LOW STREAMFLOW IN FLORIDA–MAGNITUDE AND FREQUENCY

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Prepared by
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in cooperation with
FLORIDA DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY
Tallahassee
1974

INTRODUCTION

Streamflow in Florida fluctuates and, at times, is not sufficient to supply the water required for municipal or industrial supplies, supplemental irrigation, maintenance of suitable conditions for fish, and disposal of liquid wastes. Low-flow characteristics of a stream indicate ground-water flow to a stream and can be used as parameters in regional water-resource evaluation, or as legal hydrologic parameters for pollution control. It is, therefore, important to know the magnitude and frequency of annual minimum streamflow.

This report is meant to acquaint the reader with the concept of minimum streamflows and their frequency of occurrence. The range of minimum flow to be expected in the state can readily be seen on the map. By using the procedures and references presented, low-flow frequency curves can be constructed for a stream-gaging station. It is also possible to estimate minimum flows at nongaged sites where some discharge measurements have been made. Only gaging stations with 10 years or more of record were used in this report.

FREQUENCY CURVES–RECURRENCE INTERVAL VS. DISCHARGE

The average interval of time within which annual minimum flows are expected to occur is generally referred to as recurrence interval and is estimated from a frequency curve. Frequency curves for selected streams were prepared from annual minimum flows compiled through 1964 by Heath and Wimberly (1971) for stream-gaging stations in Florida. These annual minimum flows are the minimum average flows for periods of 1, 3, 7, 14, 30, 60, 90, 120, 150, 183, and 274 consecutive days. Annual minimum flows since 1964 were compiled from records of the U.S. Geological Survey.

Frequency curves are prepared from annual minimum flows for various consecutive day periods as follows:

(1) Array the annual minimum flows for a selected time period in order of magnitude beginning with the smallest value as number 1.

(2) Compute the recurrence interval (T) in years, by $T = (n \text{ plus } 1)/m$, where n is the total number of values (years of record) and m is the order of magnitude.

(3) Plot each flow against its computed recurrence interval and fit a smooth curve to the plotted points.

The low-flow frequency curve selected for use will depend on the type of water problem to be solved. Frequency curves for several flow periods are shown in figure 1. The 7-day frequency curve is frequently used as a basis for comparing low-flow characteristics of different streams.

SHAPE OF FREQUENCY CURVES INDICATE GEOHYDROLOGIC CONDITIONS

Unless the streamflow is regulated, flat sloped low-flow frequency curves suggest that the surficial materials in the stream basin are highly permeable; much of the rainfall is absorbed where it falls and is stored in aquifers which have sufficient capacity to sustain a high level of base flow during dry weather (Searcy, 1959). The curves for Silver Springs and Econfina Creek in figure 2 are typical of such streams. Steeper sloped curves, such as shown for the St. Johns River, suggest less permeable basin materials, and less water available to sustain streamflow during dry weather (Hidaka, 1973, p. 14) although evapotranspiration also affects the shape of low-flow frequency curves. In the St. Johns River basin and in the upper Oklawaha River basin, for example, streamflow is decreased by the evaporation of water stored in the many lakes in the basin. Thus, the frequency curve for the St. Johns and Oklawaha rivers (fig. 2) is steeper than the other curves. Although evapotranspiration probably has considerable effect on the steepness of the frequency curve, the ground-water contribution also has an effect, and the respective amounts cannot be distinguished.

The similarity of the low-flow frequency curves for some selected streams in northwest Florida such as the Choctawhatchee, Escambia, and Shoal rivers (fig. 2) suggests that the low-flow hydrologic and geologic characteristics of the stream basins are similar. This to some extent might be expected because these streams originate in the same general area in Alabama.

Diversion of water for irrigation, industry, or for municipal water supplies affects low-flow frequency curves as illustrated by the curves for two stations about 30 miles apart but on the same river (fig. 3). The curve for Hillsborough River near Zephyrhills reflects substantial ground-water contribution from Crystal Springs; whereas, the Hillsborough River at Tampa has a very steep low-flow frequency curve which is the result of regulation and the heavy withdrawals for the Tampa municipal water supply.

