

Measuring High Flows

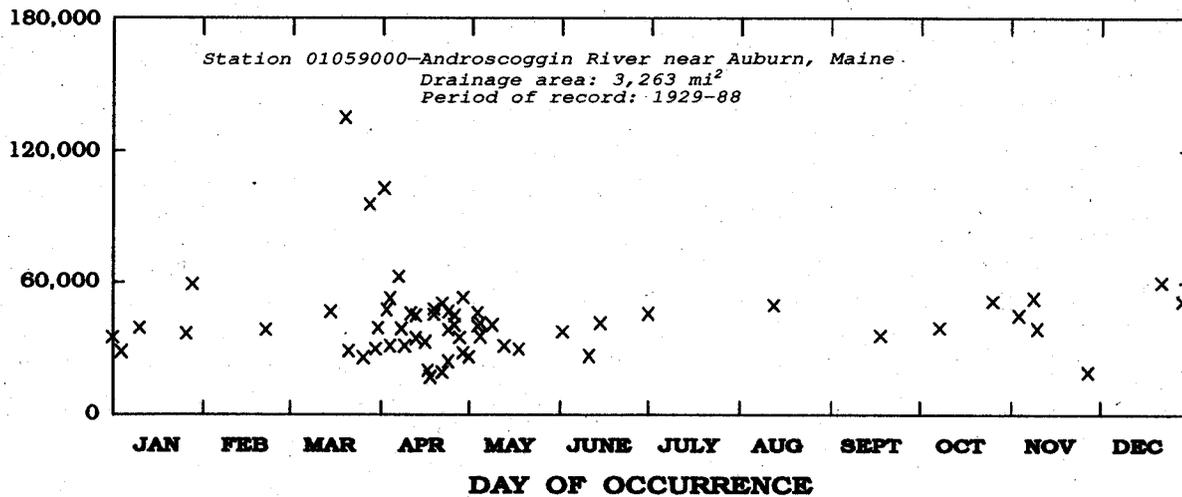
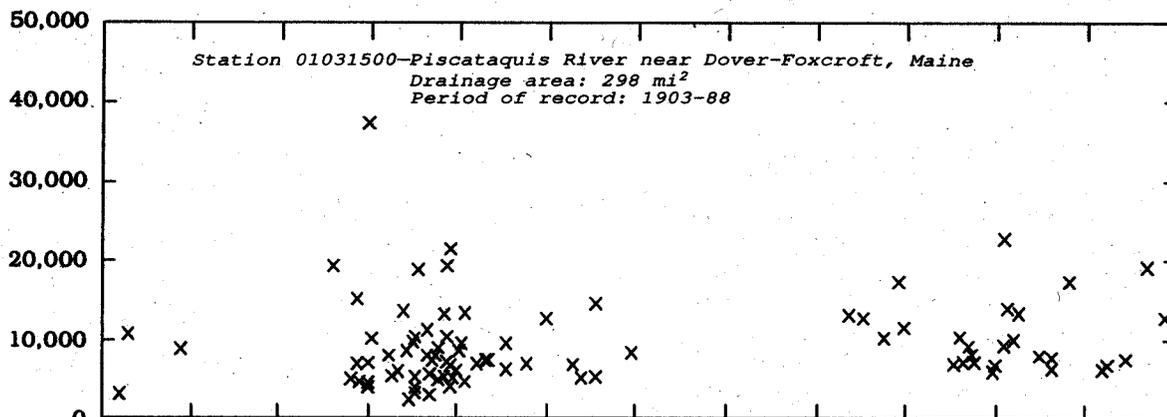
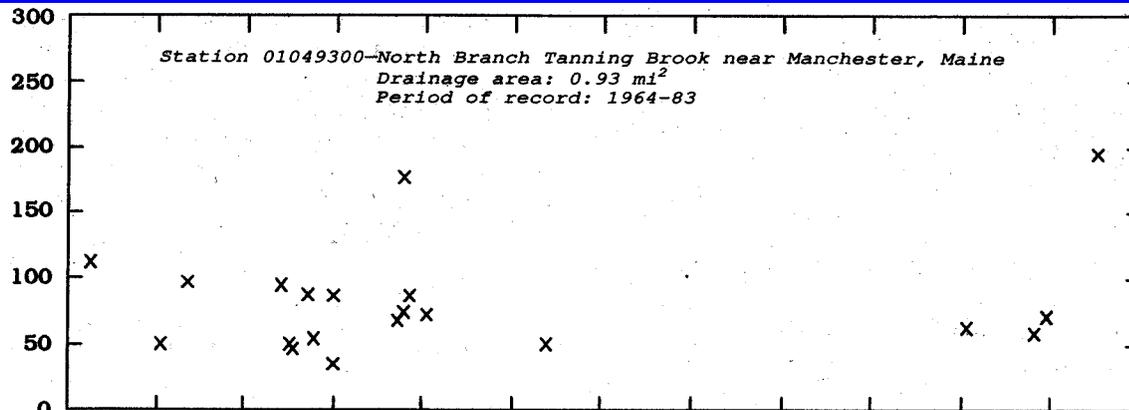
A Role for Indirects?

