A Preliminary Investigation into the Hydrology of the Jackson/Frazier Wetland, Oregon

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To Michael Drost,

my husband, technical advisor, and slave driver.

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ABSTRACT

The Jackson/Frazier Wetland is a small wetland in Benton County, Oregon. It has one main inflowing stream, Jackson/Frazier Creek, and one main outflowing stream, a man-made drainage ditch. Streamflow measurements were collected for both streams over a four month period of November 1983 to February 1984. This data was analyzed in conjunction with precipitation data to formulate some basic hydrologic relationships of the wetland: stage/discharge, time/discharge, rainfall/runoff, and inflow/outflow. These relationships were then graphically represented in the respective curves: the rating curve, the hydrograph, the rainfall/runoff curve, and the inflow/outflow curve. These relationships were further used to determine whether the Jackson/Frazier Wetland functioned as a hydrologic system, with the hydrologic components of input, storage, and output having direct relationships to each other. It was found that there was a direct relationship between the amount of water entering and leaving the wetland, but a relationship between rainfall and runoff for this wetland could not be established.

INTRODUCTION

Traditionally, wetlands have been viewed as wastelands, only useful to humans after they were drained and developed. The current scientific trend is to regard wetlands as highly productive ecosystems and as complex hydrologic systems. A great deal of research has been done on the classification and analysis of the flora and fauna of wetlands, but the role of hydrology in the wetland system has been sadly neglected. The difficulty of gathering wetland hydrologic data has put a damper on comprehensive research. The scientific push now is to gather as much hydrologic data as possible on specific wetlands, for both scientific and planning needs, in order to draw more general, comprehensive conclusions.

This paper is a preliminary investigation into the hydrology of a small freshwater wetland. It presents hydrologic data collected and analyzed from the Jackson/Frazier Wetland in Benton County, Oregon. Background information on hydrology and the wetland is also briefly presented.

BACKGROUND

Wetlands Definition

Wetlands cannot be neatly classified as either terrestrial or aquatic environments. There is often disagreement over the specifics of the definition of "wetland", but generally there is agreement on the basic definition: an environment whose single distinguishing feature is the presence of water in what would otherwise be a terrestrial environment. The U.S. Fish and Wildlife Service, in their publication Classification of Wetlands...;, defines wetlands in detail on the basis of vegetation, soil, and hydrology:[1]

> "Wetlands are transitional between terrestrial and aquatic systems where the water table is at or near the surface or the land is covered by shallow water...wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time of the year."

Other definitions vary from this one only in small detail. Baker adds that wetlands "...generally are characterized by an accumulation of organic matter [peat]...", while Novikov emphasizes the presence of a single aquifer.[2] The Jackson/Frazier Wetland easily fits the U.S. Fish and Wildlife definition. This paper will employ that definition throughout its entirity.

Since wetlands occur in many different climates, many different names have been used to describe and distinguish wetlands. Some of the nomenclature encountered in the literature is as follows: swamps, marshes, meadows, bogs, fens, estuaries, tidal flats, and prairie potholes. The Jackson/Frazier Wetland is sometimes called a "wet prairie", but throughout this paper it will be referred to with the generic term "wetland".[3]

The Wetland as a Hydrologic System

Wetlands may be viewed as hydrologic systems, where the amount of water entering the wetland directly, but not necessarily immediately, influences the amount of output. The simple components of this system, input, storage, and output, are what make wetlands hydrologically complex. Sources of wetland input are runoff in the form of overland flow and channelized flow, and precipitation that falls directly onto the wetland. Storage of water may occur when water is temporarily held in the soil or vegetation, or temporarily ponded in the wetland. The amount of time it takes water to get from a wetland's input to its output may also be regarded as storage. Wetland output includes runoff, both overland and channelized flow, soil seepage, loss to the groundwater, evaporation, and transpiration.

The key to understanding the hydrology of a specific wetland is to understand and analyze each component of the wetland's system and the relationship of the components to each other. This paper focuses on the channelized flow and precipitation into the Jackson/Frazier Wetland, the amount of time it takes to filter through the wetland, and the resulting channelized flow out of the wetland. It is the aim of this paper to show how the hydrologic components of the Jackson/Frazier Wetland do, in fact, act as a system and not just a series of unrelated events.

Study Site Description

The Jackson/Frazier Wetland, also referred to as the Starker Tract, is located in the Central Willamette Valley, Oregon. Just north of the Corvallis city limits, it covers approximately 150 acres of land zoned for farm use (Figure 1).[4] The wetland is formed on poorly drained heavy clay (Bashaw Clay).[5] The relative relief is low, ranging from 209 feet to 235 feet above sea level.[6] The geology of the area consists of recent (Holocene Period) alluvial and lacustrine deposits.[7] The Jackson/Frazier Wetland supports at least three major ecosystems: 1) grasslands, 2) shrublands, and 3) forests.

The Jackson/Frazier Wetland is a part of the drainage basin of the Jackson and Frazier Creeks, which drains a small portion of the eastern Coast Range. Jackson Creek and Frazier Creek converge just before entering the wetland. The well-defined stream channel becomes obscure after entering the wetland and re-emerges at the southeastern corner of the wetland in the form of a man-made drainage ditch, also referred to as the Stewart Slough. The drainage ditch eventually drains into the Willamette River. The Jackson/Frazier Wetland also supports a relatively large intermittent pond, which is dry most of the summer, but may well be over three feet deep during the winter months.

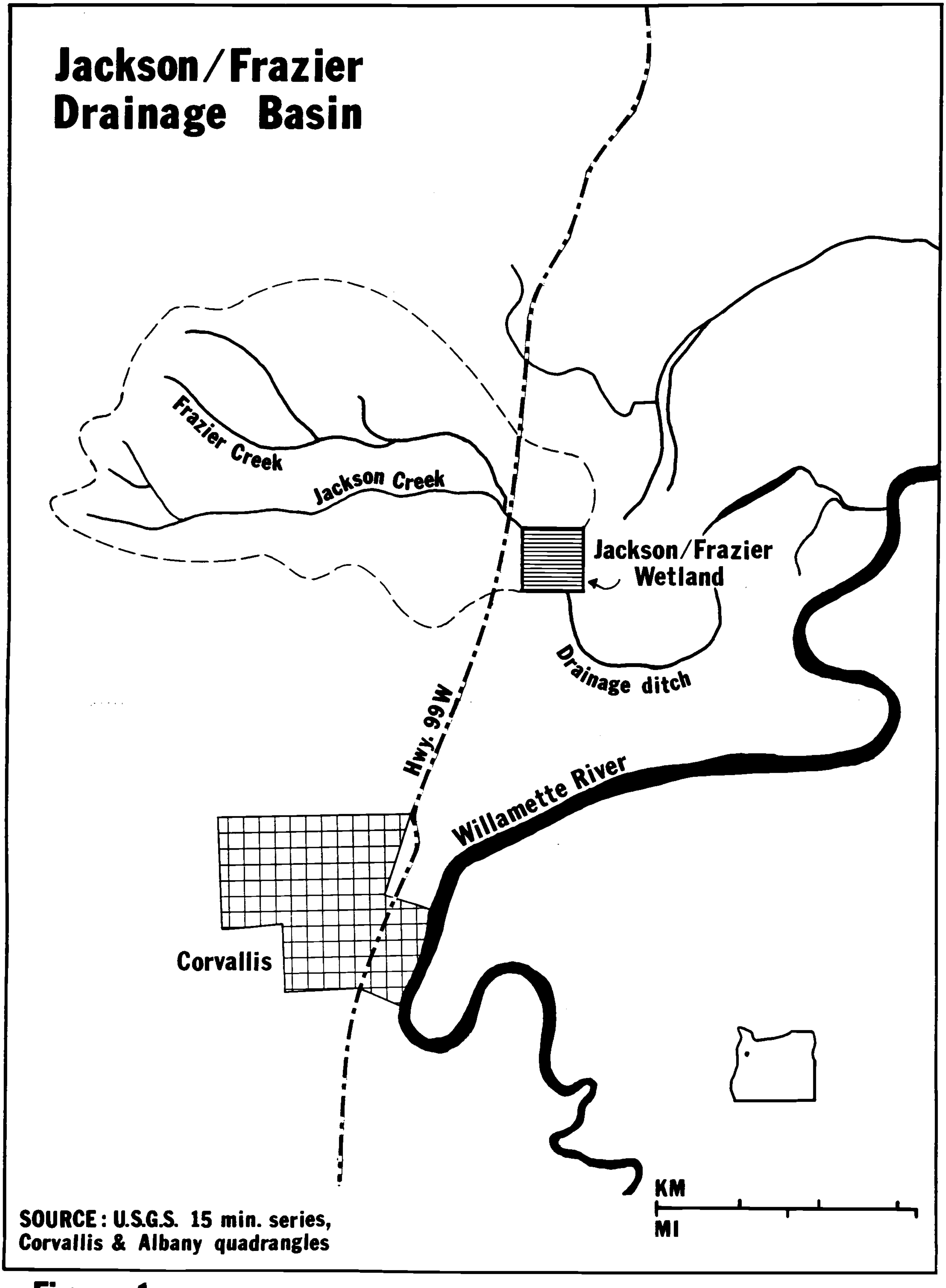
Jackson/Frazier
Drainage Basin
Frazier Creek
Jackson Creek
Jackson/Frazier
Wetland
Drainage ditch
Hwy. 99W
Willamette River
Corvallis
KM
MI
SOURCE: U.S.G.S. 15 min. series,
Corvallis & Albany quadrangles

Figure 1.

DATA COLLECTION

Hydrologic data was collected for the Jackson/Frazier Wetland for the months of January through April of 1982 and November of 1983 through February of 1984. The data was purposely collected during the winter months, Western Oregon's wettest time of year. The precipitation data was obtained from the Climatic Research Institute at Oregon State University (Figure 2). They maintain a standard rain gauge at Hyslop Experimental Farm, about five miles from Jackson/Frazier Wetland, and record the daily amount of precipitation at 8:00 am.

The runoff data was collected in the field. Three basic measurements were taken for both the wetland inflow, Jackson/Frazier Creek, and the outflow, the drainage ditch: 1) stream cross-sectional area, 2) stream velocity, and 3) daily stage readings. All of these measurements were necessary to ultimately determine the daily flow rates, also referred to as the daily discharge.

Preliminary data collection was performed January through April, 1982. This helped establish the methodology to be used and obtained some of the stream velocity measurements and stream cross-sectional measurements. The rest of the data was collected from November, 1983, to February, 1984.

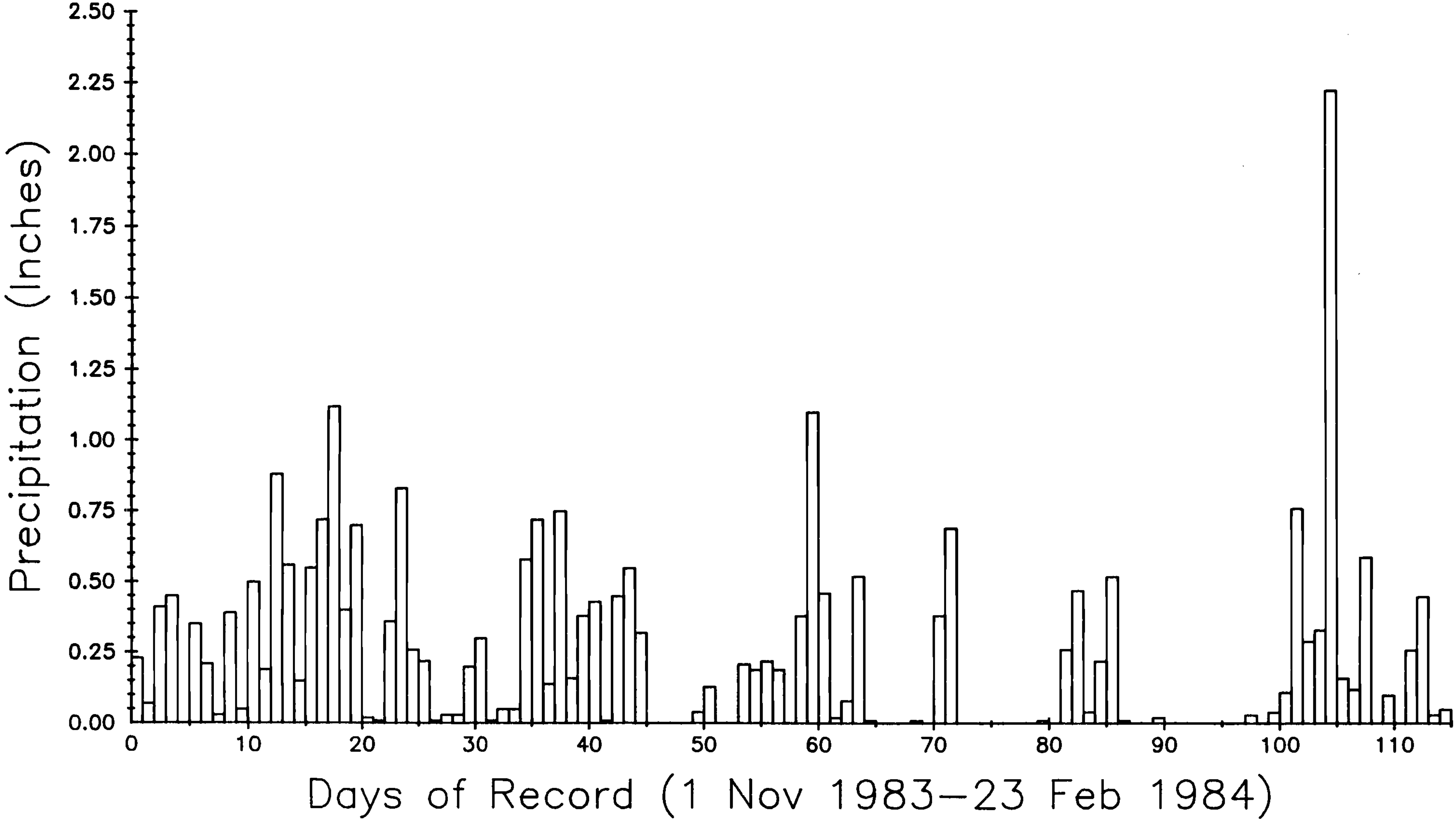

Fig. ⟨2⟩. Precipitation.