Geologic and hydrologic characteristics often vary considerably over a stream basin. Variation in the shapes of low-flow frequency curves for four stations on the Suwannee River (fig. 4) illustrate the presumed heterogeneity of hydrologic and geologic factors in the basin. The curve for the most downstream station (near Wilcox) is fairly flat, suggesting substantial ground-water discharge from the aquifer to the stream. The slope of the frequency curves steepens progressively in moving to upstream stations Branford and Ellaville until at White Springs very little ground-water discharge is indicated. The White Springs frequency curve reflects contrasting geologic differences in the upper reach of the Suwannee basin. The steep part of the curve represents a streamflow similar to the headwaters in the Okefenokee Swamp, where low flows range from several hundred cubic feet per second to zero. The flatter, lower part of the curve reflects an annual 5-10 cubic feet per second ground-water inflow from a limestone aquifer just above White Springs.

LOW FLOW AT UNGAGED SITES

Minimum streamflow at ungaged sites cannot be accurately estimated from known basin characteristcs. However, low-flow characteristics for an ungaged site may be derived from graphical correlations based on low- flow discharge measurements obtained at the ungaged site and a nearby gaging station (Riggs, 1972, p. 10, 11). Estimates should not be made when the drainage area is less than 10 square miles.

USE OF SPECIFIC RECURRENCE INTERVALS FOR LOW-FLOW COMPARISONS

For specific comparisons of low-flow characteristics, a single point on the low-flow curve is often used, such as the 2-year or 10-year recurrence interval. The map shows the location of streamflow gaging stations and the value of the 7-day, 10-year low flow in cubic feet per second for each station. Under natural conditions this data indicates the magnitude of ground-water contributions to the streams during low-flow conditions. In north Florida the major streams seldom cease flowing while streams in south Florida often go dry or cease to flow. Because of unequal or erratic distribution of rainfall, streamflow is generally lowest in northwest Florida during late summer and fall and in peninsular Florida during November, December, January, and May (Rabon, 1971).

For a given recurrence interval, low flows usually increase with drainage area. This relation is illustrated in figure 5 for the 7-day, 10-year low flows of selected streams in peninsular Florida.

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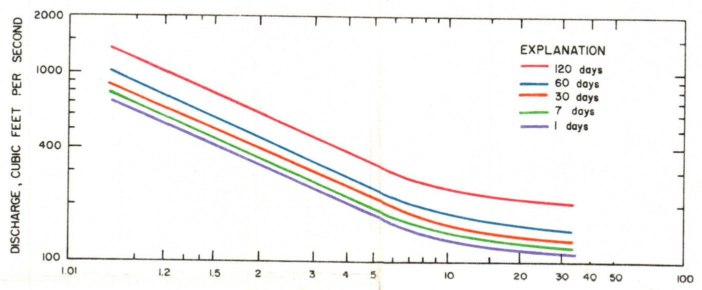


Figure 1. Magnitude and frequency of annual minimum flows for Withlacoochee River near Holder, Florida.

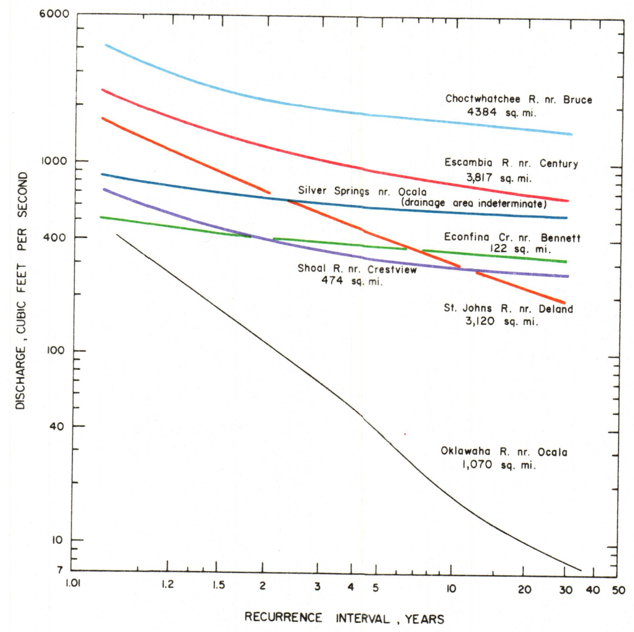


Figure 2. Magnitude and frequency of annual minimum 7-day low flow for selected Florida streams.

