duration curves, developed for one of the stations, reflect the seasonal trends of the water level.

Recession curves were prepared for the same five stations. These curves represent the average water-level decline during periods of little or no rainfall. They show the decline in level at the end of 10, 30, and 60 days for any given initial stage. A family of curves was also prepared to give the recession from various initial stages for any period up to 60 days.

INTRODUCTION

A program of water-resource investigations has been conducted in Everglades National Park since 1959; however hydrologic data collection had begun in 1953. In 1964, the program was expanded to determine the relation among seasonal and periodic fluctuations of water levels, the population of biological communities within the park, and the chemical and physical characteristics of the water, such as dissolved gases, nutrients, pesticides, and chloride content.

One objective of the cooperative program of the U.S. Geological Survey and the National Park Service is to define the historical water-level characteristics in Everglades National Park. The purpose of this report is to fulfill this objective in part by analyzing the historical water-level data to determine water-level recession rates in various parts of the park for various initial conditions, to determine the range of water levels, and to determine the percentage of time various water-levels have existed in the park. This report presents an analysis of the water-level data to provide information that can be used to relate water-level to biologic and other hydrologic parameters.

The report presents stage data for 1953-69, from five gaging stations within Everglades National Park.

STATIONS STUDIED

In early 1953, five water-level stations were established in Everglades National Park (fig. 1) and these stations are still in

Figure 1.--Belongs near here Caption on next page

operation (1971).

Table 1 lists the stations, their locations, and elevation

Table 1.--Belongs near here Caption on next page

extremes. The daily mean water levels for each of these stations have been published on an annual basis by the Geological Survey since October 1962. (See "References.")

These stations, all in the fresh-water areas of the park, are distributed to provide data that describe the water-level characteristics throughout a large part of the park. The water levels in the coastal areas of the park are affected by tide, and their characteristics are not represented by the inland stations described in this report.

Figure 1.--Map of southern Florida showing Everglades National Park and location of water-level stations.

Table 1.--Recorded maximum and minimum water-levels at long-term stations in Everglades National Park.

METHODS USED

Stage-duration and water-level recession curves were prepared for each of the five stations listed in table 1. Stage-duration curves show the percentage of time that specified stages were equaled or exceeded during a given period. A stage-duration relation is determined by counting the days that the water level remained at or above specified levels and expressing them as a percentage of the total number of days for the period of record involved (Searcy, 1959). Stage-duration curves are useful for comparing the stage characteristics at several locations in an area for a specific period and for comparing the stage characteristics at one location for different time periods to show the effects of urbanization, rainfall, or other changes in the hydrologic regimen.

For this report, stage-duration curves were prepared for three periods: (1) prior to construction of Conservation Area No. 3, (2) subsequent to its construction, and (3) the total period of record. Because data for complete water years must be available in duration analysis, estimates of October to December 1952 for P-33 and P-38, which were made for another study, were used to complete the record for these stations. The stage-duration curves for the other three stations were constructed from stage records that began in October 1953. The long period of record (1953-69) and the fact that the 1953 water year was a normal year with no extended periods of extreme high and low stages allows for valid comparison of duration curves for all stations even though the time periods are not the same.

Water-level recession curves were obtained by selecting periods of little or no rainfall and determining the recession rate from various initial stages. Recession curves of initial stage versus stage 10 days later were plotted from published data.

For the curves of initial stage versus stage 60 days later it was necessary to use periods longer than 60 days to determine the recession for a 60-day period of no rainfall. Some precipitation caused minor rises in most 60-day periods. A period equal to the time required for the stage to return to the elevation from which each rise began was added to the 60-day period selected to determine the stage after 60 days of no rainfall for a given initial stage. Similarly, for the curves of initial stage versus stage 30 days later, it was necessary to use periods longer than 30 days.

From the recession curves for periods of 10, 30, and 60 days, a family of recession curves was developed that gives the stage at the end of any period as long as 60 days for given initial stages covering the full range in stage.

RESULTS

Figures 2-6 are the stage-duration curves for the five stations

Figures 2-6.--Belong near here Caption on next page

listed in table 1. On each duration curve the approximate land-surface elevation is indicated.

The stage-duration curves for the stations with the greater range in stage (P-33, P-34, and P-37), of course, are steeper than those with the lesser range in stage (P-35 and P-38). Of particular interest is the change in slope of the duration curve at the land-surface elevation. The stage-recession rate is higher when the water level falls below the land surface because water is contained only in the voids, which constitute about 20 percent of the soil and rock mass below land surface. Evapotranspiration is not greatly reduced until the water level drops some distance below the land surface.

The slope of all the stage-duration curves except P-35 break at the elevation of land-surface. The slope of the curve for P-35 does not break because the station is near several stream channels, ponds, and wet prairies that are affected by tides at extremely low stages.

Figure 2.--Stage-duration curves for station P-33, water years 1953-69.

Figure 3.--Stage-duration curves for station P-34, water years 1954-69.

Figure 4.--Stage-duration curves for station P-35, water years 1954-69.

Figure 5.--Stage-duration curves for station P-37, water years 1954-69.

Figure 6.--Stage-duration curves for station P-38, water years 1953-69.

Figures 2-6 show that the duration curves based on the 1963-69 water years are lower than those for other base periods for each station except for the extreme high stages. The curves of stage-duration data do not show the effects of before and after construction of Area No. 3. To show such effects would require an analysis of rainfall and other parameters beyond the scope of this report. Construction of Conservation Area No. 3 and Levee 67 extended have changed the hydrologic regimen, and the stage-duration curves as presented for present conditions will provide a basis for comparison of data for future years with the period of water management rather than the prior years or the full period of stage record.

A stage-duration curve can be used to help plan future operations from past events. For example, if it is desired to know the percentage of time water had been below land surface at P-33 during 1953-69, the information can be obtained from figure 2 by entering the 1953-69 curve at the land-surface elevation of 5.2 feet. This stage was equaled or exceeded 88 percent of the time, which also means that the water can be expected to be below land surface 12 percent of the time. The curves can also be used as a management tool or as a measure of water conditions, which can be related to other research activities in the park. For example, if a certain species of vegetation does not survive in the P-33 area at an elevation below 7.0 feet, the 1953-69 curve in figure 2 shows that 6 percent of the time the species will be under water and will be destroyed.

Figure 7 shows the monthly stage-duration curves at P-33 for

Figure 7.--Belongs near here Caption on next page

the water years 1953-69. These monthly curves reflect seasonal patterns and can be useful for planning operational work in the Park when specified water levels are needed.