Cross-sectional Area

The stream cross-sectional area is defined by the area that is actually occupied by water, also known as the stream's "wetted perimeter." Both the Jackson/Frazier Creek and the drainage ditch cross-sectional areas were determined by the same method.

The measurements were made using a stadia rod, a tape measure, a line level, and string. Depth readings were taken at regular intervals along a horizontal, linear base reference. A railroad bridge spanning Jackson/Frazier Creek was used for its base reference. Depth readings were taken once every three feet. String, staked and leveled, was used as a base reference for the drainage ditch. Depth readings were taken once every two feet (Table 1). The data was plotted to create graphic representations of both streams' cross-sections (Figure 3).

Velocity Readings

Stream velocity measurements were gathered using a pygmy meter and a timepiece. The pygmy meter was lowered into the stream at the thalweg to approximately six-tenths depth of the stream. The number of clicks emitted by the pygmy meter was counted and recorded over a sixty minute time frame.

Table 1. Cross-sectional data.

Jackson/Frazier Creek (January 31,1982)

Feet	Stage Reading	
0	2'04"	
3	2'08"	
6	3'05"	
9	3'01"	
12	3'09"	
15	4'00"	
18	4'00"	
21	5'03"	
24	5'04"	
27	3'09"	
30	4'07"	
33	5'09"	
36	6'04"	
39	7'10"	
42	7'10"	
45	9'05"	
48	9'10"	
51	9'11"	
54	9'04"	(measurements taken here)
57	8'09"	
60	7'06"	
63	6'04"	
66	5'10"	
69	5'09"	
72	5'03"	
75	4'00"	
78	3'09"	
81	3'09"	
84	3'02"	
87	2'05"	
91	2'04"	

Drainage Ditch (November 4, 1983)

Feet	Stage Reading	
0	3'04"	
2	3'11"	
4	4'09"	
6	5'06"	
8	5'07"	
10	5'08"	
12	5'11"	
14	5'11"	
16	5'10"	(measurements taken here)
18	5'06"	
20	4'01"	
21	3'05"	

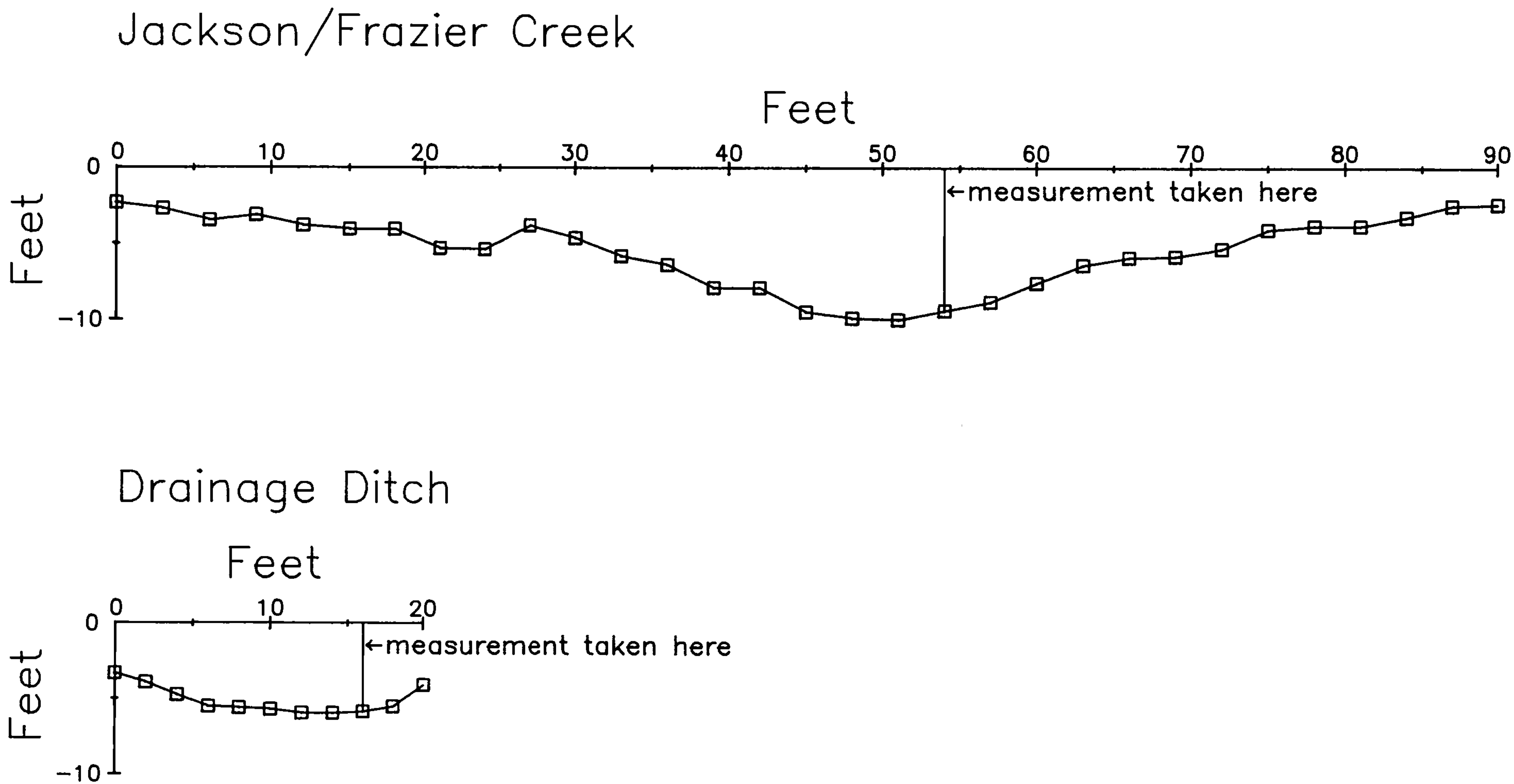

Fig. ⟨3⟩. Stream Cross Sections.

At times, the velocity of Jackson/Frazier Creek was so slow that the pygmy meter could not detect water movement. Whenever this was the case, an estimate was made using an object which floated over a premeasured distance for a timed interval. This "floating object" method was also used to determine the velocities of the drainage ditch because it was too shallow and slow moving for the pygmy meter.[8] Values collected by this method were multiplied by 0.8 to convert surface velocity to mean velocity of the streams (Table 2).[9]

Daily Stage Readings

Stage, or stream depth, readings were gathered daily from Jackson/Frazier Creek and the drainage ditch from November 1, 1983, to February 23, 1984. Technical difficulties, such as broken stadia rods and frozen streams, prevented a completely continuous daily record. However, the data was continuous enough to gain valuable information. Date, time of day, and stage reading were recorded (Appendix A).

For measuring the stage of Jackson/Frazier Creek, a hand-held stadia rod was lowered from the railroad bridge. The measurements were taken 60 feet from the north end of the bridge. For the drainage ditch, a four foot stake, marked in

Table 2. Velocity Data.

Jackson/Frazier Creek (January 31 - April 6, 1982)

Date	Stage Reading	Velocity (ft/sec)	Adjusted Velocity (ft/sec X 0.8)
01 Jan	5'08"	0.40	0.32
14 Feb	6'09"	0.80	0.64
08 Mar	5'04"	0.25	0.20
09 Mar	5'03"	0.20	0.16
14 Mar	5'03"	0.20	0.16
28 Mar	5'01"	0.09	0.07
06 Apr	5'04"	0.20	0.16

Drainage Ditch (January 6 - 30, 1984)

Date	Stage Reading	Velocity (ft/sec)	Adjusted Velocity (ft/sec X 0.8)
06 Jan	1'11"	0.57	0.46
07 Jan	1'10"	0.37	0.30
08 Jan	1'09"	0.33	0.26
09 Jan	1'09"	0.25	0.20
10 Jan	2'03"	1.33	1.07
11 Jan	2'00"	0.77	0.62
12 Jan	1'11"	0.50	0.40
13 Jan	1'10"	0.44	0.35
14 Jan	1'09"	0.36	0.29
22 Jan	1'11"	0.55	0.44
24 Jan	2'02"	1.18	0.94
25 Jan	2'05"	1.33	1.07
26 Jan	1'11"	0.64	0.52
27 Jan	1'10"	0.54	0.43
29 Jan	1'09"	0.42	0.34
30 Jan	1'08"	0.44	0.35

one-inch increments, was implanted in the stream bed. It was located 16 feet from the west bank of the established cross-section. Recording of stage data was halted when the hand-held stadia rod was stolen.

Mapping and Digitizing

Mapping the Jackson/Frazier Wetland and surrounding areas was necessary to provide basic locational and areal information. A 1983 aerial photograph from W.A.C Corporation of Eugene, Oregon, was used. Also, the U.S.G.S 7.5 minute series of topographic maps of Albany and Corvallis served as a base map. The Jackson/Frazier drainage basin and wetland areas were digitized to obtain area data. The drainage basin, including the wetland, was found to be 4605 acres. The Jackson/Frazier Wetland was found to be 151 acres.

DATA ANALYSIS

In order to begin to understand the hydrology of the Jackson/Frazier Wetland, the field data had to be analyzed mathematically and graphically. From the raw data of dates, times, stream stage readings, precipitation, and snow, a series of mathematical calculations were performed which eventually yielded daily stream discharges, wetland water input/output differences, and wetland water storage amounts. Small BASIC and FORTRAN programs were written to facilitate these calculations.

A relationship between stream stage and stream velocity, called a rating curve, was established. This information was used to calculate daily discharge values for both streams. In turn, the discharge values were plotted against time and precipitation to create hydrographs and rainfall/runoff curves. Finally, the relationship between the wetland inflow and the wetland outflow was examined to help analyze the wetland's water storage characteristics.

Data Processing

A series of steps were taken in processing the data. First, daily snow accumulations were converted to their water equivalents and added to daily precipitation amounts. Second, the stage readings were adjusted by interpolation as if they had all been taken at 8:00 am. This corresponded to the time that the precipitation readings were taken at Hyslop Farm. Third, cross-sectional areas were calculated for each different stage height. Because the cross-section was defined by the wetted perimeter of the stream, this area varied with the stream depths.

The Rating Curve

There is a direct relationship between a stream's stage and a stream's velocity at a given time and reaches that may be graphically represented in a rating curve. As the stream level rises, the velocity increases. This relationship is valuable because it can be established with relatively little data collection and used to interpolate, with fair accuracy, other velocities at different stage readings.[10]

Calculations were required to convert the number of clicks per second from the pygmy meter to feet per second. An equation from the U.S. Geological Survey was used:[11]

$$V = 0.951N + 0.15$$

where

V = the velocity in feet per second

N = the number of clicks per second from the pygmy meter

This equation was adapted from the small Price meter equations of the U.S. Geological Survey by taking into account that the "bucket wheel [of the pygmy meter] revolves 2.25 times as fast as that of the small Price current meter" (Appendix B).[12] Rating curves for both Jackson/Frazier Creek and the drainage ditch were generated (Figures 4 and 5).