- Experiences in Maine
 - Annual Rainfall 34 to 55 inches
 - Snowmelt
 - Watersheds Ranging from 0.04 to 7,764 mi²
- Experiences in Hawaii
 - Annual Rainfall 6.5 to 450+ inches
 - Steep Gradients
 - Small Watersheds
- Experiences in Saudi Arabia and Remote Pacific Islands

Why Few Indirect Measurements Are Done in Maine

- Availability of Real-Time Data
- Duration of Peak Runoff
- Variety of Basin Sizes
- Distinctive Flood Seasons
- Good Access
- Measurement Structures at Majority of Sites
- Office Structure
- Emphasis on Making Direct Measurements
- Lack of Experienced Staff

ANNUAL PEAK FLOW, IN CUBIC FEET PER SECOND



Summary of 1996 WY Annual Peak Discharge Data--Maine

- 11 Smallest Drainage Basins
 - Range in Drainage Area 0.042 to 152 mi²
 - Average Drainage Area = 93.6 mi²
 - Average Ratio of Annual Peak to Mean Daily = 0.70
- 18 Larger Unregulated Basins
 - Range in Drainage Area 169 to 5,665 mi²
 - Average Drainage Area = 1,052 mi²
 - Average Ratio of Annual Peak to Mean Daily = 0.88