Figure 8-12 portray the recession curves for the five stations

Figures 8-12.--Belong near here Caption on next page

listed in table 1. In each figure, the family of curves in the upper left corner shows the recession rates from a selected initial stage. For example, in figure 8, from an initial stage of 6.0 feet at P-33, the stage 60 days later, with little or no rainfall, can be expected to be 5.2 feet. In like manner, from an initial stage of 5.5 feet, a stage of 3.8 feet can be anticipated after 60 days of little or no rainfall. The break in slope of some of these curves and the lack of symetry of the segments of the curves 10, 30, and 60 days after the initial stage reflect the different recession rates at different stages and the abrupt change in the recession rates when the water level recedes below land surface.

The recession curves represent an average of summer and winter conditions. In summer the actual recession might be greater than that shown because of increased evapotranspiration, whereas in winter the actual recession might be somewhat less than the indicated recession.

These recession curves can be used by park management to forecast when certain stages will be reached if dry weather persists or to plan and time research and other activities that require specified water-level conditions.

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U.S. Geological Survey, 1963, Surface water records of Florida 1963, v. 1 Streams: U.S. Geol. Survey open-file rept., 393 p.

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U. S. Geological Survey, 1970, Water resources data for Florida 1969, Pt. 1 Surface water records, v. 2 Streams-southern Florida, Lake Okeechobee and the Everglades: U.S. Geol. Survey open-file rept., 178 p.

Table 1.--Recorded maximum and minimum water-levels at long-term stations in Everglades National Park.

Station name	Station No.	Latitude	Longitude	Record began	Maximum elevation (feet)	Maximum elevation (Date)	Min. (feet)
Everglades P-33	2-2908.15	25°36'30"	80°41'30"	January 1953	7.69	11- 1-60	2.20
Everglades P-34	2-2908.70	25°36'30"	80°55'30"	January 1953	3.42	9-12-60	-2.13
Everglades P-35	2-2908.30	25°27'20"	80°52'30"	February 1953	3.47	9-10-60	-0.27
Everglades P-37	2-2908.10	25°17'30"	80°40'30"	January 1953	3.05	9-11-60	-1.85
Everglades P-38	2-2908.20	25°22'30"	80°49'00"	January 1953	2.92	9-12-60	-1.43

Note.--All elevations are to mean sea level datum.

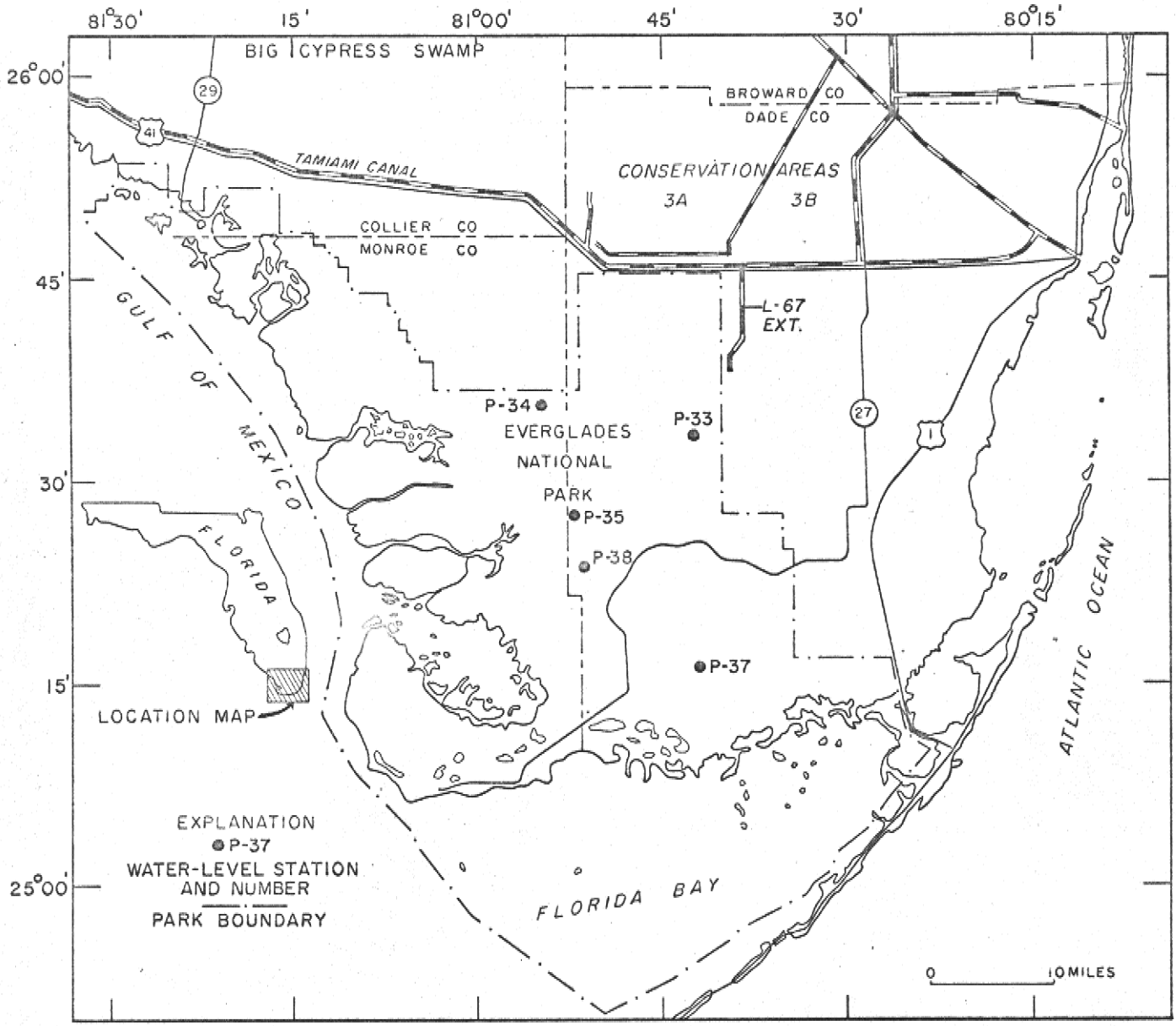

Figure 1.--Map of southern Florida showing Everglades National Park and location of water level stations