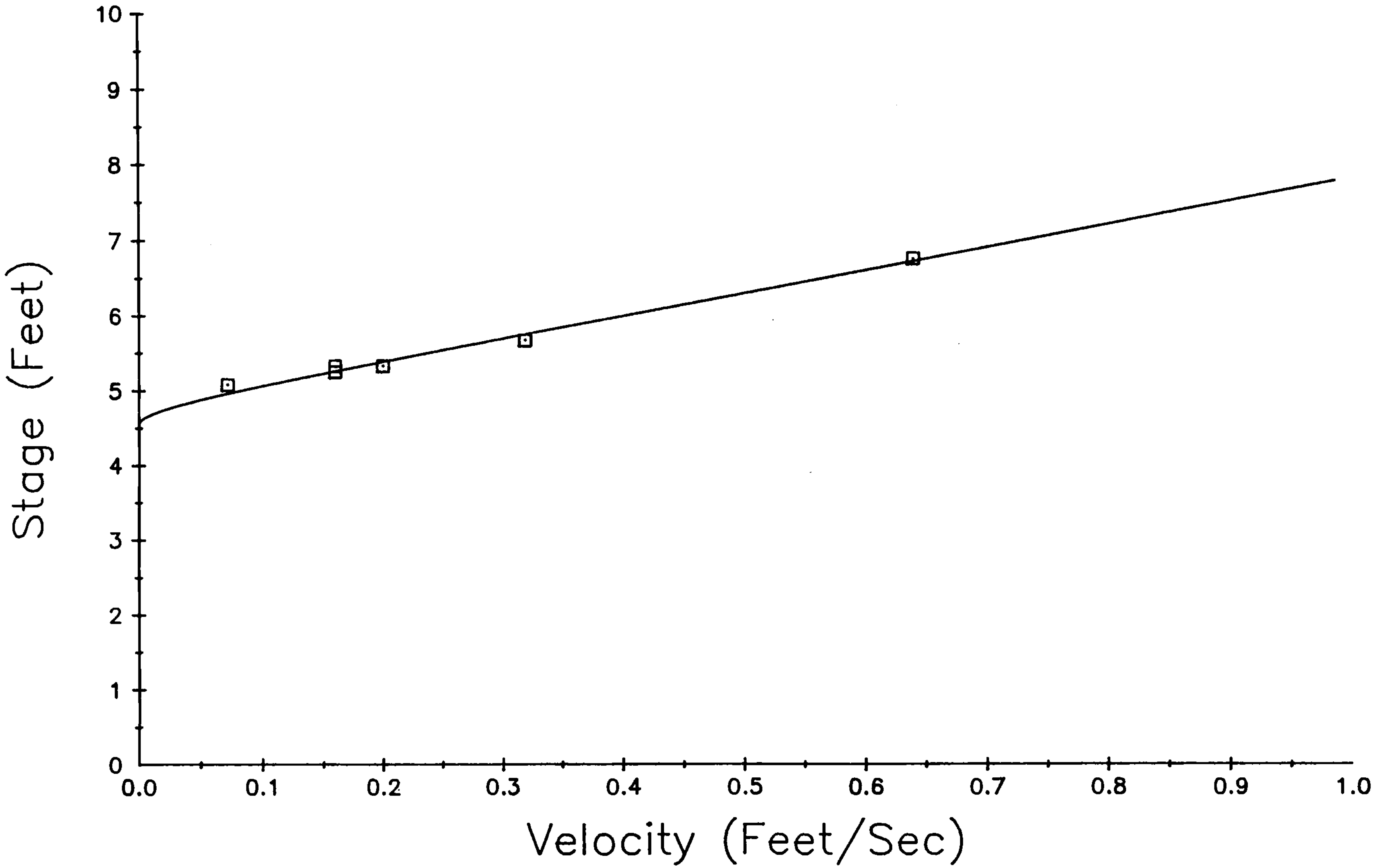

Fig. ⟨4⟩. Velocity Rating Curve for Jackson/Frazier Creek.

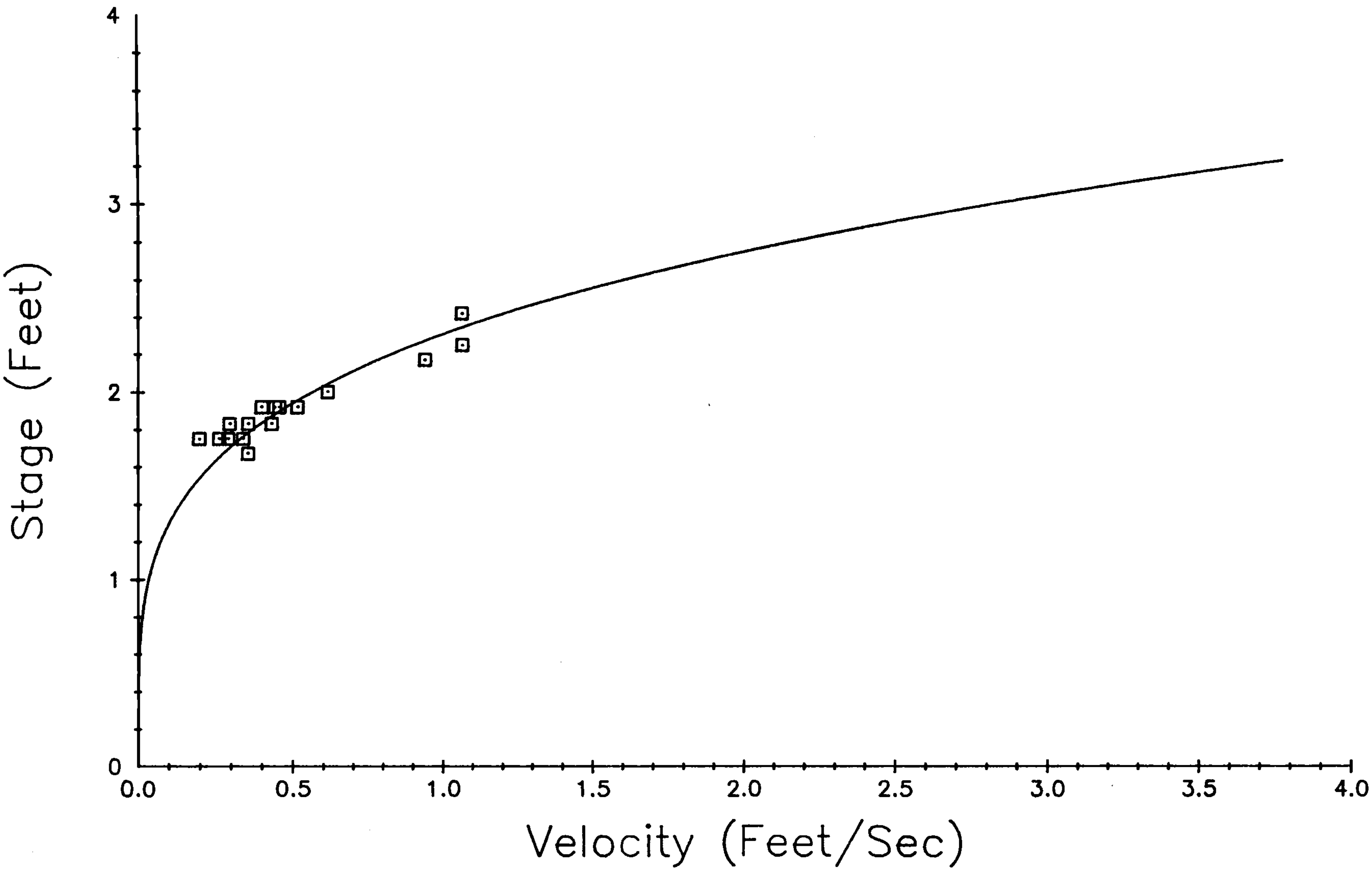

Fig. ⟨5⟩. Velocity Rating Curve for the Drainage Ditch.

Discharge

The quantity of water, or discharge, flowing in Jackson/Frazier Creek and the drainage ditch was calculated from the adjusted cross-sectional area and velocity. The Velocity-Area equation was used:

$$Q = AV$$

where

Q = the discharge, in cubic feet per second (cfs)

A = the adjusted cross-sectonal area, in square feet (ft^2)

V = the velocity, in feet per second

From the data collected, it was found that Jackson/Frazier Creek had an average daily winter discharge of 29 cfs and the drainage ditch had an average daily winter discharge of 20 cfs.

The Hydrograph

Discharge data from both streams was plotted against time to create two hydrographs (Figures 6 and 7). A composite hydrograph of the total input and total output to the Jackson/Frazier Wetland was generated to illustrate the timing differences between the input and output (Figure 8).

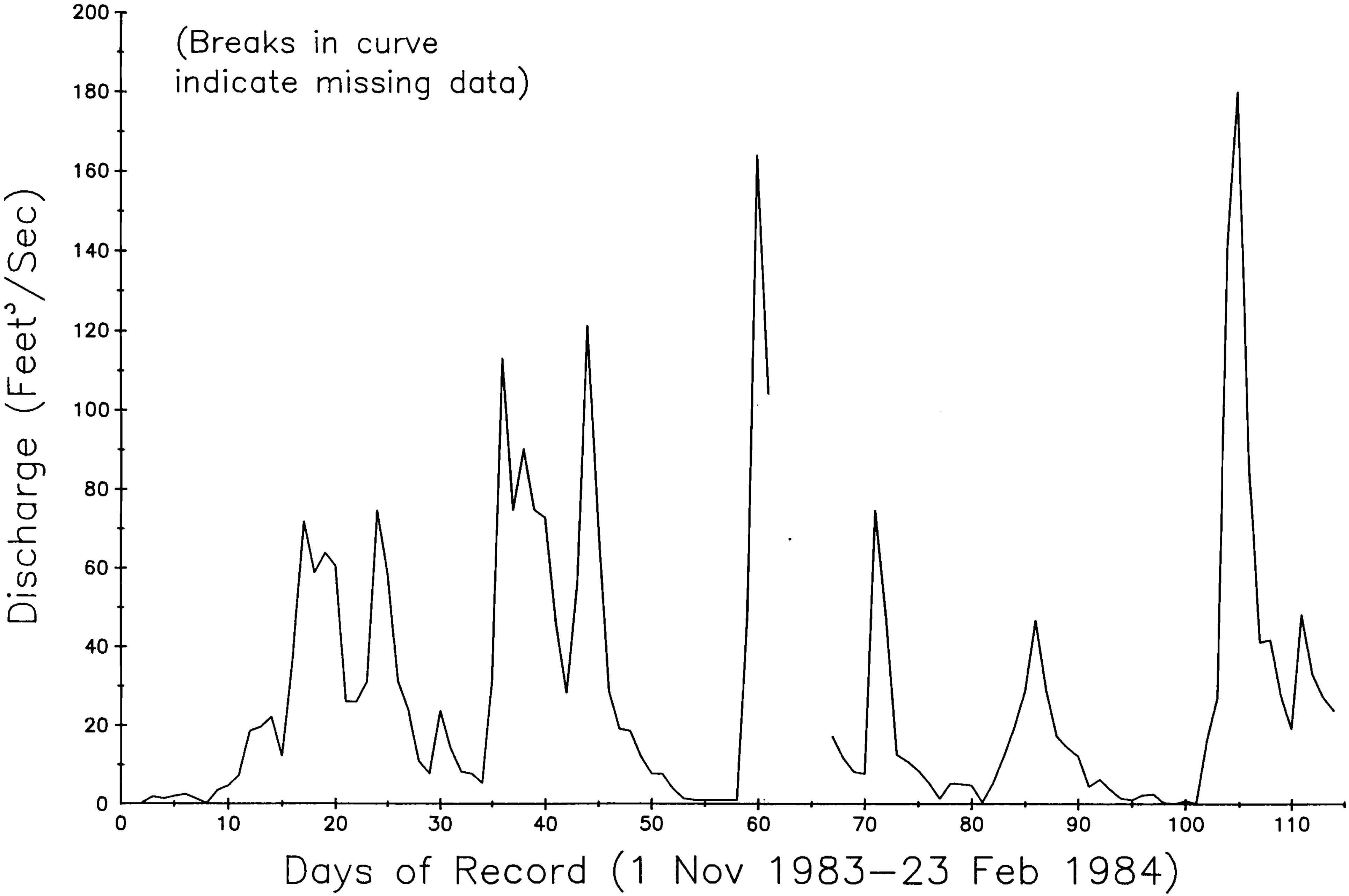

Fig. ⟨6⟩. Hydrograph of Jackson/Frazier Creek.