Distribution of 1996 WY Annual Peak Discharges--Maine

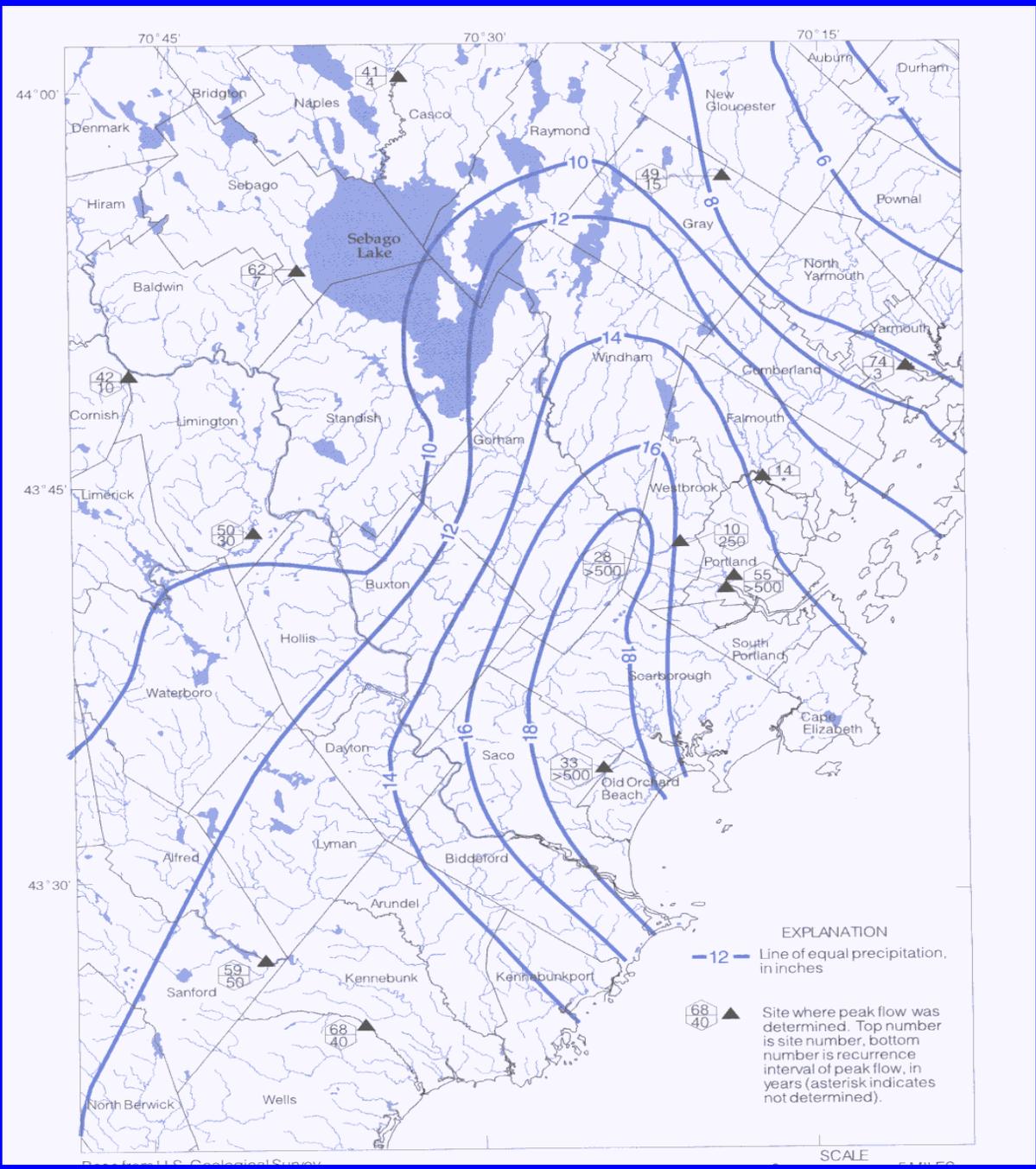
October	1
November	2
January	7
April	18
July	1

The 1987 Flood in Maine, What Changed?

- Availability of Experienced Staff
- Scale of Event
- Magnitude of Event
- Timing of Runoff--Midsize Basins
- Bridges Closed
- Cableways not operational
- New gage—No Measurement Structure

The 1996 Flood in Maine, More Change!

