STATE OF NEBRASKA
DEPARTMENT OF WATER RESOURCES

APPLICATION FOR A PERMIT TO APPROPRIATE WATER FOR INSTREAM FLOWS

STRUCTIONS	For Department Use Only
Complete Items 1 through 5 by typing the appropriate information and by placing an (X) in the appropriate box. The following information must accompany this form and is made a part of this application: A. Copy of any studies completed to quantify the instream flow. B. List of persons and their addresses who testified at public hearings held by the applicant. C. U.S. Geological Survey Topographic Quadrangle map(s) marked to show the location of the stream reach.	Filed in the office of the Department of Water Resources at 11:00 a.m./~~p.m.~~ on July 25, 1990. Application No. A-17004 Water Division 1-A

1. Name and address of applicant: Central Platte Natural Resources District
215 North Kaufman Avenue, Grand Island, Nebraska
Zip code 68803 Telephone No. (308) 381-5825

2. Identify the stream: Platte River - J-2 Return to Columbus

3. A permit is sought for the purpose of providing flows for:
[X] Fish & Wildlife [ ] Recreation

4. Describe below the quantity of water necessary to provide adequate instream flows, and the time of year when instream flows are most critical.

Beginning Month/Day	Ending Month/Day	Quantity cfs.
January 1	June 23	500
June 24	August 22	600
August 23	December 31	500

5. I believe the information contained in this application is true, complete, and accurate.

Date July 25, 1990

[signature], General Manager
Signature & Title

This form must be completed in full. An incomplete or defective application will be returned with 30 days being allowed for resubmission. Failure to resubmit a corrected application within this period shall cause dismissal of the application.

A non-refundable filing fee (payable to the Director of Water Resources) of $10.00 must accompany this application. Forward this application and fee to:

State of Nebraska
Department of Water Resources
301 Centennial Mall South
P.O. Box 94676
Lincoln, Nebraska 68509-4676
(402) 471-2363