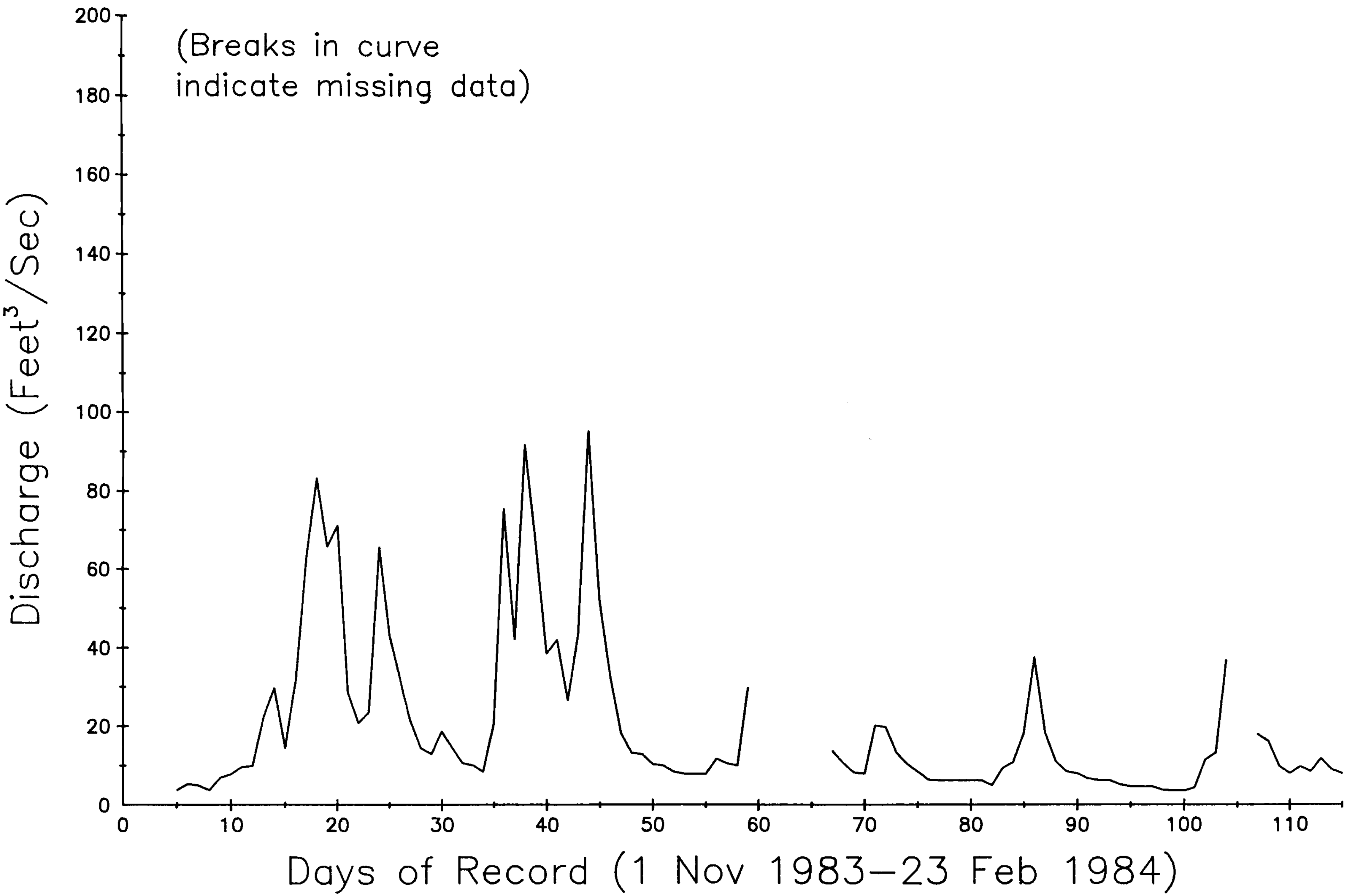

Fig. ⟨7⟩. Hydrograph of the Drainage Ditch.

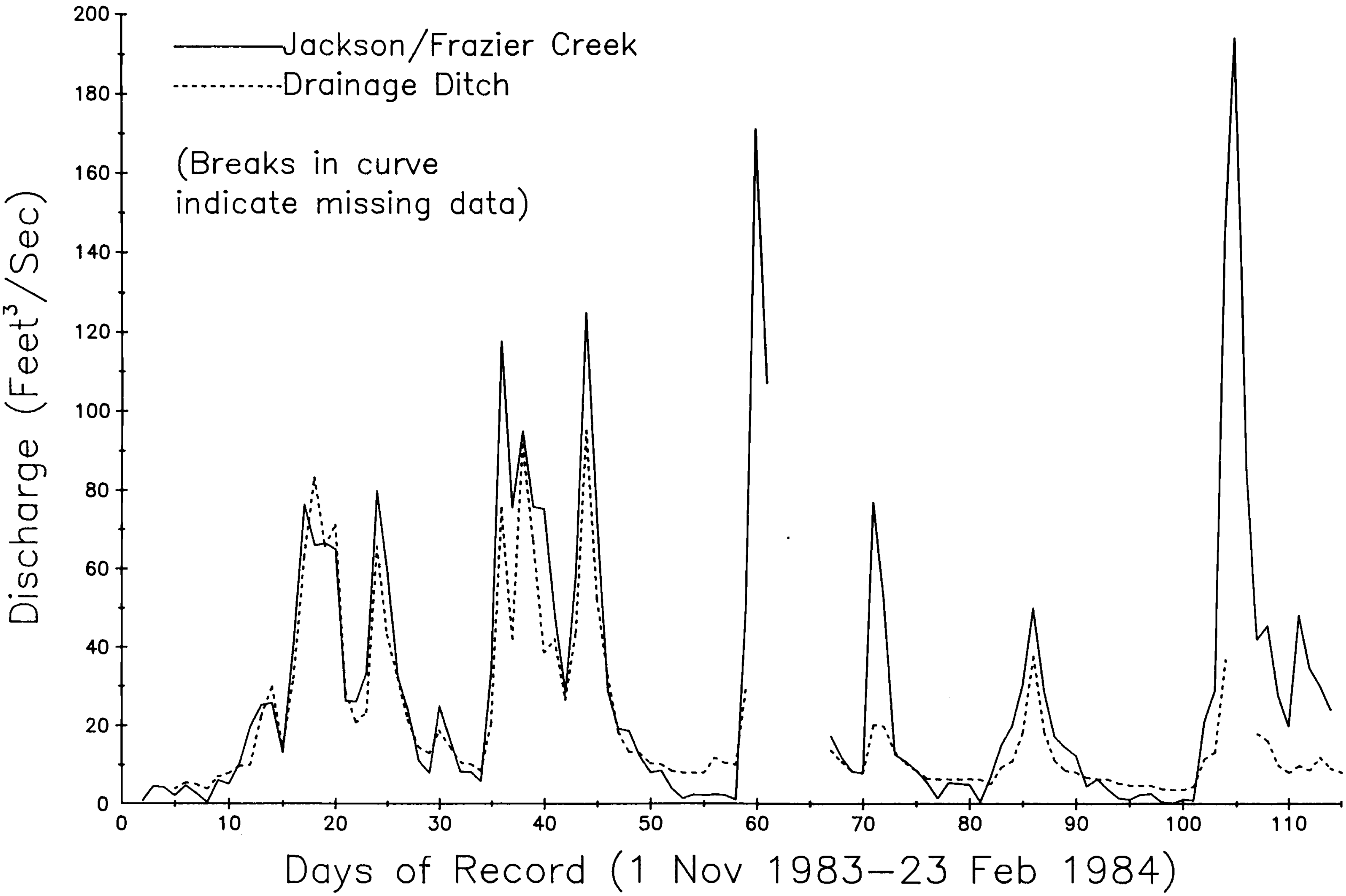

Fig. ⟨8⟩. Composite Hydrograph of the Jackson/Frazier Wetland.

The Rainfall/Runoff Curve

There is a direct relationship between the amount of precipitation falling in a drainage and the amount of water that the main stream discharges. Unfortunately, this is not a simple relationship. Many other factors, such as size of basin, soil, vegetation cover, slope steepness, and amount of evapotranspiration, can influence how directly the rainfall relates to a specific stream. Jackson/Frazier Creek drains a relatively small basin, which decreases the effect of any of the above influencing factors. The drainage ditch essentially drains just the Jackson/Frazier Wetland.

For simplicity, the daily rainfall was plotted against the same day's discharge for each stream. This may be justified because both drainage basins are relatively small and have a relatively quick response time. (Figures 9 and 10).

Inflow/Outflow

The water budget for the the Jackson/Frazier Wetland was broken into two components: 1) the input, which consisted of the water flowing into the wetland from the Jackson/Frazier Creek PLUS the precipitation falling on the wetland area, and 2) the output, which consisted of the water flowing out of the wetland in the drainage ditch. Water losses within the wetland, such as evapotranspiration and

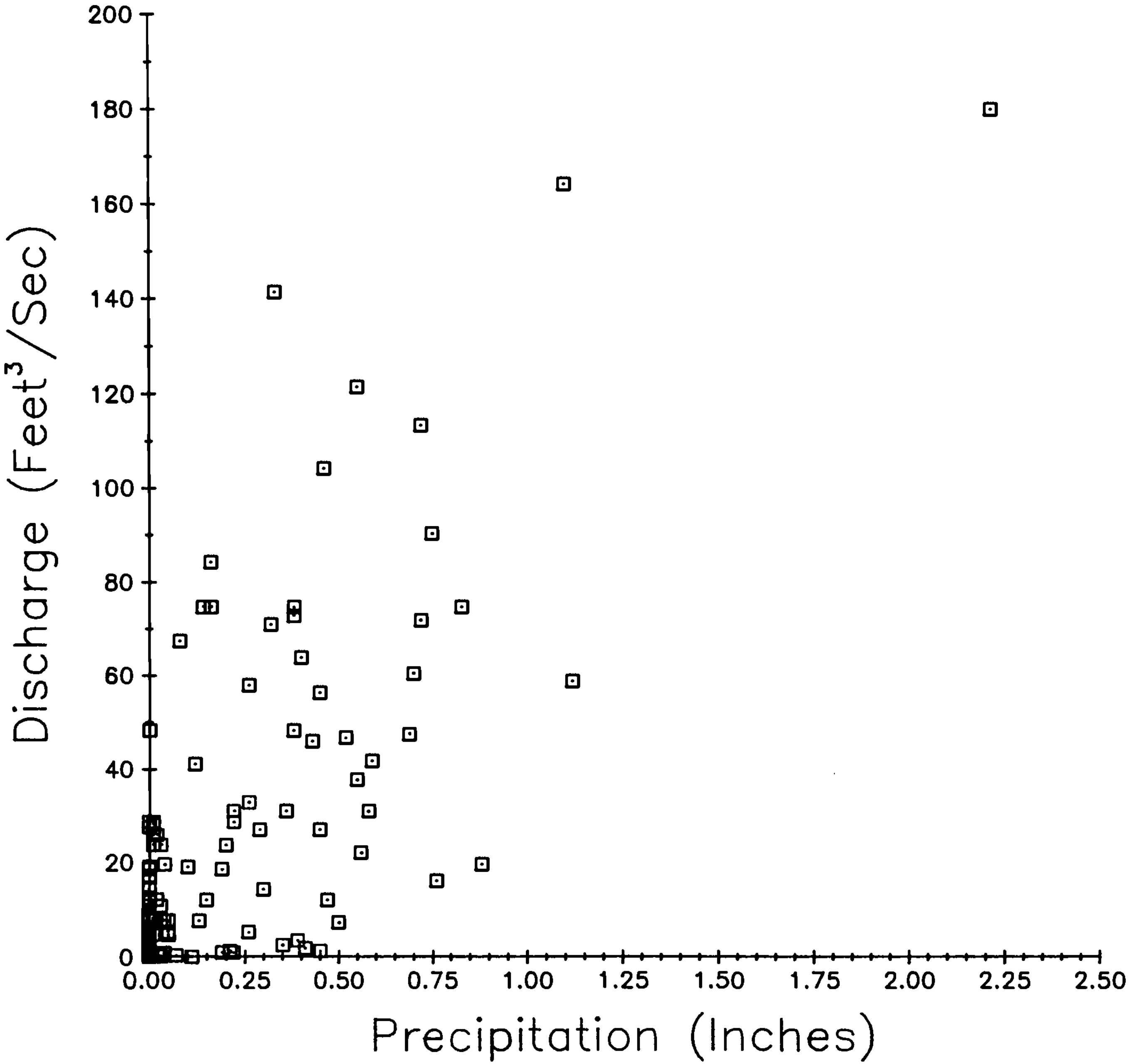

Fig. ⟨9⟩. Rainfall/Runoff Correlation for Jackson/Frazier Creek.