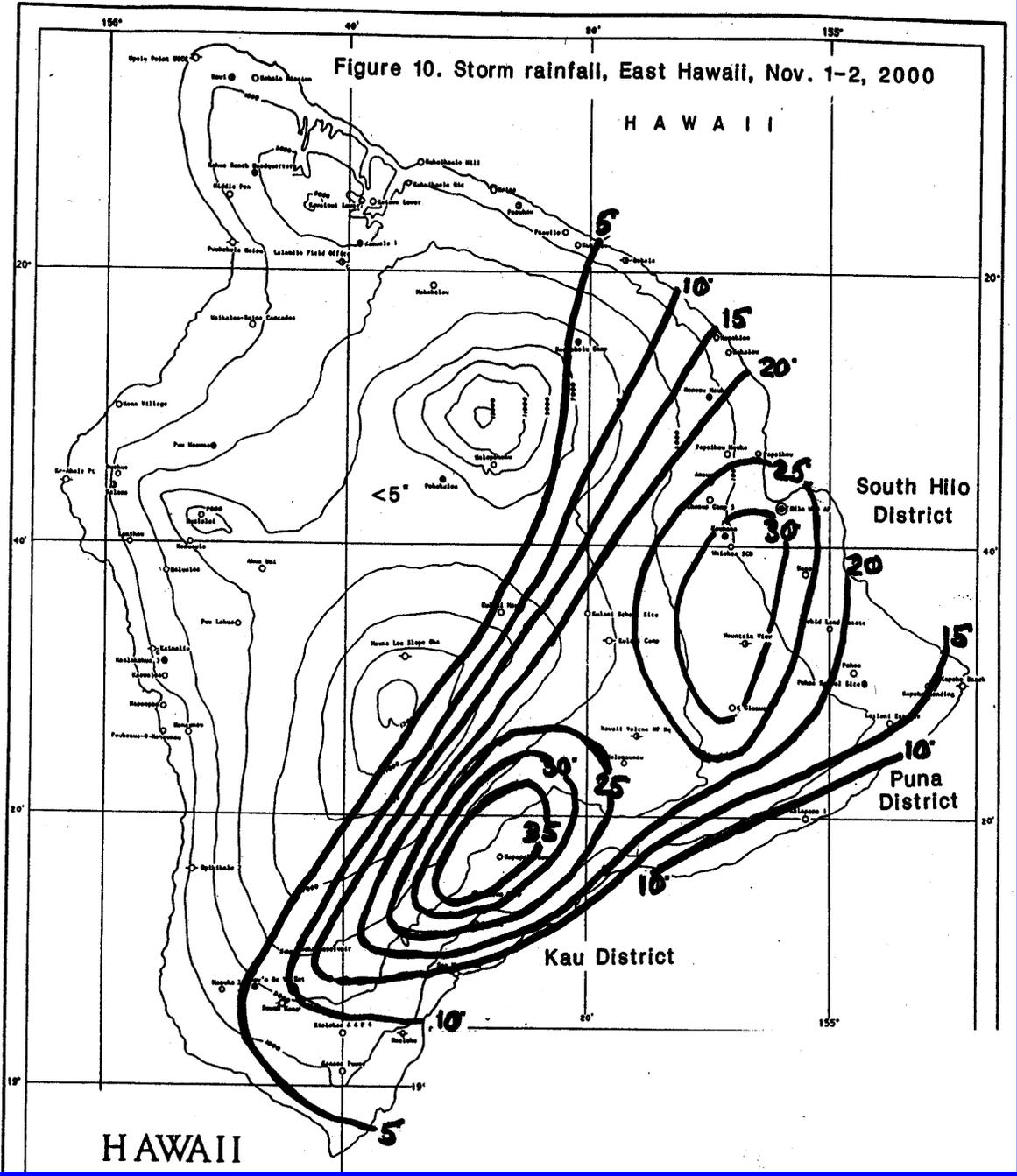
- FUNDING SUPPORT!
- Unique Event for Maine--Up to 19.2 inches of Rain
- Impacted Heavily Urbanized Area
- Impacted Basins are Small
- Lack of Gaging Stations in Area
- Need to Define Regional Flood Frequencies
- FUNDING SUPPORT!



Data from U.S. Geological Survey

SCALE 1:50,000

Figure 10. Storm rainfall, East Hawaii, Nov. 1-2, 2000



Why So Many Indirect Measurements are Currently Being Made in Hawaii

- Lack of Distinctive Flood Season
- Timing of Stream Response
- Duration of Peak Runoff
- Uniformity of Basin Sizes----SMALL
- Poor Access
- Lack of Measurement Structures
- Structure of Field Offices
- Lack of Emphasis on Direct Measurements