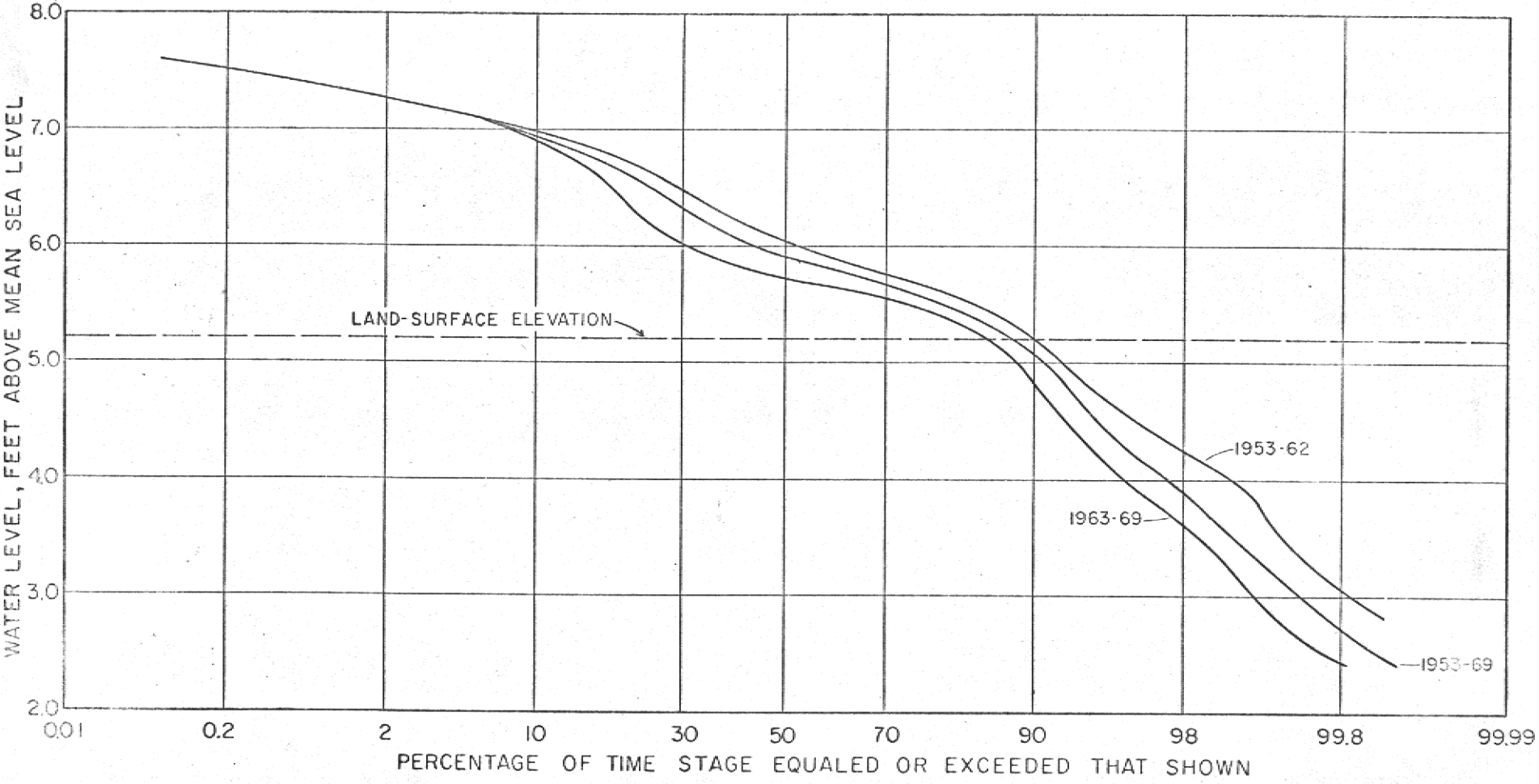

Figure 2.--Stage-duration curves for station P-33, water years 1953-69

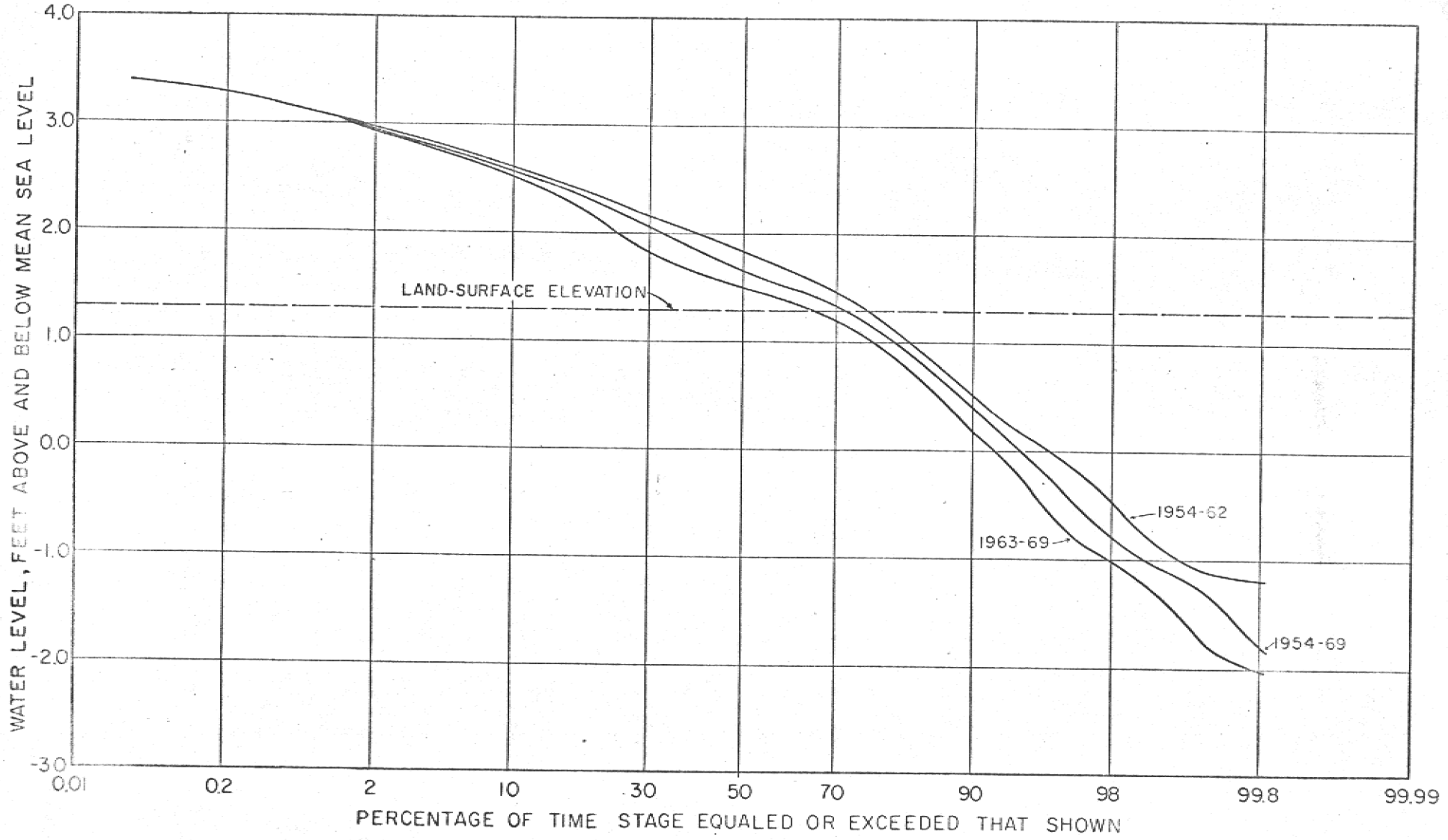

Figure 3.--Stage-duration curves for station P-34, water years 1954-69