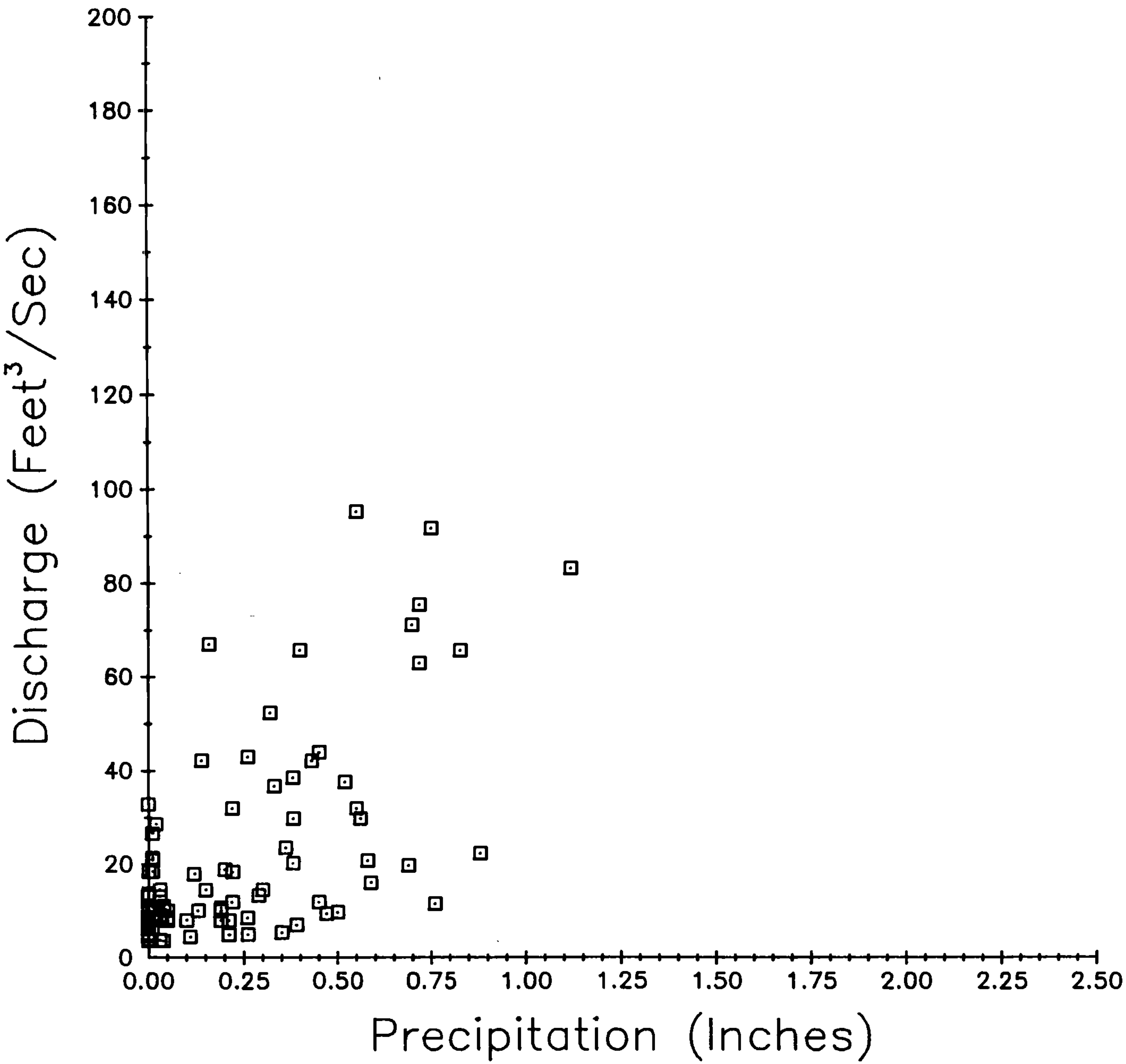

Fig. ⟨10⟩. Rainfall/Runoff Correlation for the Drainage Ditch.

seepage, were assumed to be negligble, because these processes occur very slowly during the winter months. Overland flow, into or out of the wetland, was also ignored as it represents relatively small amounts of runoff and is difficult to measure.

The differences between the wetland's input and output were calculated. The daily precipitation amount for the 151 wetland acres was converted from inches per day to cubic feet per second and then added to the Jackson/Frazier Creek daily discharge. This comprised the daily input for Jackson/Frazier Wetland. The drainage ditch daily discharge was subtracted from the daily input and the resulting value was the daily difference between the input and the output in cfs. A plot was generated to illustrate the input/output differences for the study period (Figure 11).

Storage

Finally, the cumulative water storage for the study period was calculated and plotted (Figure 12). This illustrated the wetland's tendency to store water over longer periods of time.

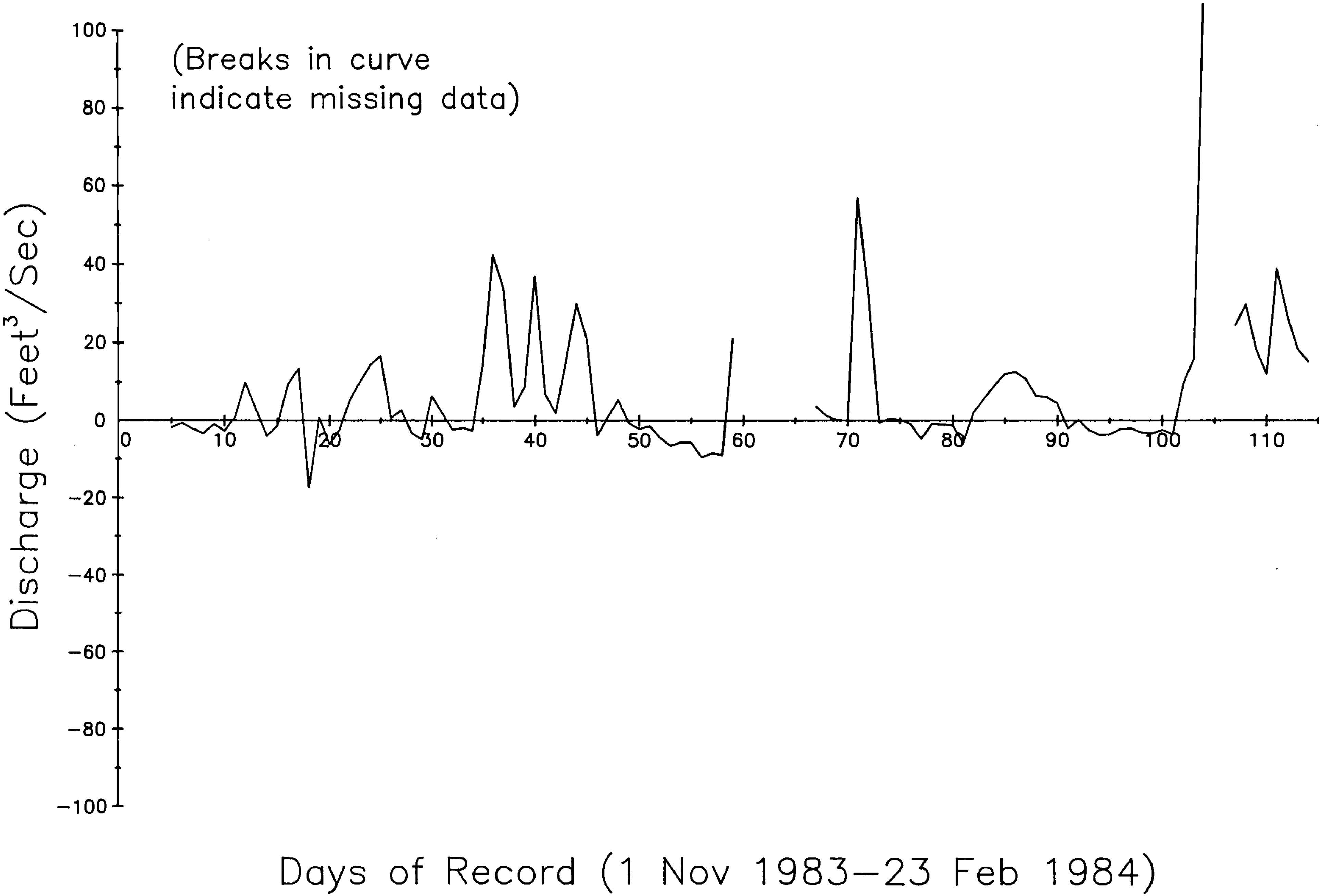

Fig. ⟨11⟩. Hydrograph of the Jackson/Frazier Wetland.

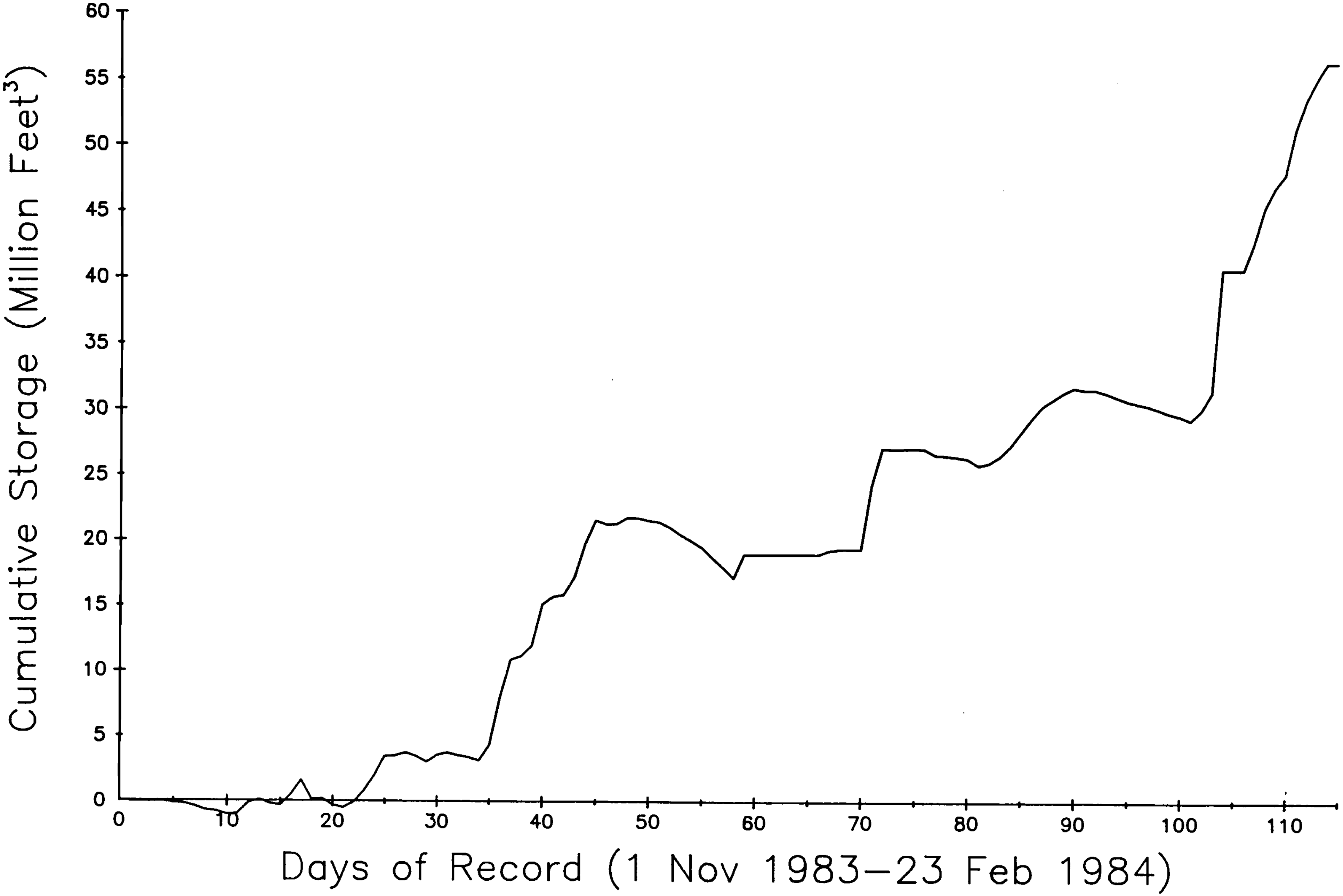

Fig. ⟨12⟩. Cumulative Storage in the Jackson/Frazier Wetland.

RESULTS

In general, the results of gathering and analyzing data from the Jackson/Frazier Wetland proved interesting and useful. Graphically displaying the data was the easiest and most informative method of analysis. Findings concerning velocity, discharge, and hydrologic relationships were gleaned from the analyzed data and graphs.

Velocity

Basically, the rating curves from Jackson/Frazier Creek and the drainage ditch fit the classic text book models. There was a slight variation in Jackson/Frazier Creek's rating curve, though. A standard rating curve usually starts from near zero flow rate and smoothly curves in a concave manner up to higher flow rates. The drainage ditch's curve is a good example of this. Jackson/Frazier Creek's curve, however, was flatter and had only a slight downward turn at the very slowest velocities. This can be explained by field observations and the role that a wetland plays in a drainage basin.

It was observed that, at very slow flow rates in the Jackson/Frazier Creek, the water essentially formed a pool. One hypothesis might be that the measurements were actually taken in a reach of the streambed that was slightly depressed relative to the rest of the stream profile. In conjunction with that hypothesis, it might be that there is an obstacle downstream that would have a damming effect on the stretch just upstream.

The most likely explanation is probably that the wetland itself acts as a "psuedo-dam." Within the Jackson/Frazier drainage basin, the wetland represents an area of very low gradient. The gradient of the stream drops off drastically as it enters the relatively flat wetland. This decreases the energy and velocity of the stream, and essentially acts as a dam does, backing up the water like the tailwater in a reservoir.

Discharge

The discharge results were useful, also. The hydrographs pointed out two characteristics of the Jackson/Frazier Wetland: 1) the ability to speed up or slow down the throughput of water, and 2) the ability to modify peak and base flow fluctuations. Both of these characteristics are common to wetlands.