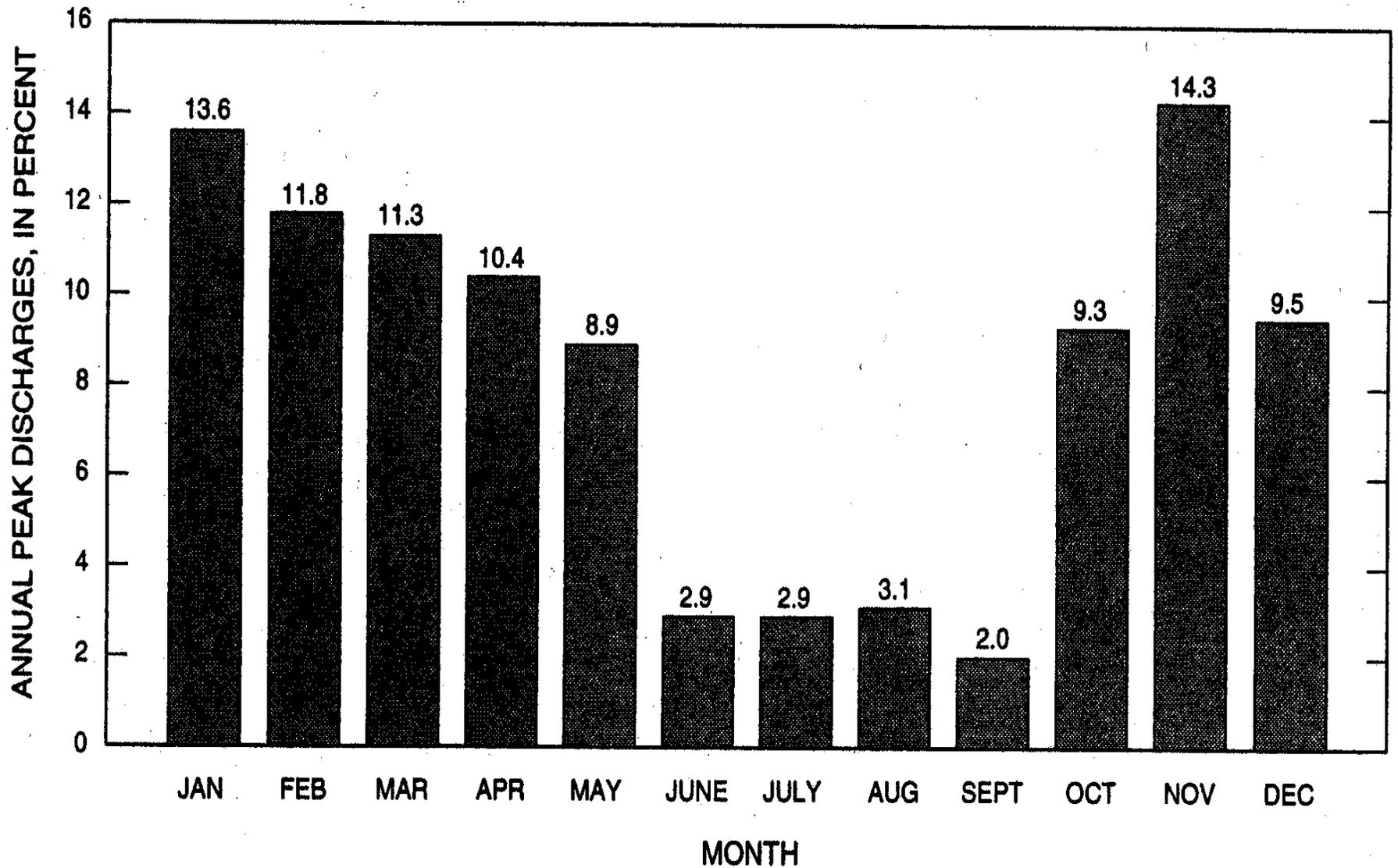