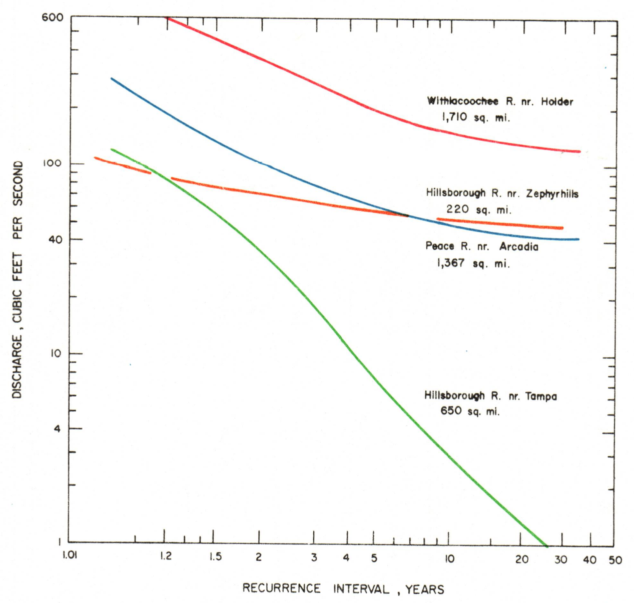


Figure 3. Magnitude and frequency of annual minimum 7-day low flow for selected central Florida streams.

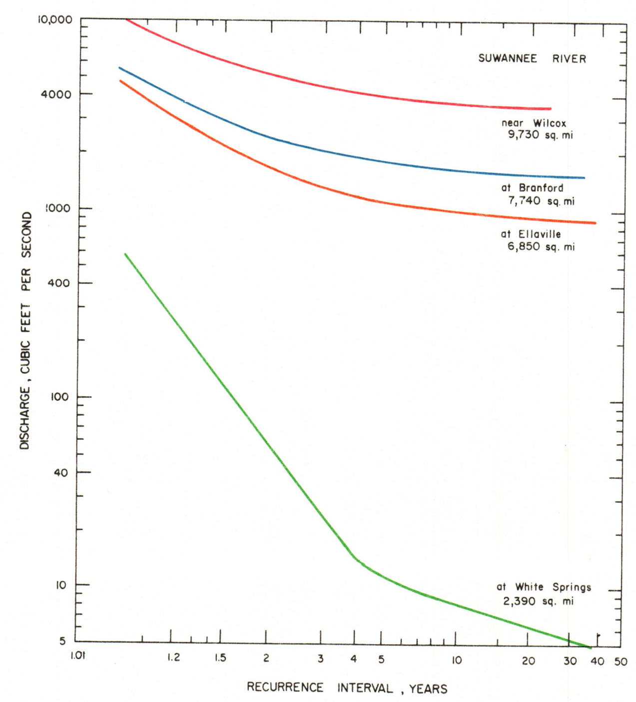


Figure 4. Magnitude and frequency of annual minimum 7-day low flow for the Suwannee River.