Often, wetlands are praised for their ability to mitigate floods and/or peak runoff from intense storms by "slowing down" the time it takes water to pass through the wetland.[13] From the composite hydrograph (Figure 8) it was obvious that the Jackson/Frazier Wetland did a better job of this in the beginning of the study period than at the end. The difference in time between when the input discharge peaks for a given storm and when the output discharge peaks for the same storm constitutes the timing factor of the wetland. The peaks and valleys of the output graph are much more delayed from the peaks and valleys of the input graph in the month of November than they are in the month of February. This illustrates how the timing factor for the wetland is greater at the beginning of the rainy season, when the soil is dry, than it is at the middle and/or end of the rainy season, when the soil is saturated.

Another characteristic that the discharge data revealed is the wetland's ability to modify the peak and base flow fluctuations. This is easily seen by comparing the Jackson/Frazier Creek hydrograph (Figure 6) with the drainage ditch hydrograph (Figure 7). Jackson/Frazier Creek has greater relative fluctuations between its storm peaks and base flow valleys than the drainage ditch. This may be attributed to the effect of the wetland slowing down and storing storm runoff, and releasing the water into the drainage ditch in a more uniform manner.

Hydrologic Relationships

Two hydrologic relationships that were studied, rainfall/runoff and inflow/outflow, did not produce the expected results.

The rainfall/runoff curves for both streams that used the same day's precipitation versus the same day's discharge, did not exhibit a strong correlation. Two other correlations were tried for the streams with no better success: 1) the previous day's precipitation versus the present day's discharge, and 2) the sum of the previous day's and present day's precipitation versus the present day's discharge. These other correlations were tried with the assumption that the previous day's precipitation also had an effect on the daily discharge for both streams. Although this may be the general case for documented streams, it could not be shown experimentally for the Jackson/Frazier drainage basin.[14]

The inflow/outflow relationship for the Jackson/Frazier Wetland was not expected to be as unbalanced as it was found to be. The total water input turned out to be 56,304.5 cfs more than the total water output. There are many possible explanations for this, which will be discussed later in this paper.

DISCUSSION

Differences in Input and Output

Theoretically, the wetland's water budget should balance over time, with the input quantity matching fairly closely the output quantity. During the study period of November 1983 to February 1984, the experimental results indicate a net gain of water in Jackson/Frazier Wetland. If this continued throughout the year, from year to year, the wetland would have become a permanent lake years ago. There are several possible explanations for this apparent net water gain: 1) there is an unmeasured water output source, 2) input into the wetland has been overestimated, and/or 3) the wetland tends to have a net gain of water during the winter months and a net loss during the summer months.

An unmeasured output source is a highly likely explanation. Losses to evaporation, vegetation, transpiration, and ground seepage, were considered negligible during these winter months, but may, in fact, play a more important role in the water budget. Further studies would be needed to prove or disprove this assumption. Water may also be escaping the wetland undetected by smaller stream channels and overland flow that only fill during periods of high precipitation. There are no finite boundaries or shorelines in the average wetland, the

Jackson/Frazier Wetland included. Therefore, well-defined stream channels flowing into and out of the wetland are not always the rule. It is fortunate that Jackson/Frazier Wetland has a major input stream and a major output stream. However, small stream channels have been observed around the perimeter of the wetland with and without flowing water. These small streams were few and probably represented less than five cubic feet per day. Overland flow was observed out of the wetland during periods of high precipitation.

Overestimating the amount of water entering the wetland would create the effect of a continuous net gain of water to the wetland. However, this possibility seems unlikely as both sources of input, Jackson/Frazier Creek and precipitation, were carefully gauged. If an incorrect procedure was used in collecting streamflow data from Jackson/Frazier Creek, then the same incorrect procedure was also used in collecting data for the drainage ditch. This would theoretically result in a balanced water budget, but incorrect base data.

The possibility of a net water gain in the winter and a net water loss in the summer is also strong. A traditional function of wetlands in a drainage basin is that of a storage device. Like snow packs in the mountains, winter water has been stored until spring and summer, and released at a slower rate. During the summer months, Jackson/Frazier Wetland was observed to have little or no standing water on it, which would help support this theory.

The seasonal fluctuation of water in the Jackson/Frazier Wetland seems the most logical explanation for the disparity between the winter input and output, although the most probable explanation is an unmeasured output source.

Methodology Improvements

As with any field study, there are usually methods and procedures that could or should have been improved. With this study of Jackson/Frazier Wetland, many improvement ideas became apparent after the data was gathered in the field. Other improvements could have been made had there been more time and more money for equipment. Some of the more noticeable areas in which the data collection was lacking were: 1) more time to collect stream data, 2) more technologically advanced equipment, and 3) supplementary data collected on soil moisture, transpiration rates, and soil permeability.

When dealing with statistical data, usually the longer period of time the data covers, the better. This is especially true of metereological and stream data, as one month, one year, or even one decade, may not be truly representative of the "normal" conditions. Having only four months of stream data for Jackson/Frazier Wetland is probably this study's weakest point. An ideal study would be a continuous record for at least five years (although this would probably be impractical for one person). With that amount of data, it would be easy to determine what the long term water budget for the wetland. Also, predictions concerning flood mitigation, water storage, and the wetland's life span, could made confidently.

"High tech" equipment for measuring and recording data would have made data collection easier, but probably not all that much more accurate. It is documented that for small streams, using a floating object on the surface of the stream is relatively accurate.[15] The cost difference between a pygmy meter and a twig makes the "floating object" method more practical. Of course, the ideal data collection setup would be to have a fixed, continuous recording stream gage at both Jackson/Frazier Creek and the drainage ditch. There would be less chance of missing days of data and it would be possible to generate storm hydrographs from hourly data.

Other parameters, such as the soil moisture, transpiration, and soil permeability, would have been useful in assessing the overall hydrology of the wetland and its basin. This information would have been useful in evaluating the rainfall/runoff correlation. Soil moisture, especially, would have helped in evaluating the basin's pre-existing conditions for specific storms and would have made predicting the runoff from the storm more precisely. Unfortunately, the equipment needed to measure these "less obvious" parameters is more expensive than string and wooden stakes.

CONCLUSION

From the data collected over the short period of time, it was obvious that the Jackson/Frazier Wetland does function as a hydrologic system. The quantity of water flowing out of the wetland at the drainage ditch was shown to be directly related to the quantity of water entering the wetland through precipitation and Jackson/Frazier Creek, although the timing was not necessarily immediate. This exemplifies the storm peak flow modification properties of wetlands. The net gain of water to the Jackson/Frazier Wetland during the four study months illustrates the water storage capacity of the wetland. Whether this water is released later during the spring and summer to augment the flow of the drainage ditch is subject to more research.

As a preliminary investigation, this study was successful in collecting basic sreamflow data and determining the simple hydrologic relationships that exist in the Jackson/Frazier Wetland. Further research into this specific wetland would not only benefit local scientists and planners, but would also add to the general database of wetland hydrology.

Appendix A. Collected Data from the Field.

DATE	TIME	JF	DD	
10/31/83	1000	4'08"	0'09"	
11/01/83	1030	4'09"	0'09"	
11/02/83	1600	4'07"	0'09"	
11/03/83	1100	4'09"	0'10"	
11/04/83	1400	4'09"	1'08"	
11/05/83	1200	4'09"	1'06"	
11/06/83	1300	4'09"	1'08"	
11/07/83	1430	4'08"	1'07"	
11/08/83	1330	4'07"	1'06"	
11/09/83	1200	4'10"	1'09"	
11/10/83	1300	4'10"	1'09"	
11/11/83	1030	4'11"	1'10"	
11/12/83	1430	5'03"	1'10"	
11/13/83	1500	5'02"	2'03"	
11/14/83	1000	5'03"	2'03"	
11/15/83	1130	5'00"	1'11"	
11/16/83	1100	5'07"	2'04"	
11/17/83	1430	6'00"	2'08"	
11/18/83	1330	5'08"	2'09"	
11/19/83	1100	5'10"	2'07"	
11/20/83	1400	5'09"	2'08"	
11/21/83	1030	5'03"	2'02"	
11/22/83	1430	5'04"	2'01"	
11/23/83	1330	5'05"	2'02"	
11/24/83	1030	6'00"	2'08"	
11/25/83	0730	5'09"	2'05"	
11/26/83	1230	5'04"	2'03"	
11/27/83	1230	5'03"	2'01"	
11/28/83	1430	4'11"	1'11"	
11/29/83	1130	4'11"	1'11"	
11/30/83	1200	5'04"	2'01"	
12/01/83	1430	5'00"	1'11"	
12/02/83	1200	4'11"	1'10"	
12/03/83	1200	4'11"	1'10"	
12/04/83	1230	4'10"	1'09"	
12/05/83	1130	5'06"	2'02"	
12/06/83	1100	6'05"	2'09"	
12/07/83	1200	5'10"	2'04"	
12/08/83	1400	6'02"	2'11"	
12/09/83	1530	5'10"	2'06"	
12/10/83	1030	5'11"	2'04"	
12/11/83	1400	5'06"	2'05"	
12/12/83	1030	5'04"	2'02"	
12/13/83	1430	5'10"	2'06"	
12/14/83	1500	6'07"	2'11"	
12/15/83	1130	5'09"	2'05"	
12/16/83	1400	5'03"	2'03"	
12/17/83	1200	5'02"	2'00"	
12/18/83	1300	5'02"	1'11"	
12/19/83	1130	5'00"	1'11"	
12/20/83	1000	4'11"	1'10"	
12/21/83	1430	4'11"	1'10"	
12/22/83	1430	4'09"	1'09"	ICE COVERED
12/23/83	1500	4'08"	1'09"	FROZEN, ICE COVERED

12/24/83	1000	4'08"	1'09"	FROZEN
12/25/83	1600	4'08"	1'09"	FROZEN
12/26/83	1100	4'08"	1'11"	
12/27/83	1200	4'08"	1'10"	
12/28/83	1100	4'08"	1'10"	
12/29/83	1630	6'00"	2'05"	
12/30/83	1430	7'00"*	NR	*ESTIMATE, DD HAD BROKEN STICK
12/31/83	1300	6'00"	NR	
01/01/84	NR	NR	NR	
01/02/84	1330	5'10"	NR	
01/03/84	NR	NR	NR	
01/04/84	NR	NR	NR	
01/05/84	NR	NR	NR	
01/06/84	1500	5'01"	1'11"	
01/07/84	1230	5'00"	1'10"	
01/08/84	1200	4'11"	1'09"	
01/09/84	1530	4'11"	1'09"	
01/10/84	1600	6'05"	2'03"	
01/11/84	1500	5'03"	2'00"	
01/12/84	1100	5'00"	1'11"	
01/13/84	1100	5'00"	1'10"	
01/14/84	1630	4'11"	1'09"	
01/15/84	1130	4'10"	1'08"	PARTIALLY FROZEN (DD)
01/16/84	1100	4'08"	1'08"	FROZEN (DD)
01/17/84	1600	4'11"	1'08"	" "
01/18/84	1030	4'10"	1'08"	" "
01/19/84	1600	4'10"	1'08"	PARTIALLY FROZEN (DD)
01/20/84	1200	4'07"	1'08"	FROZEN (DD)
01/21/84	1300	4'11"	1'07"	
01/22/84	1700	5'01"	1'11"	
01/23/84	1600	5'03"	1'10"	
01/24/84	1630	5'05"	2'02"	
01/25/84	1400	5'08"	2'05"	
01/26/84	1430	5'03"	1'11"	
01/27/84	1600	5'01"	1'10"	
01/28/84	1400	5'01"	1'09"	
01/29/84	1630	5'00"	1'09"	
01/30/84	1400	4'09"	1'08"	
01/31/84	1400	4'11"	1'08"	
02/01/84	1400	4'09"	1'08"	
02/02/84	1600	4'08"	1'07"	
02/03/84	1030	4'08"	1'07"	
02/04/84	1200	4'09"	1'07"	
02/05/84	0900	4'09"	1'07"	
02/06/84	1130	4'07"	1'06"	
02/07/84	1100	4'07"	1'06"	
02/08/84	1030	4'08"	1'06"	
02/09/84	1030	4'07"	1'07"	
02/10/84	1630	5'04"	2'00"	
02/11/84	1030	5'04"	1'11"	
02/12/84	1200	6'09"	2'05"	
02/13/84	1430	6'10"	NR	NO STAKES
02/14/84	1600	5'08"	NR	" "
02/15/84	1600	5'06"	2'00"	
02/16/84	1100	5'07"	2'00"	
02/17/84	1530	5'03"	1'09"	
02/18/84	1200	5'02"	1'09"	
02/19/84	1330	5'09"	1'10"	
02/20/84	1330	5'04"	1'09"	
02/21/84	1130	5'04"	1'11"	

02/22/84	1500	5'03"	1'09"	
02/23/84	1400	NR	1'09"	NO POLE

KEY

DATE = date of collected data
REC = number of record
TEMP, HI & LO = daily temperature, high and low, in degrees Fahrenheit
JF STAGE = daily stage reading in feet and inches for Jackson/Frazier Creek
DD STAGE = daily stage reading in feet and inches for the drainage ditch
PRCIP = daily precipitation in inches
SNOW = daily snow accumulation in inches
AD JF STAGE = stage reading adjusted to 8 am for Jackson/Frazier Creek in tenths of feet
AD DD STAGE = stage reading adjusted to 8 am for the drainage ditch in tenths of feet
JF XSEC = daily cross-sectional area of Jackson/Frazier Creek in square feet
DD XSEC = daily cross-sectional area of the drainage ditch in square feet
JF VLCTY = daily velocity of Jackson /Frazier Creek in feet per second
DD VLCTY = daily velocity of the drainage ditch in feet per second
JF CFS = daily flow of Jackson/Frazier Creek in cubic feet per second
PRCIP CFS = daily flow equivalent of the precipitaion and snow in cubic feet per second
DD CFS = daily flow of the drainage ditch in cubic feet per second
NET CFS = the difference between total wetland input (JF CFS + PRCIP CFS) and output (DD CFS) in cubic feet per second
STORAGE = cumulative storage of the Jackson/Frazier Wetland in cubic feet per second

Values of -999.99 or -9.999 represent no records and/or calculations available.