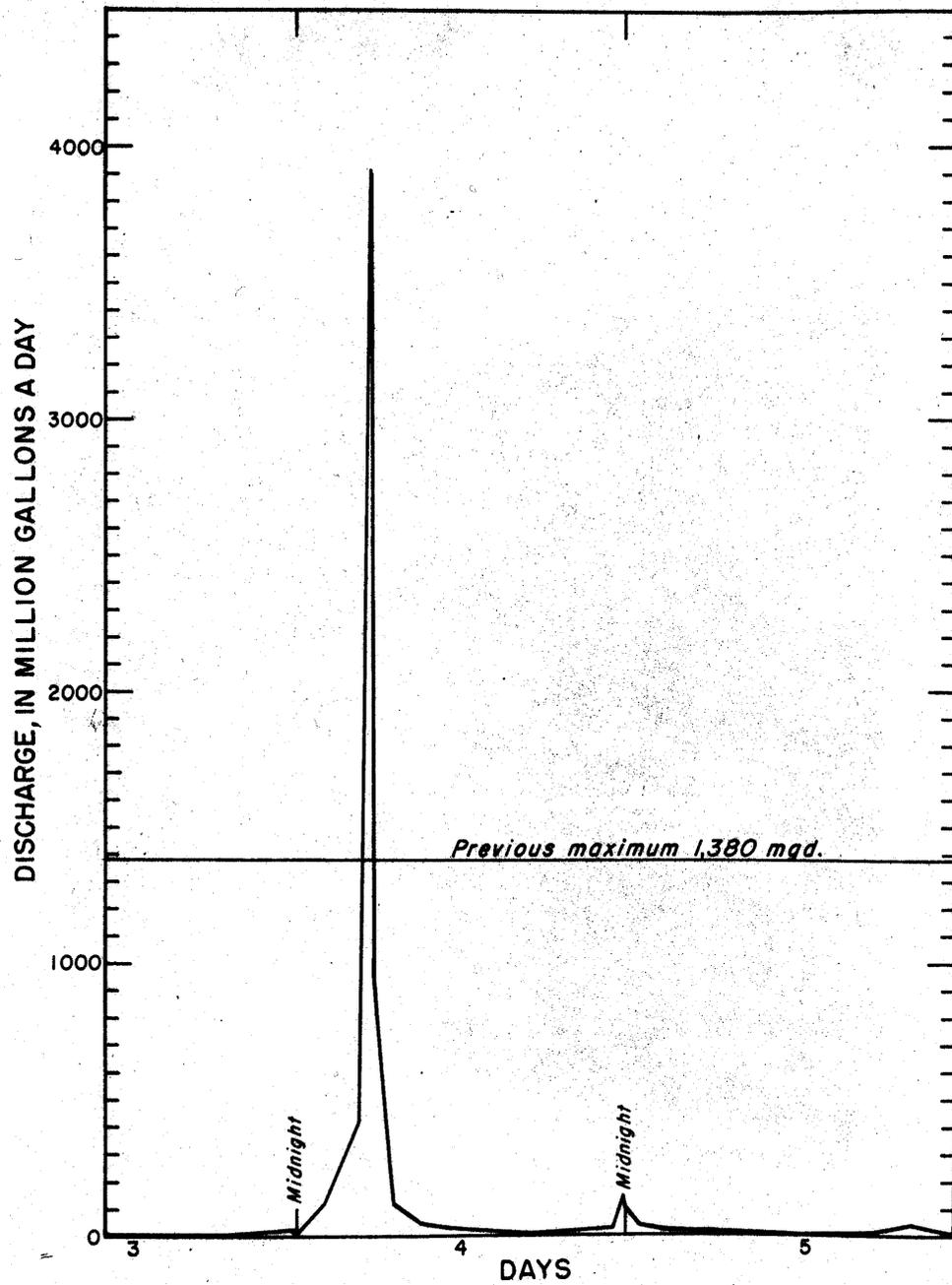