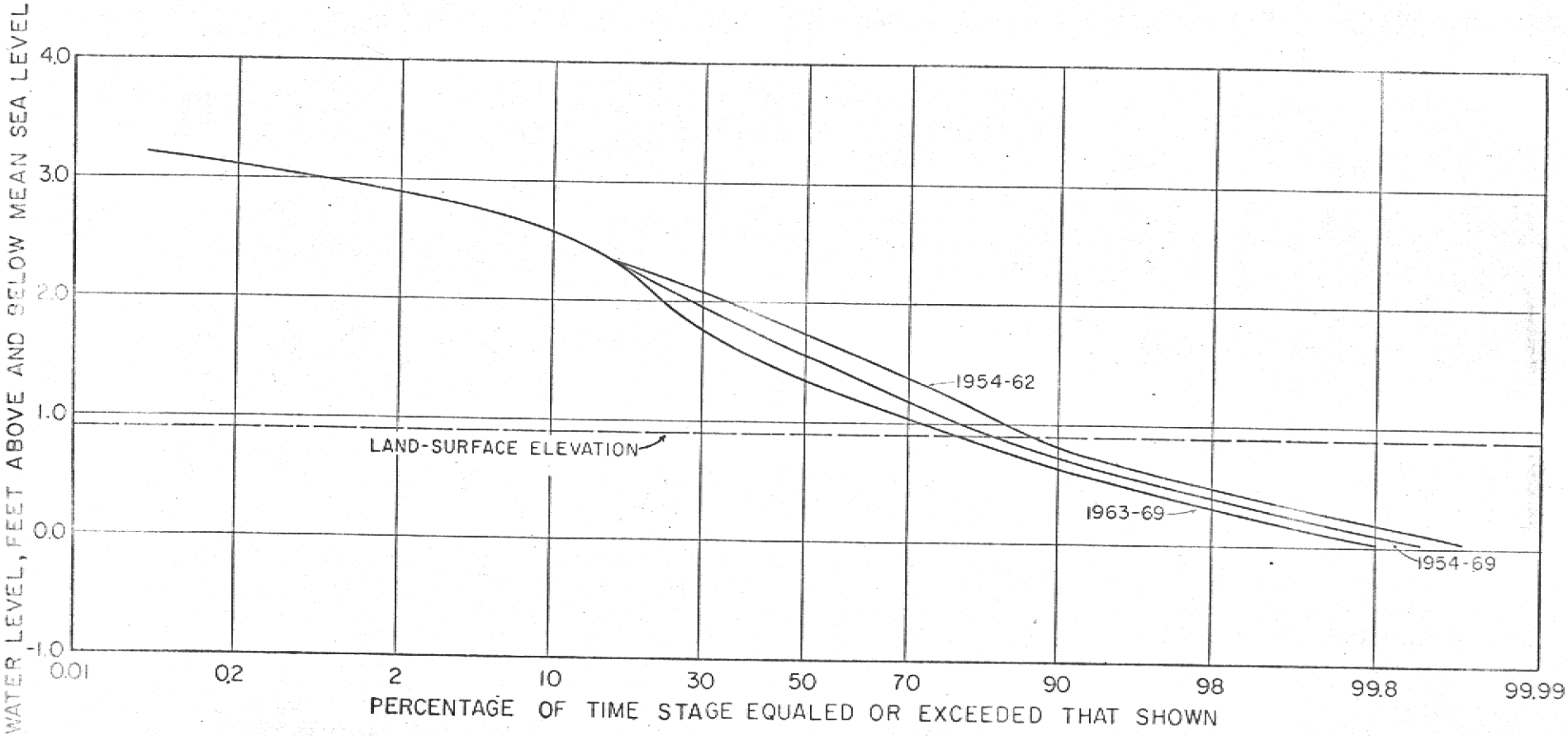

Figure 4.--Stage-duration curves for station P-35, water years 1954-69

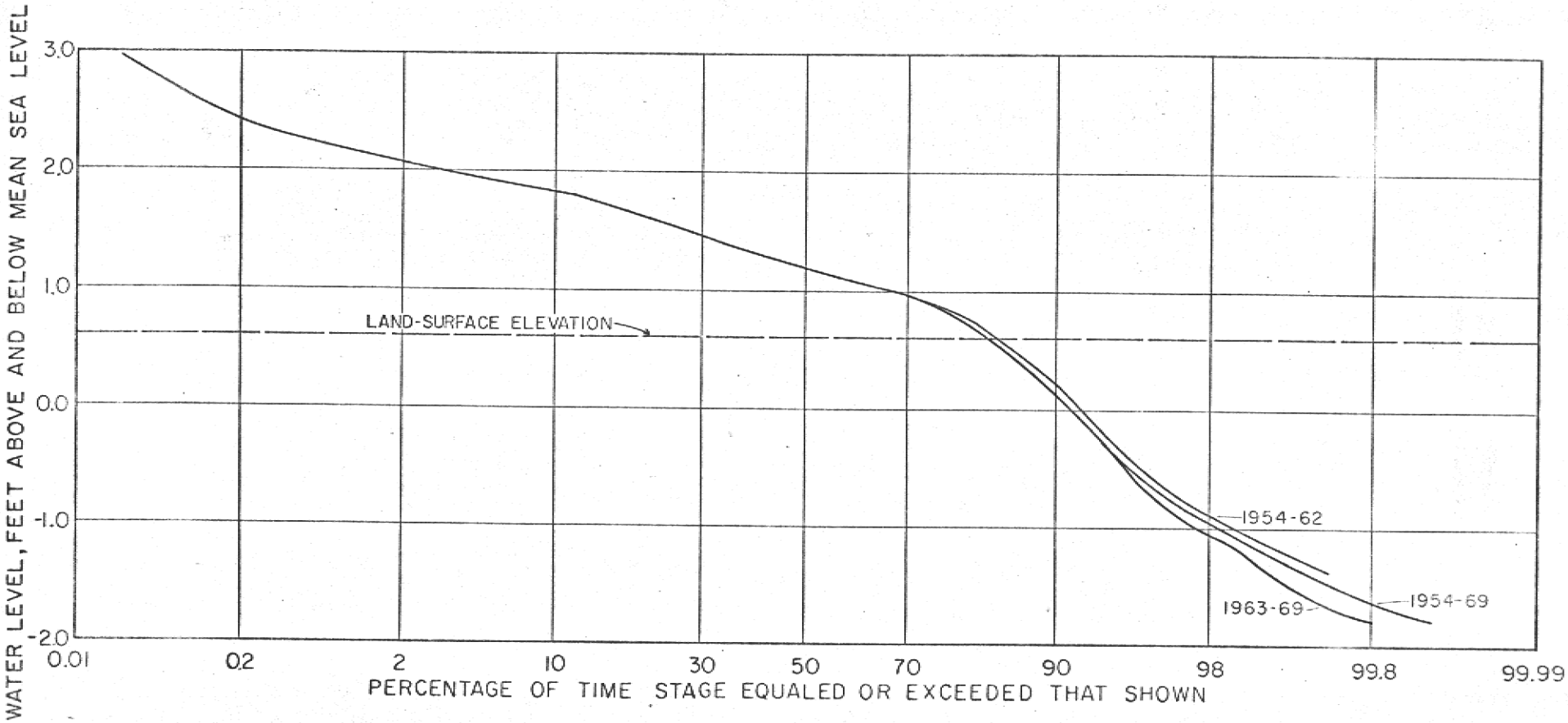