RAW DATA

DATE	REC	TEMP HI	TEMP LO	TIME	JF STAGE	DD STAGE	PRCIP	SNOW	AD JF STAGE	AD DD STAGE	JF XSEC	DD XSEC	JF VLCTY	DD VLCTY	JF CFS	PRCIP CFS	DD CFS	NET CFS	STORAGE
831101	001	57	48	1030	04 09	00 00	.230	.000	-9.99	-9.99	-999.99	-999.99	-9.999	-9.999	-999.99	1.46	-999.99	-999.99	.0
831102	002	60	52	1600	04 07	00 00	.070	.000	4.63	-9.99	118.93	-999.99	.004	-9.999	.44	.44	-999.99	-999.99	.0
831103	003	61	54	1100	04 09	00 00	.410	.000	4.72	-9.99	122.82	-999.99	.015	-9.999	1.90	2.60	-999.99	-999.99	.0
831104	004	62	45	1400	04 08	01 08	.450	.000	4.69	-9.99	121.52	-999.99	.011	-9.999	1.32	2.86	-999.99	-999.99	.0
831105	005	59	38	1200	04 09	01 06	.001	.000	4.73	1.53	123.25	20.15	.017	.193	2.11	.01	3.89	-1.77	-152.6
831106	006	53	42	1300	04 09	01 08	.350	.000	4.75	1.63	124.12	21.84	.021	.248	2.57	2.22	5.43	-.64	-207.6
831107	007	55	41	1430	04 08	01 07	.210	.000	4.69	1.60	121.52	21.33	.011	.231	1.32	1.33	4.92	-2.27	-403.7
831108	008	54	32	1330	04 07	01 06	.030	.000	4.60	1.52	117.64	19.98	.001	.188	.17	.19	3.75	-3.40	-697.1
831109	009	46	34	1200	04 10	01 09	.390	.000	4.79	1.71	125.87	23.23	.029	.301	3.59	2.47	6.99	-.93	-777.3
831110	010	59	45	1300	04 10	01 09	.050	.000	4.83	1.75	127.63	23.93	.037	.330	4.74	.32	7.90	-2.84	-1022.9
831111	011	58	46	1030	04 11	01 10	.500	.000	4.91	1.82	131.18	25.17	.056	.386	7.40	3.17	9.72	.85	-949.8
831112	012	57	44	1430	05 03	01 10	.190	.000	5.17	1.83	142.97	25.35	.130	.395	18.63	1.21	10.01	9.83	-100.8
831113	013	54	42	1500	05 02	02 03	.880	.000	5.19	2.13	143.89	30.82	.136	.725	19.63	5.58	22.33	2.88	148.4
831114	014	50	43	1000	05 03	02 03	.560	.000	5.24	2.25	146.21	33.10	.152	.902	22.21	3.55	29.86	-4.09	-205.3
831115	015	55	44	1130	05 00	01 11	.150	.000	5.03	1.96	136.57	27.68	.089	.519	12.14	.95	14.38	-1.29	-316.9
831116	016	58	48	1100	05 07	02 04	.550	.000	5.51	2.28	159.16	33.67	.238	.951	37.95	3.49	32.03	9.41	496.5
831117	017	54	45	1430	06 00	02 08	.720	.000	5.90	2.59	196.00	39.79	.367	1.584	71.94	4.57	63.03	13.48	1661.4
831118	018	50	43	1330	05 08	02 09	1.120	.000	5.75	2.73	185.30	42.59	.317	1.955	58.81	7.11	83.27	-17.36	161.3
831119	019	52	43	1100	05 10	02 07	.400	.000	5.81	2.61	189.56	40.19	.337	1.633	63.92	2.54	65.65	.81	231.3
831120	020	53	38	1400	05 09	02 08	.700	.000	5.77	2.65	186.71	40.99	.324	1.736	60.49	4.44	71.15	-6.23	-306.6
831121	021	45	38	1030	05 03	02 02	.020	.000	5.31	2.23	149.49	32.71	.174	.870	26.01	.13	28.47	-2.34	-508.7
831122	022	49	39	1430	05 04	02 01	.010	.000	5.31	2.10	149.49	30.26	.174	.685	26.01	.06	20.72	5.36	-45.9
831123	023	44	40	1330	05 05	02 02	.360	.000	5.40	2.15	153.76	31.20	.203	.752	31.18	2.28	23.47	10.00	817.8
831124	024	57	43	1030	06 00	02 08	.830	.000	5.93	2.61	198.17	40.19	.377	1.633	74.71	5.27	65.65	14.33	2055.7
831125	025	50	38	0730	05 09	02 05	.260	.000	5.74	2.41	184.59	36.20	.314	1.187	57.97	1.65	42.99	16.63	3492.8

831126	026	48	38	1230	05	04	02	03	.220	.000	5.40	2.28	153.76	33.67	.203	.951	31.18	1.40	32.03	.55	3540.1
831127	027	50	41	1230	05	03	02	01	.010	.000	5.27	2.11	147.61	30.45	.161	.698	23.81	.06	21.25	2.63	3767.6
831128	028	53	44	1430	04	11	01	11	.030	.000	5.00	1.96	135.21	27.68	.080	.519	10.87	.19	14.38	-3.32	3481.1
831129	029	53	34	1130	04	11	01	11	.030	.000	4.92	1.92	131.62	26.96	.059	.478	7.76	.19	12.90	-4.95	3053.4
831130	030	45	34	1200	05	04	02	01	.200	.000	5.27	2.06	147.61	29.52	.161	.634	23.81	1.27	18.71	6.37	3603.9
831201	031	39	33	1430	05	00	01	11	.300	.000	5.08	1.96	138.84	27.68	.103	.519	14.34	1.90	14.38	1.87	3765.4
831202	032	42	35	1200	04	11	01	10	.010	.000	4.93	1.85	132.07	25.70	.062	.412	8.13	.06	10.60	-2.41	3557.3
831203	033	50	38	1200	04	11	01	10	.050	.000	4.92	1.83	131.62	25.35	.059	.395	7.76	.32	10.01	-1.93	3390.3
831204	034	44	31	1230	04	10	01	09	.050	.000	4.85	1.77	128.51	24.28	.042	.345	5.36	.32	8.39	-2.71	3156.2
831205	035	45	34	1130	05	06	02	02	.580	.000	5.40	2.10	153.76	30.26	.203	.685	31.18	3.68	20.72	14.14	4378.2
831206	036	48	36	1100	06	05	02	09	.720	.000	6.30	2.68	226.56	41.59	.500	1.816	113.30	4.57	75.52	42.34	8036.7
831207	037	43	39	1200	05	10	02	04	.140	.000	5.93	2.40	198.17	36.01	.377	1.168	74.71	.89	42.05	33.54	10934.8
831208	038	48	39	1400	06	02	02	11	.750	.000	6.09	2.78	210.08	43.59	.430	2.102	90.37	4.76	91.64	3.48	11235.9
831209	039	51	41	1530	05	10	02	06	.160	.000	5.93	2.62	198.17	40.39	.377	1.659	74.71	1.02	66.99	8.73	11990.4
831210	040	52	41	1030	05	11	02	04	.380	.000	5.91	2.36	196.73	35.22	.370	1.092	72.86	2.41	38.46	36.81	15171.2
831211	041	52	39	1400	05	06	02	05	.430	.000	5.59	2.40	174.12	36.01	.265	1.168	46.08	2.73	42.05	6.75	15754.6
831212	042	46	33	1030	05	04	02	02	.010	.000	5.35	2.20	151.37	32.14	.187	.825	28.26	.06	26.50	1.83	15912.3
831213	043	48	43	1430	05	10	02	06	.450	.000	5.72	2.42	183.18	36.40	.307	1.207	56.32	2.86	43.94	15.23	17227.9
831214	044	52	46	1500	06	07	02	11	.550	.000	6.37	2.80	232.19	43.99	.523	2.164	121.53	3.49	95.18	29.84	19806.0
831215	045	48	38	1130	05	09	02	05	.320	.000	5.89	2.50	195.28	37.99	.364	1.375	71.03	2.03	52.24	20.82	21605.0
831216	046	47	35	1400	05	03	02	03	.000	.000	5.36	2.29	151.85	33.86	.190	.968	28.84	.00	32.78	-3.94	21264.8
831217	047	39	31	1200	05	02	02	00	.001	.000	5.18	2.05	143.43	29.33	.133	.622	19.13	.01	18.23	.90	21342.6
831218	048	40	32	1300	05	02	01	11	.000	.000	5.17	1.93	142.97	27.14	.130	.488	18.63	.00	13.26	5.37	21806.9
831219	049	38	33	1130	05	00	01	11	.001	.000	5.03	1.92	136.57	26.96	.089	.478	12.14	.01	12.90	-.75	21741.7
831220	050	42	28	1000	04	11	01	10	.040	.001	4.92	1.84	131.62	25.53	.059	.403	7.76	.25	10.30	-2.29	21543.9
831221	051	30	16	1430	04	11	01	10	.010	1.200	4.92	1.83	131.62	25.35	.059	.395	7.76	.83	10.01	-1.43	21420.7
831222	052	23	15	1430	04	09	01	09	.000	.000	4.80	1.77	126.31	24.28	.031	.345	3.87	.00	8.39	-4.52	21029.9
831223	053	21	11	1500	04	08	01	09	.001	.001	4.69	1.75	121.52	23.93	.011	.330	1.32	.01	7.90	-6.57	20461.8
831224	054	25	11	1000	04	08	01	09	.010	2.000	4.67	1.75	120.65	23.93	.008	.330	.98	1.33	7.90	-5.59	19979.2
831225	055	27	15	1600	04	08	01	09	.040	1.500	4.67	1.75	120.65	23.93	.008	.330	.98	1.21	7.90	-5.71	19485.6
831226	056	33	24	1100	04	08	01	11	.220	.001	4.67	1.89	120.65	26.42	.008	.449	.98	1.40	11.87	-9.49	18665.7
831227	057	38	26	1200	04	08	01	10	.190	.000	4.67	1.85	120.65	25.70	.008	.412	.98	1.21	10.60	-8.41	17939.2
831228	058	35	26	1100	04	08	01	10	.000	.000	4.67	1.83	120.65	25.35	.008	.395	.98	.00	10.01	-9.03	17159.4
831229	059	33	29	1630	06	00	02	05	.380	.000	5.62	2.25	176.20	33.10	.274	.902	48.36	2.41	29.86	20.91	18966.4
831230	060	36	31	1430	07	00	00	00	1.100	.000	6.70	-9.99	259.25	-999.99	.633	-9.999	164.20	6.98	-999.99	-999.99	18966.4
831231	061	46	34	1300	06	00	00	00	.460	.000	6.22	-9.99	220.18	-999.99	.473	-9.999	104.24	2.92	-999.99	-999.99	18966.4
840101	062	50	33	0000	00	00	00	00	.020	.000	-9.99	-9.99	-999.99	-999.99	-9.999	-9.999	-999.99	.13	-999.99	-999.99	18966.4
840102	063	41	33	1330	05	10	00	00	.080	.000	5.85	-9.99	192.41	-999.99	.350	-9.999	67.43	.51	-999.99	-999.99	18966.4
840103	064	51	39	0000	00	00	00	00	.520	.000	-9.99	-9.99	-999.99	-999.99	-9.999	-9.999	-999.99	3.30	-999.99	-999.99	18966.4
840104	065	60	47	0000	00	00	00	00	.010	.000	-9.99	-9.99	-999.99	-999.99	-9.999	-9.999	-999.99	.06	-999.99	-999.99	18966.4
840105	066	63	47	0000	00	00	00	00	.000	.000	-9.99	-9.99	-999.99	-999.99	-9.999	-9.999	-999.99	.00	-999.99	-999.99	18966.4
840106	067	54	48	1500	05	01	01	11	.000	.000	5.14	1.94	141.59	27.32	.121	.499	17.16	.00	13.62	3.54	19272.0
840107	068	51	43	1230	05	00	01	10	.001	.000	5.02	1.85	136.12	25.70	.086	.412	11.71	.01	10.60	1.12	19368.7
840108	069	53	36	1200	04	11	01	09	.010	.000	4.93	1.76	132.07	24.11	.062	.338	8.13	.06	8.14	.05	19372.6
840109	070	49	38	1530	04	11	01	09	.001	.000	4.92	1.75	131.62	23.93	.059	.330	7.76	.01	7.90	-.14	19360.8
840110	071	45	40	1600	06	05	02	03	.380	.000	5.93	2.09	198.17	30.07	.377	.672	74.71	2.41	20.20	56.93	24279.1
840111	072	48	40	1500	05	03	02	00	.690	.000	5.61	2.08	175.50	29.89	.271	.659	47.60	4.38	19.69	32.28	27068.0
840112	073	50	40	1100	05	00	01	11	.000	.000	5.04	1.93	137.02	27.14	.092	.488	12.57	.00	13.26	-.69	27008.6
840113	074	43	33	1100	05	00	01	10	.000	.000	5.00	1.84	135.21	25.53	.080	.403	10.87	.00	10.30	.57	27058.1
840114	075	47	31	1630	04	11	01	09	.000	.000	4.94	1.77	132.52	24.28	.064	.345	8.50	.00	8.39	.11	27067.8
840115	076	43	28	1130	04	10	01	08	.000	.000	4.85	1.68	128.51	22.71	.042	.280	5.36	.00	6.37	-1.01	26980.8
840116	077	40	21	1100	04	08	01	08	.000	.000	4.69	1.67	121.52	22.53	.011	.274	1.32	.00	6.17	-4.85	26561.8
840117	078	39	21	1600	04	11	01	08	.000	.000	4.85	1.67	128.51	22.53	.042	.274	5.36	.00	6.17	-.81	26492.1
840118	079	40	23	1030	04	10	01	08	.000	.000	4.84	1.67	128.07	22.53	.039	.274	5.05	.00	6.17	-1.12	26395.2
840119	080	36	23	1600	04	10	01	08	.010	.001	4.83	1.67	127.63	22.53	.037	.274	4.74	.06	6.17	-1.36	26277.3
840120	081	40	23	1200	04	07	01	08	.000	.000	4.63	1.67	118.93	22.53	.004	.274	.44	.00	6.17	-5.72	25782.8
840121	082	34	24	1300	04	11	01	07	.260	.001	4.85	1.60	128.51	21.33	.042	.231	5.36	1.65	4.92	2.09	25963.4
840122	083	49	32	1700	05	01	01	11	.470	.000	5.03	1.81	136.57	24.99	.089	.378	12.14	2.98	9.44	5.68	26453.9
840123	084	52	43	1600	05	03	01	10	.040	.000	5.19	1.86	143.89	25.88	.136	.421	19.63	.25	10.90	8.98	27229.9
840124	085	52	42	1630	05	05	02	02	.220	.000	5.36	2.05	151.85	29.33	.190	.622	28.84	1.40	18.23	12.00	28266.9