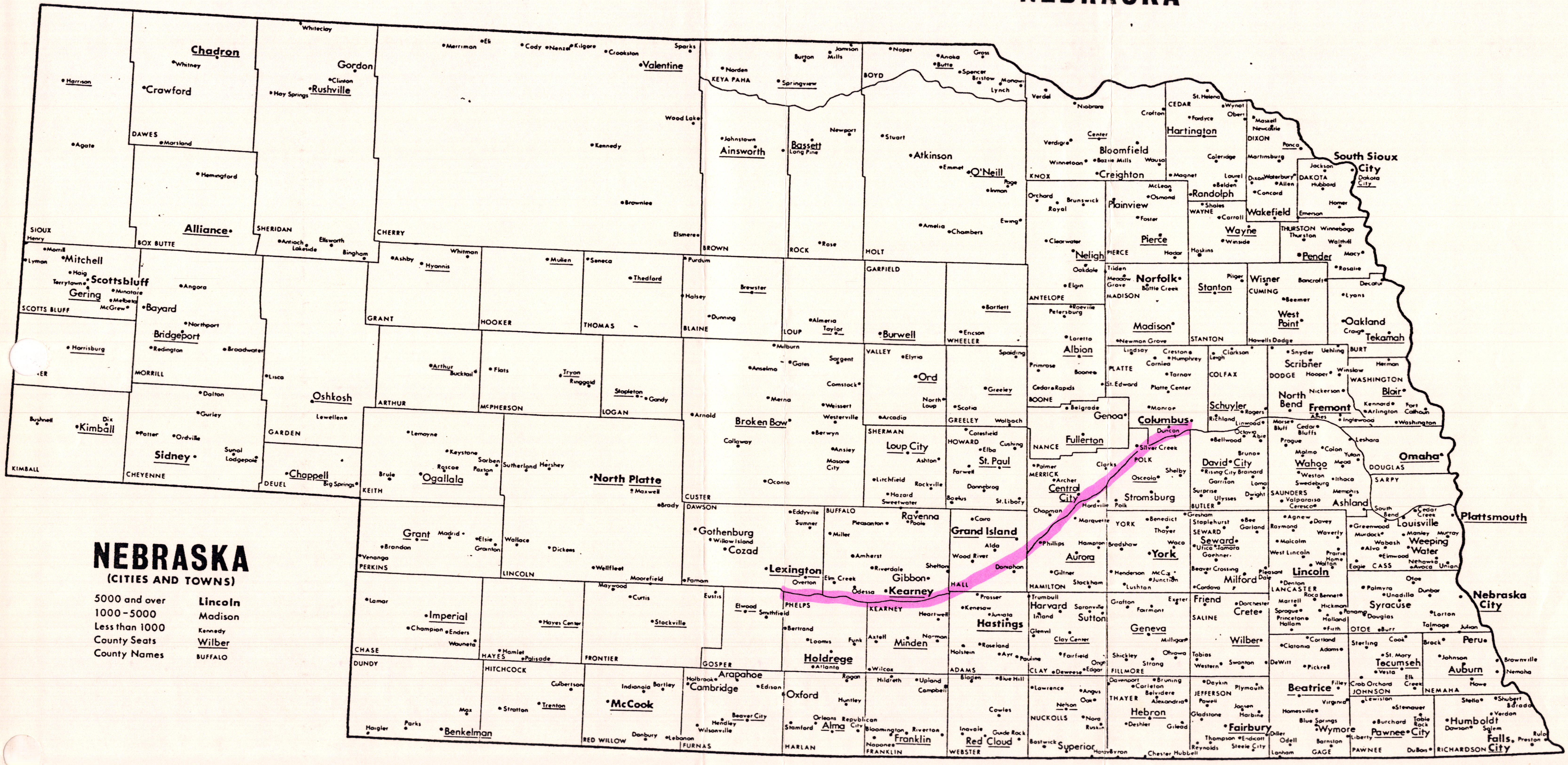
SUPPORTING MATERIALS

Book #1

J-2 Return to Columbus

Forage Fish Maintenance Flow

NEBRASKA



5/29/90

Proposed Instream Flows for Water Right Applications

Time Period	Purpose	Segment	Minimum Flow - C.F.S.
January 1 - June 23	**Forage Fish Maintenance Flow**	**J-2 Return to Columbus**	**500**
January 1 - February 25	Feeding / Bald Eagle	J-2 Wasteway Gate to Wasteway Mouth	750
January 1 - February 25	Feeding / Bald Eagle	J-2 Return to Elm Creek	1100
February 15 - February 28	Wet Meadow / Initiate Biological Activity	J-2 Return to Chapman	1100
March 1 - March 31	Staging / Sandhill Crane	J-2 Return to Chapman	1100
April 1 - April 14	Staging Sandhill / Stopover Whooping Crane	J-2 Return to Grand Island	1300
April 1 - April 14	Staging Sandhill Crane	Grand Island to Chapman	1100
April 15 - May 3	Stopover / Whooping Crane	J-2 Return to Grand Island	1500
June 24 - August 22	**Maintenance / Fish**	**J-2 Return to Columbus**	**600**
August 23 - December 31	**Forage Fish Maintenance Flow**	**J-2 Return to Columbus**	**500**
October 1 - October 11	Stopover / Sandhill Crane & Whooping Crane	J-2 Return to Chapman	1100
October 12 - November 10	Stopover / Whooping Crane	J-2 Return to Grand Island	1500
December 10 - December 31	Feeding / Bald Eagle	J-2 Wasteway Gate to Wasteway Mouth	750
December 10 - December 31	Feeding / Bald Eagle	J-2 Return to Elm Creek	1100

INSTREAM FLOWS
PURPOSE AND DESCRIPTION

Following is a brief description of the timing, purpose and amount of water proposed for the segment:

<u>January 1 - June 23 - Food Source Maintenance for Interior Least Tern and Piping Plover - 500 cfs. (J-2 Return to Columbus)</u>

The purpose of this flow is to maintain adequate habitat for forage fish and aquatic macroinvertebrates which serve as food items for terns and plovers respectively. Least terns feed on the plains killifish, sand shiner, flathead minnows and other small fish species. As part of the ongoing studies of the Platte River by the U. S. Bureau of Reclamation and U. S. Fish and Wildlife Service, a habitat model development workshop was held in July, 1986 to describe the habitat occupied by forage fish in the Platte River. Among the fish species of interest were sand shiner, plains killifish and flathead chub. The workshop participants identified the following as important components of forage fish habitat:

Velocity - the velocity of the water column
Depth - the measure of the water column from the surface to the substrate
Substrate - measure of the wetted channel bottom at a given flow
Cover - consists of four classes
1) no cover
2) bank cover
3) object cover
4) overhead cover
Periodicity - describes the portion of the year when a particular life stage of a species is present.

In April, 1988 a second workshop was held in which certain fish species were selected to represent habitat needs of other similar fish species. The sand shiner was selected to represent the habitat needs of other forage fish species such as the plains killifish and flathead chub. It was believed by species authorities that habitat which can maintain a population of sand shiners could maintain similar species. The sand shiner forage fish model was intended to determine habitat flow needs to sustain an adequate supply of forage fish on which the interior least tern feeds.