Figure 5.--Stage-duration curves for station P-37, water years 1954-69

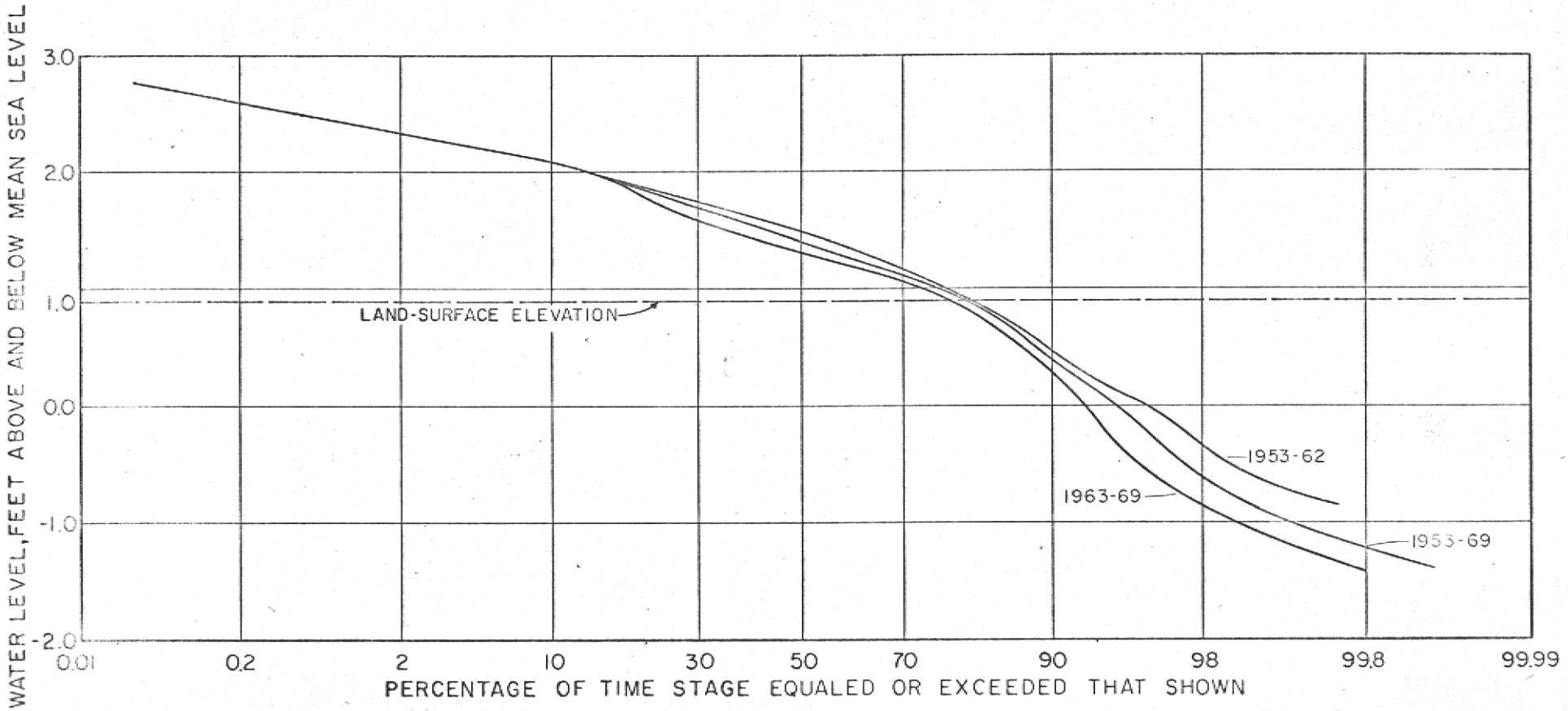

Figure 6.--Stage-duration curves for station P-38, water years 1953-69

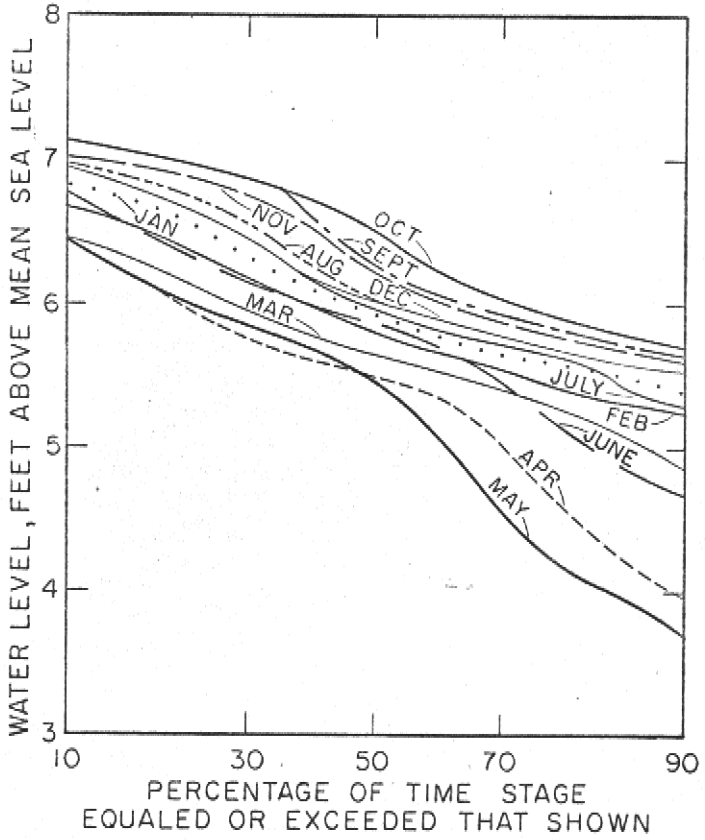