840125	086	58	49	1400	05	08	02	05	.520	.000	5.60	2.35	174.81	35.03	.268	1.074	46.83	3.30	37.61	12.53	29349.3
840126	087	52	36	1430	05	03	01	11	.010	.000	5.36	2.05	151.85	29.33	.190	.622	28.84	.06	18.23	10.67	30271.2
840127	088	48	34	1600	05	01	01	10	.000	.000	5.14	1.86	141.59	25.88	.121	.421	17.16	.00	10.90	6.26	30811.6
840128	089	55	35	1400	05	01	01	09	.000	.000	5.08	1.77	138.84	24.28	.103	.345	14.34	.00	8.39	5.96	31326.3
840129	090	53	36	1630	05	00	01	09	.020	.000	5.03	1.75	136.57	23.93	.089	.330	12.14	.13	7.90	4.36	31703.2
840130	091	56	40	1400	04	09	01	08	.000	.000	4.82	1.69	127.19	22.88	.035	.287	4.44	.00	6.57	-2.13	31519.3
840131	092	57	29	1400	04	11	01	08	.000	.000	4.88	1.67	129.84	22.53	.049	.274	6.35	.00	6.17	.18	31534.7
840201	093	50	29	1400	04	09	01	08	.000	.000	4.79	1.67	125.87	22.53	.029	.274	3.59	.00	6.17	-2.58	31311.9
840202	094	51	29	1600	04	08	01	07	.000	.000	4.69	1.61	121.52	21.50	.011	.237	1.32	.00	5.08	-3.77	30986.5
840203	095	52	30	1030	04	08	01	07	.000	.000	4.67	1.58	120.65	20.99	.008	.219	.98	.00	4.60	-3.62	30673.5
840204	096	52	28	1200	04	09	01	07	.000	.000	4.74	1.58	123.69	20.99	.019	.219	2.34	.00	4.60	-2.27	30477.7
840205	097	60	29	0900	04	09	01	07	.000	.000	4.75	1.58	124.12	20.99	.021	.219	2.57	.00	4.60	-2.03	30301.9
840206	098	55	31	1130	04	07	01	06	.030	.000	4.61	1.51	118.07	19.81	.002	.183	.25	.19	3.63	-3.19	30026.6
840207	099	62	35	1100	04	07	01	06	.000	.000	4.58	1.50	116.78	19.65	.000	.178	.05	.00	3.50	-3.45	29728.5
840208	100	49	39	1030	04	08	01	06	.040	.000	4.66	1.50	120.22	19.65	.007	.178	.83	.25	3.50	-2.42	29519.6
840209	101	61	42	1030	04	07	01	07	.110	.000	4.59	1.57	117.21	20.82	.001	.214	.10	.70	4.45	-3.65	29204.2
840210	102	47	37	1630	05	04	02	00	.760	.000	5.12	1.88	140.67	26.24	.115	.440	16.20	4.82	11.54	9.49	30023.7
840211	103	48	39	1030	05	04	01	11	.290	.000	5.33	1.93	150.43	27.14	.180	.488	27.13	1.84	13.26	15.71	31381.4
840212	104	52	42	1200	06	09	02	05	.330	.000	6.53	2.34	245.20	34.83	.577	1.055	141.41	2.09	36.76	106.74	40603.8
840213	105	55	46	1430	06	10	00	00	2.220	.000	6.81	-9.99	268.51	-999.99	.670	-9.999	179.90	14.08	-999.99	-999.99	40603.8
840214	106	50	35	1600	05	08	00	00	.160	.000	6.03	-9.99	205.55	-999.99	.410	-9.999	84.32	1.02	-999.99	-999.99	40603.8
840215	107	47	37	1600	05	06	02	00	.120	.000	5.56	2.04	161.67	29.15	.255	.610	41.19	.76	17.77	24.18	42693.3
840216	108	53	38	1100	05	07	02	00	.590	.000	5.57	2.00	162.18	28.41	.258	.563	41.85	3.74	16.00	29.60	45250.4
840217	109	49	30	1530	05	03	01	09	.000	.000	5.34	1.82	150.90	25.17	.184	.386	27.69	.00	9.72	17.97	46803.3
840218	110	52	31	1200	05	02	01	09	.100	.000	5.18	1.75	143.43	23.93	.133	.330	19.13	.63	7.90	11.86	47828.2
840219	111	55	41	1330	05	09	01	10	.001	.000	5.62	1.82	176.20	25.17	.274	.386	48.36	.01	9.72	38.65	51167.5
840220	112	53	43	1330	05	04	01	09	.260	.000	5.43	1.77	155.22	24.28	.212	.345	32.98	1.65	8.39	26.24	53434.5
840221	113	53	39	1130	05	04	01	11	.450	.000	5.33	1.89	150.43	26.42	.180	.449	27.13	2.86	11.87	18.12	54999.8
840222	114	50	32	1500	05	03	01	09	.030	.000	5.27	1.79	147.61	24.64	.161	.361	23.81	.19	8.90	15.10	56304.5
840223	115	45	35	1400	00	00	01	09	.050	.000	-9.99	1.75	-999.99	23.93	-9.999	.330	-999.99	.32	7.90	-999.99	56304.5

Appendix C. Time Adjustment Program for Stage Readings.
(Written in BASIC for an IBM PC.)

```
'
'    This program standardizes stream stage readings to 8:00 am.
'

PRINT "This program standardizes stream stage readings to 8:00 am."
PRINT
PRINT
'
'     Inputs the stage height reading from the day before and
'     converts it to feet and tenths of feet.
'
INPUT "Enter the first day's stage height reading (FT,IN):";S2,S3
IF S3>=12 THEN 100 ELSE 130
   PRINT
   PRINT "The 'INCHES' entry is greater than 12. Please reenter."
   GOTO 80
S0=S2+S3/12
PRINT
'
'     Inputs the time of the stage reading of the day before
'     in military time and converts it to hours and tenths of
'     hours.
'
INPUT "Enter the time of the first stage reading (in military time):"T0
IF T0>=2400 THEN 220 ELSE 240
   PRINT "The 'TIME' entry is greater than 2400. Please reenter."
   GOTO 200
X2=T0*0.01
X3=X2-INT(X2)
X4=X3*100
IF X4>=60 THEN 280 ELSE 300
   PRINT "Invalid entry. Please reenter."
   GOTO 200
T0=X4/60+INT(X2)
PRINT
'
'     Inputs the stage height reading from the day after and
'     converts it to feet and tenths of feet.
'
INPUT "Enter the second day's stage height reading (FT,IN):"S4,S5
IF S5>=12 THEN 380 ELSE 410
   PRINT
   PRINT "The 'INCHES' entry is greater than 12. Please reenter."
   GOTO 360
S1=S4+S5/12
PRINT
'
'     Inputs the time of the stage reading of the day after
'     in military time and converts it to hours and tenths of
'     hours.
'
INPUT "Enter the time of the second stage reading (in military time):";T1
IF T1>=2400 THEN 500 ELSE 520
```

```
   PRINT "The 'TIME' entry is greater than 2400. Please reenter."
   GOTO 480
Y2=T1*0.01
Y3=Y2-INT(Y2)
Y4=Y3*100
IF Y4>=60 THEN 560 ELSE 580
   PRINT "Invalid entry. Please reenter."
   GOTO 480
T1=Y4/60+INT(Y2)
'
'     Interpolates the stage height reading for 8:00 am on the
'     day after using a ratio and reconverts the feet and
'     tenths of feet back to feet and inches.
'
B=S0-(S0-S1)*((24-T0)+8)/((24-T0)+T1)
B1=INT(B)
B2=(B-B1)*12
B3=INT(B2+0.5)
IF B3=12 THEN B1=B1+1
IF B3=12 THEN B3=0
PRINT
PRINT
PRINT
'
'     Prints the output and asks for more input.
'
PRINT "The depth at 8:00 am was";B1"feet and";B3"inches."
PRINT
PRINT
PRINT
INPUT "Do you want to enter more data (Y or N):"Q$
IF Q$="Y" GOTO 30
END
```

Appendix D. Cross-sectional Area Program for Varying Stream Stages. (Written in BASIC for an IBM PC.) This program is for the drainage ditch. The program for Jackson/Frazier Creek is similar except for the DATA statement.

```
00010 PRINT "This program calculates the cross-sectional area of"
00020 PRINT "the Drainage Ditch based on its stage height."
00030 PRINT
00040 PRINT
00050 PRINT
00060 PRINT
00070 PRINT
00080 PRINT
00090 DIM D(10)
00100 DATA 3.33,3.92,4.75,5.50,5.58,5.67,5.92,5.92,5.83,5.50,4.08
00110 N=10
00120 W=2
00130 FOR I=0 TO N
00140    READ D(I)
00150 NEXT I
00160 INPUT "Enter the stage height reading (FT,IN):";S1,S2
00170 S=S2/12+S1
00180 D1=D(8)-S
00190 A=0
00200 FOR I=0 TO N-1
00210    IF D(I)>D(I+1) GOTO 250
00220    D2=D(I+1)
00230    D3=D(I)
00240    GOTO 270
00250    D2=D(I)
00260    D3=D(I+1)
00270    IF D1>=D2 GOTO 320
00280    IF D1<=D3 GOTO 310
00290    A=A+.5*W*((D2-D1)/(D2-D3))*(D2-D1)
00300    GOTO 320
00310    A=A+W*(D3-D1)+.5*W*(D2-D3)
00320 NEXT I
00330 PRINT
00340 PRINT "The cross-sectional area is";A"square feet."
00350 PRINT
00360 A=(12*2.54/100)^2*A
00370 PRINT "The cross-sectional area is";A"square meters."
00380 PRINT
00390 PRINT
00400 RESTORE
00410 INPUT "Do you want to enter more data (Y or N)";Q$
00420 IF Q$="Y" GOTO 30
00430 END
```

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