Figure 3. Monthly occurrence of 2,317 annual peak discharges for 79 stream-gaging stations, Oahu, Hawaii, 1913-88.



Summary of 1999 WY Annual Peak Discharge Data--Hawaii

- 19 Unregulated Basins on Oahu
 - Average Drainage Area = 6.34 mi²
 - Range in Drainage Area 0.84 to 45.7 mi²
 - Average Ratio of Annual Peak to Mean Daily = 0.12
 - 16 of 19 Peaks Took Place at Night

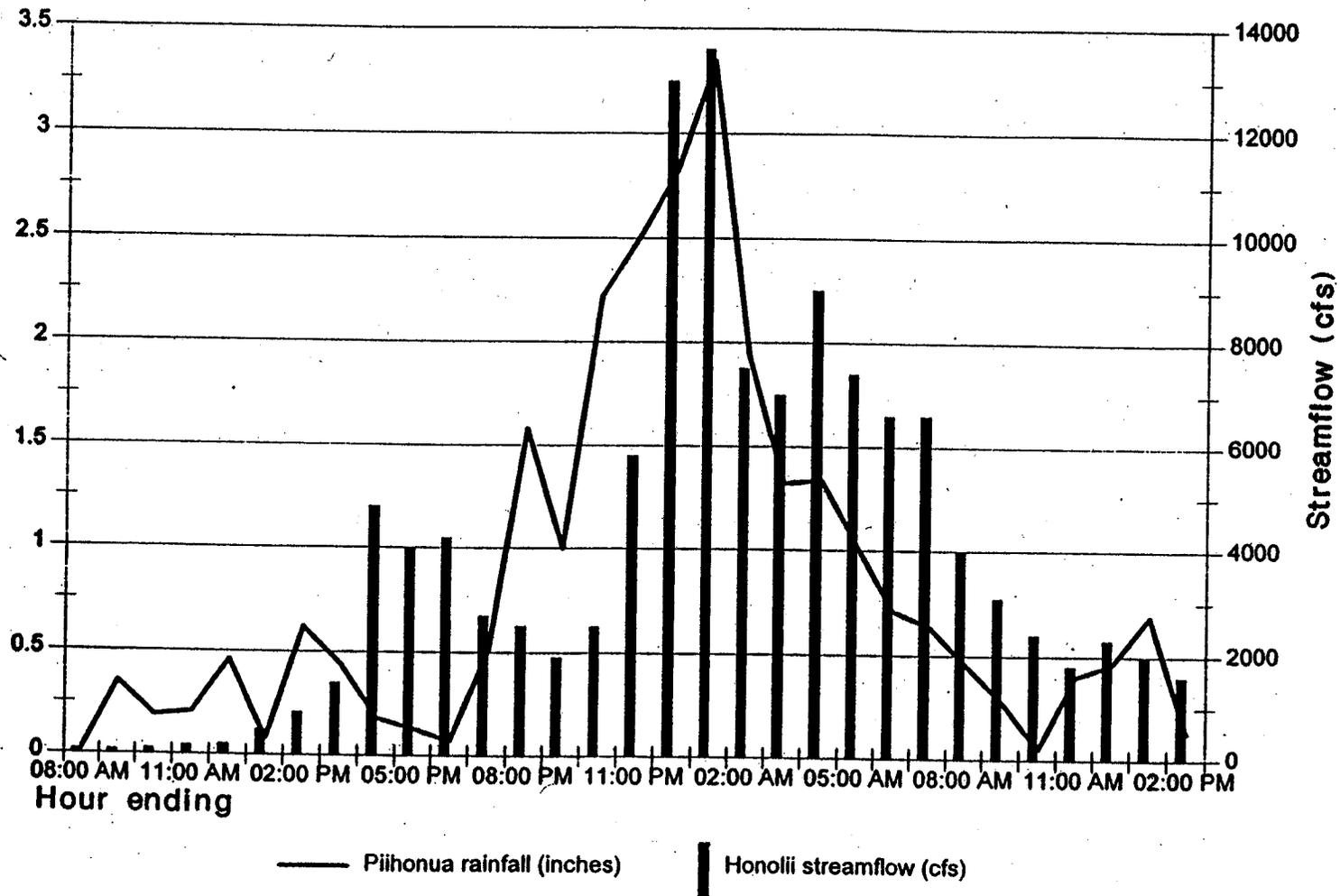


Figure 13. Hourly rainfall at Piihonua and streamflow at Honolii Stream, beginning 7 am, Nov. 1, 2000