Figure 7.--Monthly stage-duration curves for station P-33, water years 1953-69

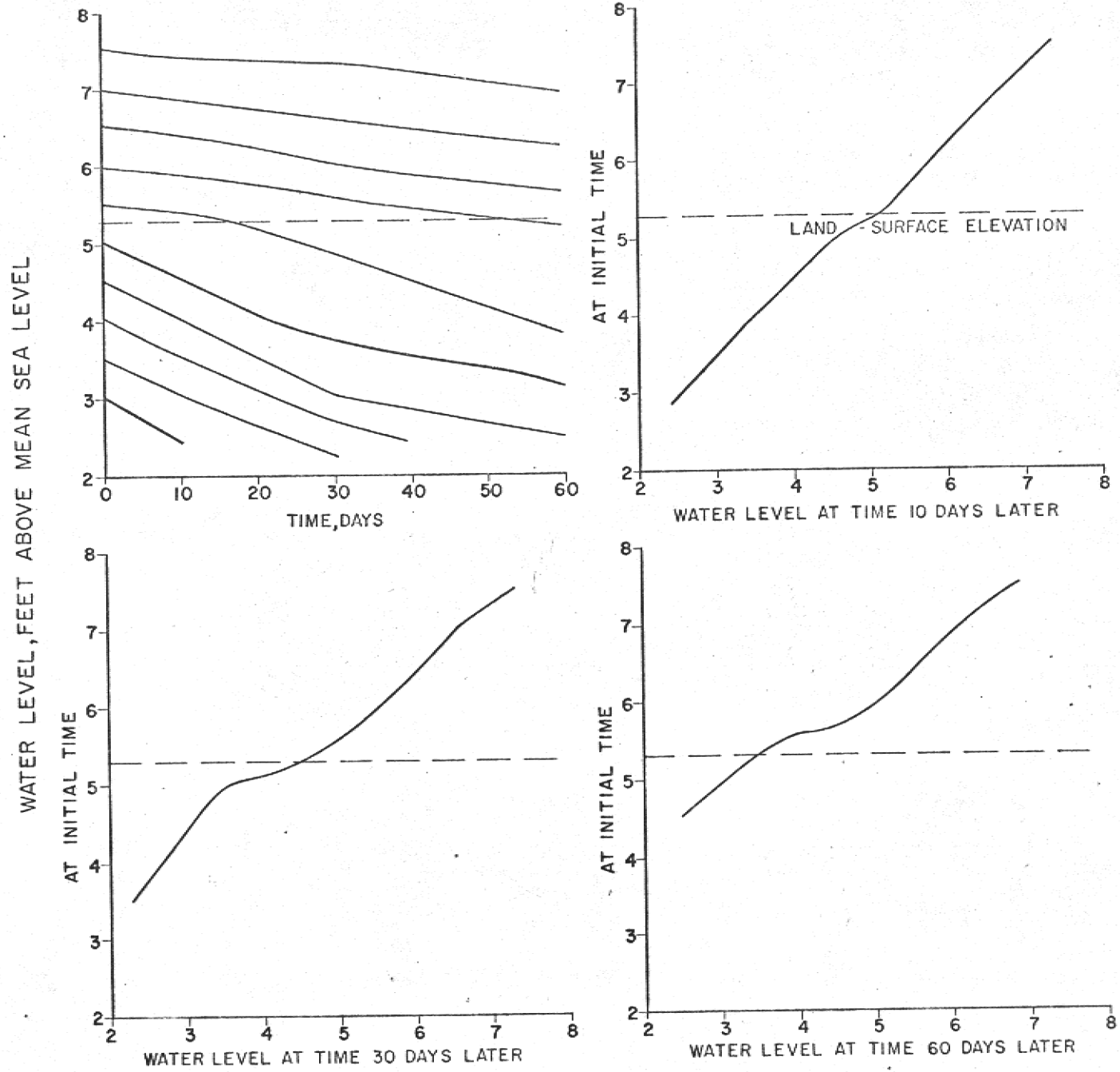

Figure 8.--Water-level recession curves for station P-33