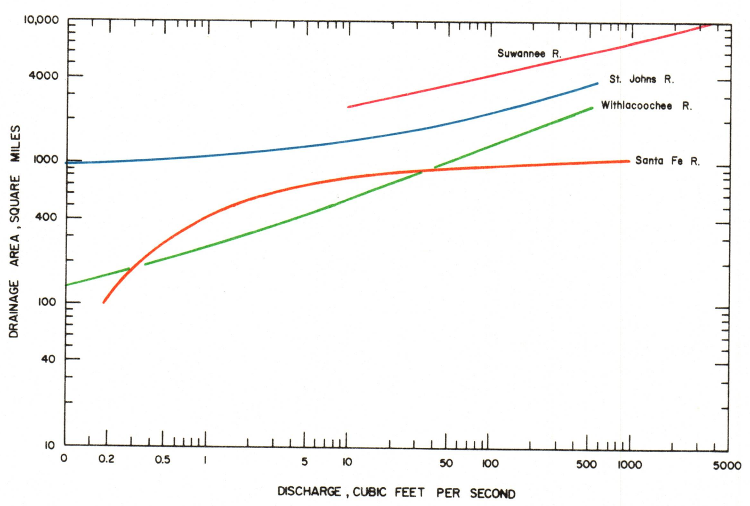
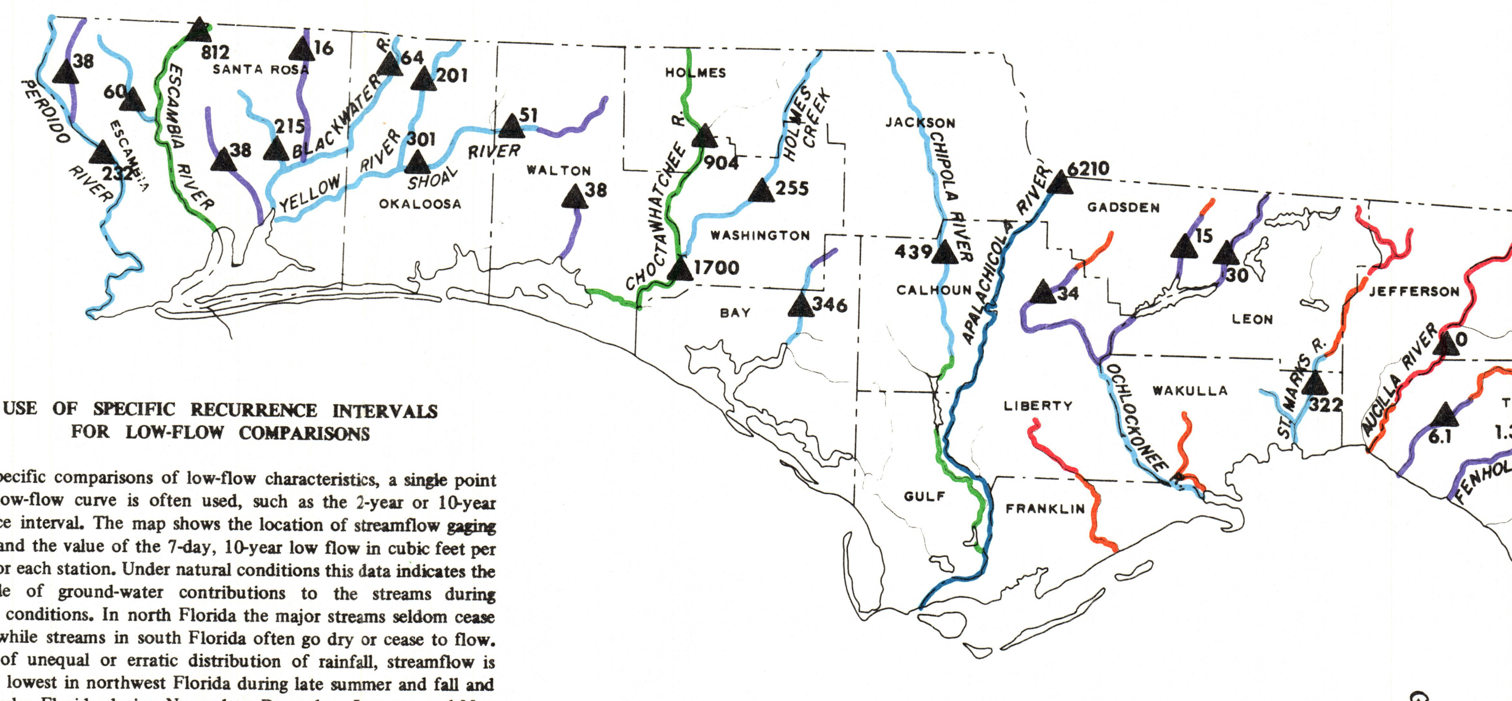
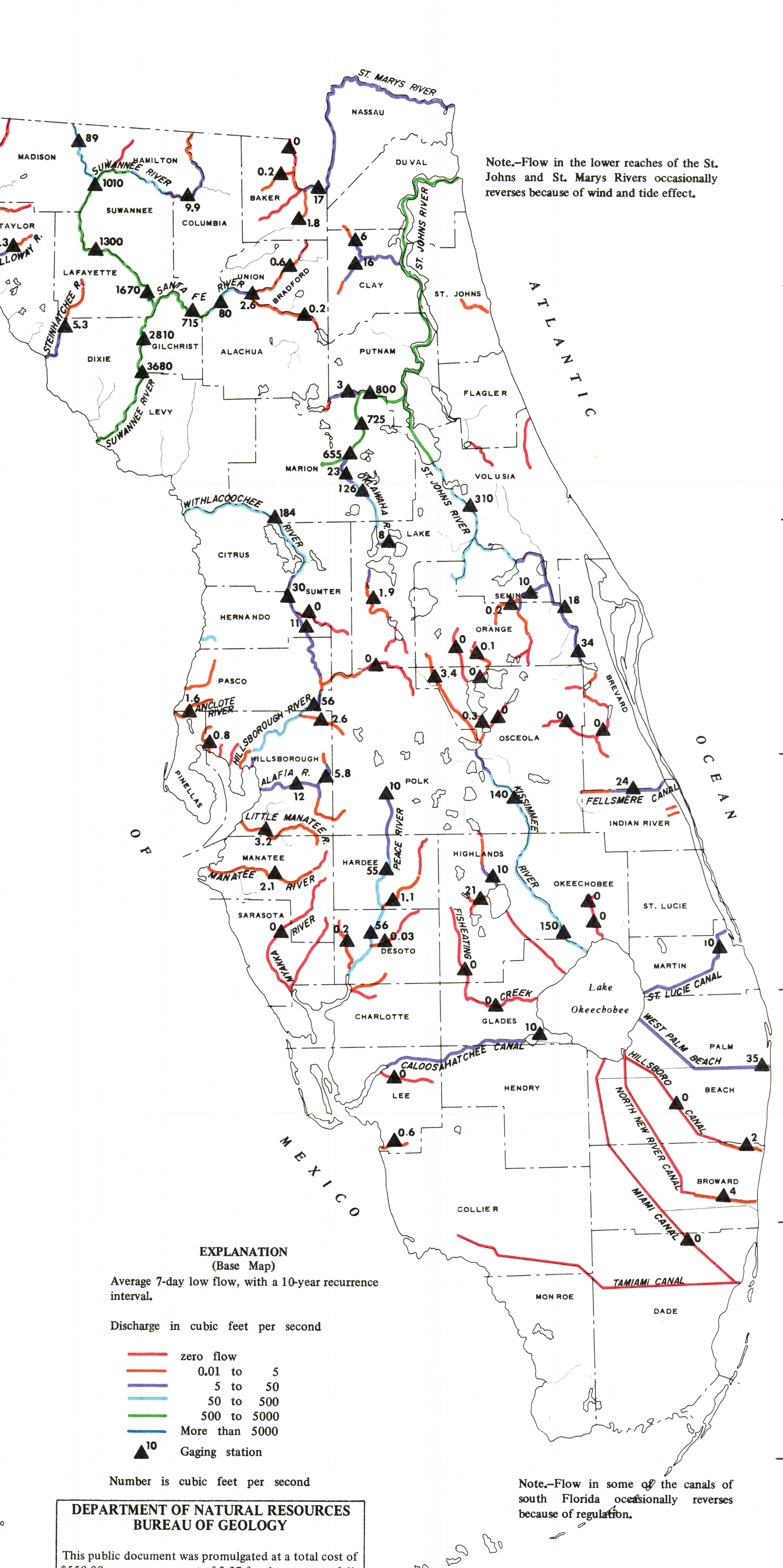


Figure 5. Relation of 7-day, 10-year low flow to drainage area for some major rivers in peninsular Florida.

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