Time and Amount of Maximum 3 hr Precipitation Nov. 1-2, 2000 Hawaii

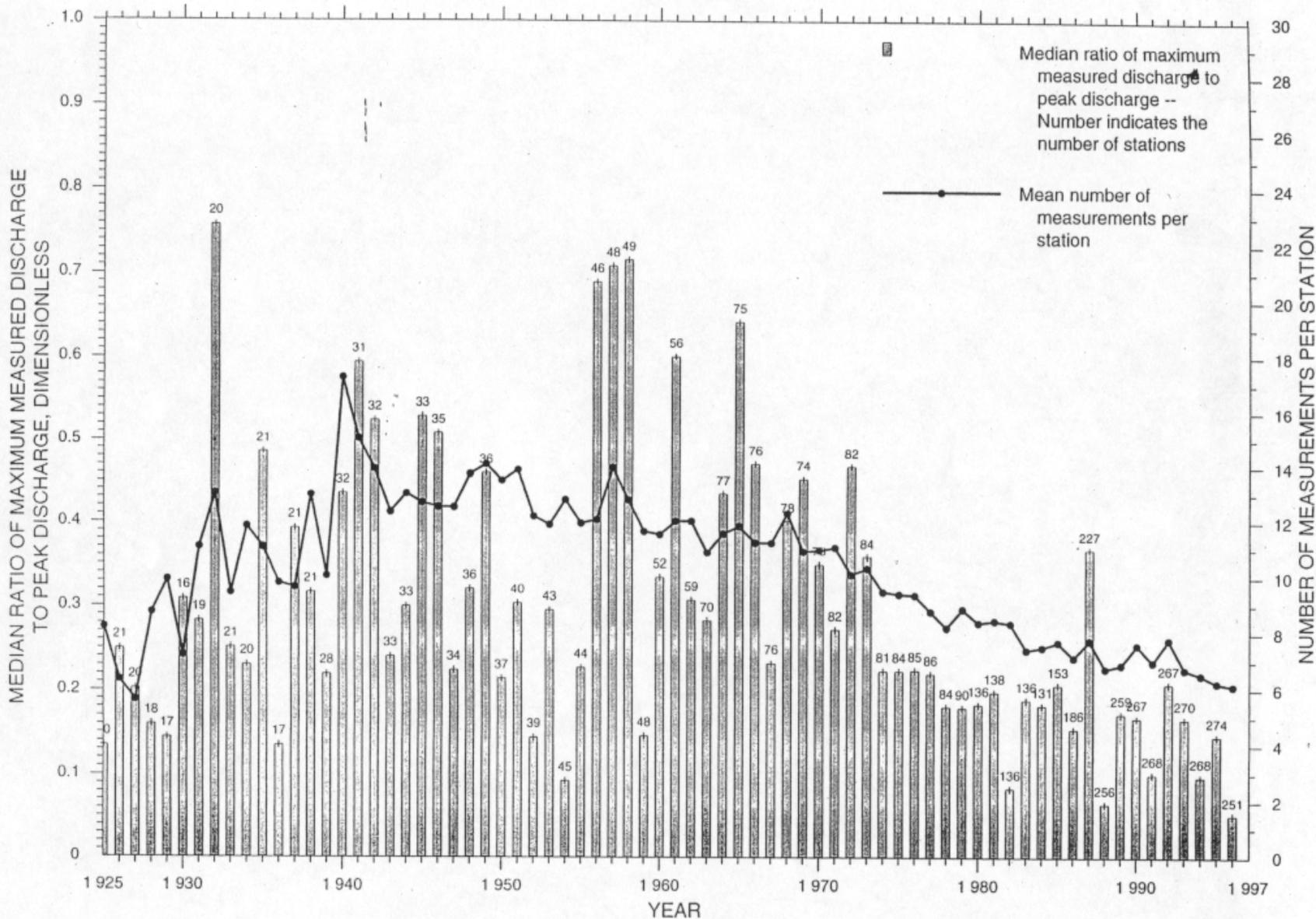
Piihonua	8.67 in.	10 pm to 1 am
Hilo Airport	9.78 in.	11 pm to 2 am
Waiakea Uka	8.78 in.	10 pm to 1 am
Mt. View	8.56 in.	2 am to 5 am
Glenwood	6.24 in.	2 am to 5 am
Pahoa	5.73 in.	4 am to 7 am
Pahoa School	5.60 in.	5 am to 8 am
HI Vol. NP	5.40 in.	9 pm to 12 pm
Kapapala Ranch	12.25 in.	6 am to 9 am

Mean High-End Rating Definition Data In Hawaii

Number of Stations	DA (mi ²)	Peak Q (cfs)	Max. Direct Meas. (cfs)	Max. Indirect Meas. (cfs)	Ext. (percent of peak)
49	11	13,500	1,830	11,500	15

Mean High-End Rating Definition Data In Other Districts

Number of Stations	DA (mi ²)	Peak Q (cfs)	Max. Direct Meas. (cfs)	Max. Indirect Meas. (cfs)	Ext. (percent of peak)
49	11	13,500	1,830	11,500	15
40	15	1,330	186	1,040	37
7	28	2,020	346	1,230	42
11	16	711	166	586	---
67	20	4,700	283	1,400	---



Use of Indirects in Other Parts of the World

- Saudi Arabia
- Oman (ASCE Hydrologic Eng. April 2001)
- Eritrea (ASCE Hydrologic Eng. July 1998)
- Central America (USGS tech assistance)
- Remote Pacific Islands

Summary

- Direct Measurements, Using Traditional Methods, are Not Always Possible During Extreme Events
- At the Present Time Indirect Measurements, of Some Type, Will Continue to Have a Role