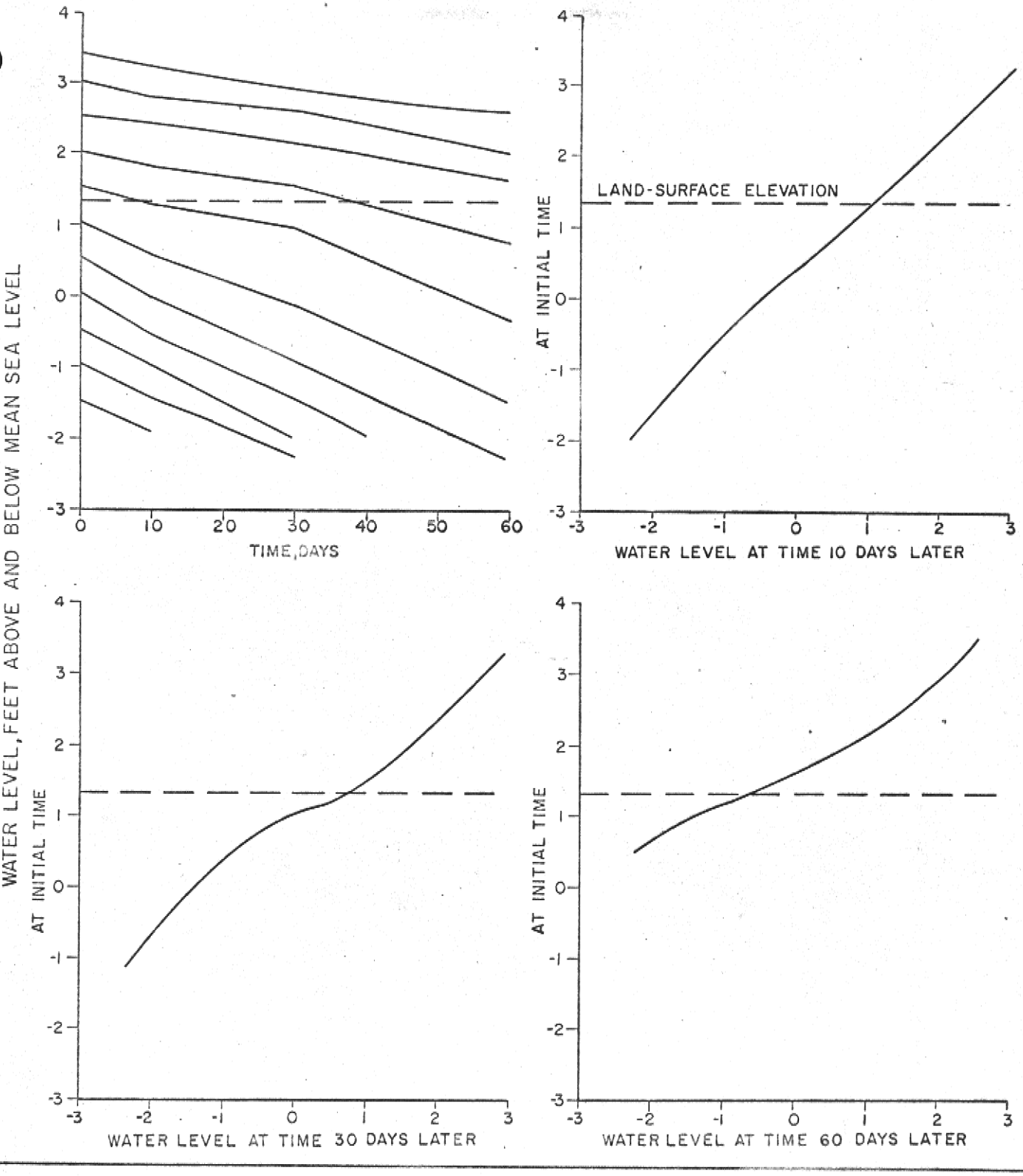

Figure 9.--Water-level recession curves for station P-34

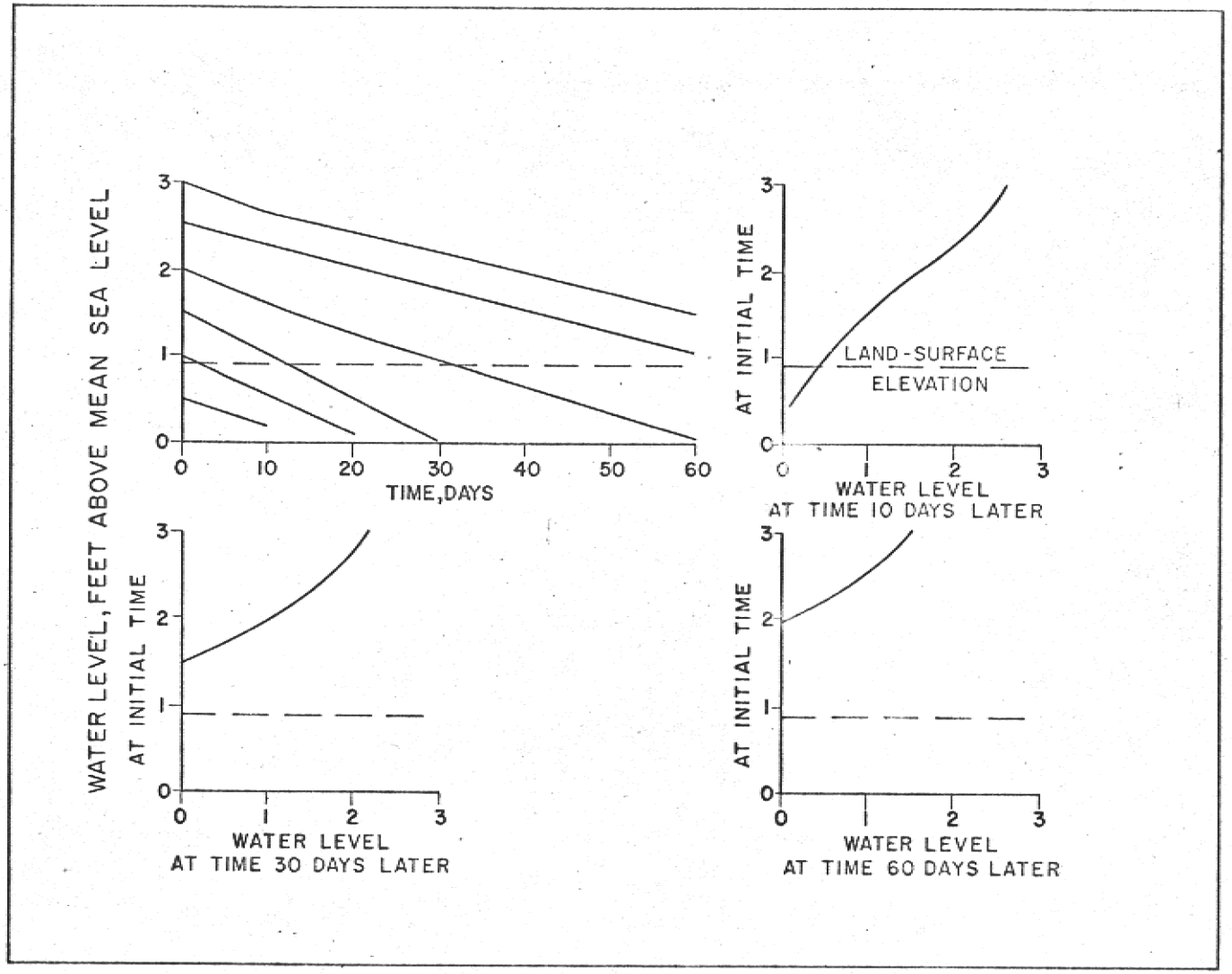

Figure 10.--Water-level recession curves for station P-35

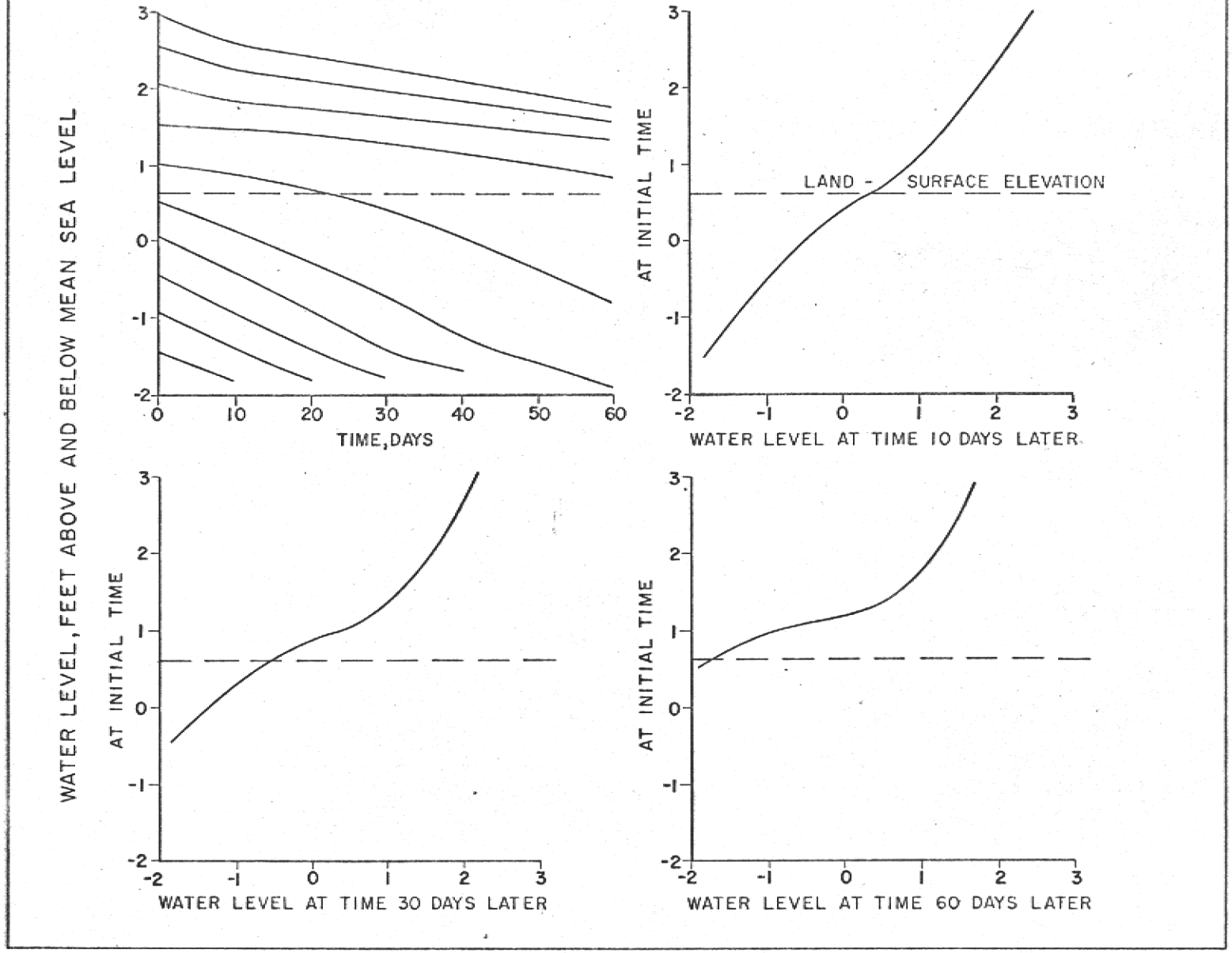

Figure 11.--Water-level recession curves for station P-37

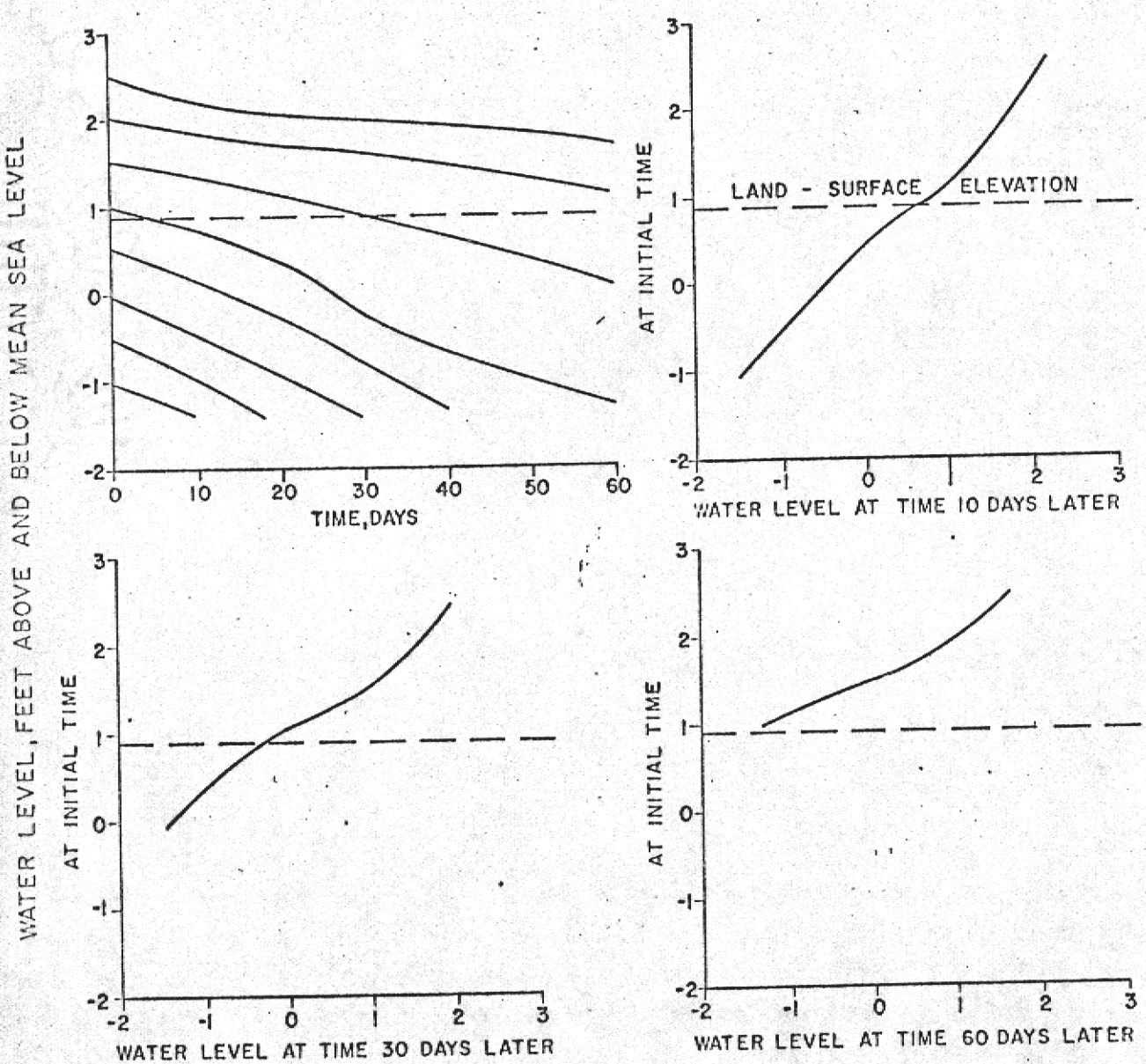

Figure 12.--Water-level recession curves for station P-38