The HSI (Habitat Suitability Indices) depth and velocity curves for the spawning, fry, juvenile and adult warm season and adult cold season life stages were developed in the July 1986 workshop (Fannin and Nelson, 1986). The adult cold season curve was modified in the April 1988 workshop. It was agreed upon by the April 1988 workshop participants that HSI curves from a recent fish study on the lower Platte River could be used to update and refine the 1986 curves (Peters et al. 1988). Juvenile and adult depth and velocity warm season curves were derived from this study.

The PHABSIM (Physical Habitat Simulation) analysis was performed for all study sites from Lexington to Chapman. Habitat/flow relationships were developed for all life stages of the sand shiner. Habitat ratios for each life stage were determined by the FWS and NG&PC (Pers. comm. 1988). These ratios were: spawning 0.40; fry 0.16; juveniles 0.29; and adults 1.0.

After habitat ratios were applied, it was determined that available adult warm season habitat was limiting, therefore, further analysis was performed only on this life stage.

The present condition habitat discharge relationship (KWUA) for the 17 study sites was used to display an optimum adult sand shiner warm season flow requirement of 750 cfs. The flow requirement was estimated by using the discharge that produced the amount of habitat for which the maximum KWUA occurs. The maximum adult habitat values and associated discharges for each segment are shown in Table I.

Habitat discharge relationships were developed for the three hydrologic reaches A, B, and C. Maximum habitat values and the associated discharge are shown in Table II.

The range of discharges and associated habitat values for sand shiner for each study site and reach are displayed in Appendix A.

The computations previously described provide weighted usable area values in thousands (KWUA) for each discharge simulated at a study site. These values were then adjusted to represent KWUA per river reach (KWUA/reach).

Table I. Sand Shiner Maximum Habitat Discharge Relationship for all Study Sites

Study Site	Maximum KWUA	Discharge (cfs)
2	3,717	800
3	10,824	700
4A	4,164	550
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9BE	10,230	1300
9BW	10,015	850
10	3,404	1750
11	9,599	400
12A	19,625	400
12B	8,171	700
River total	123,477	Average 750

Table II. Sand Shiner Maximum Habitat Discharge Relationship for the Hydrologic Reaches

Reach	Maximum KWUA	Discharge (cfs)
A	14,501	800
B	40,997	550
C	70,082	850
A, B & C	123,477	750

A composite of all study sites indicated that the single flow that maximized habitat for the entire study area was 750 cfs.

A flow of greater than 750 cfs reduces available forage fish habitat (as does a lesser flow) and therefore the instream flows requested for bald eagle food source maintenance (1100 cfs), for roosting and staging habitat for sandhill crane (1100 cfs), for stopover habitat for whooping crane during sandhill crane roosting and staging (1300 cfs), and for stopover habitat for whooping crane (1500 cfs) are all flows that reduce the amount of habitat available when compared to the habitat maximizing flow of 750 cfs and they become a control on the amount of available habitat in any year.

The instream flow of 1500 cfs requested from April 15 - May 3 and from October 12 - November 10 for stopover habitat for whooping crane provides 109,316 KWUA of forage fish habitat (Appendix A), 88.5 percent of the 123,477 KWUA provided at the maximizing flow of 750 cfs.

An instream flow of 450 cfs provides approximately the same KWUA (109,382) of forage fish habitat as the 1500 cfs requested each spring and fall. A flow rate of 500 cfs is proposed as the flow necessary to maintain adequate forage fish for the interior least tern. Five hundred cfs provides approximately 92 percent (Appendix A) of the habitat that would be provided at the maximizing flow of 750 cfs.

INSTREAM FLOWS
PURPOSE AND DESCRIPTION

Following is a brief description of the timing, purpose and amount of water proposed for the segment:

<u>June 24 - August 22 - Food Source Maintenance for Interior Least Tern and Piping Plover - 600 cfs. (J-2 Return to Columbus)</u>

The purpose of this flow is to maintain adequate habitat for forage fish and aquatic macroinvertebrates which serve as food items for terns and plovers respectively. Least terns feed on the plains killifish, sand shiner, flathead minnows and other small fish species. As part of the ongoing studies of the Platte River by the U. S. Bureau of Reclamation and U. S. Fish and Wildlife Service, a habitat model development workshop was held in July, 1986 to describe the habitat occupied by forage fish in the Platte River. Among the fish species of interest were sand shiner, plains killifish and flathead chub. The workshop participants identified the following as important components of forage fish habitat:

Velocity - the velocity of the water column
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4) overhead cover
Periodicity - describes the portion of the year when a particular life stage of a species is present.

In April, 1988 a second workshop was held in which certain fish species were selected to represent habitat needs of other similar fish species. The sand shiner was selected to represent the habitat needs of other forage fish species such as the plains killifish and flathead chub. It was believed by species authorities that habitat which can maintain a population of sand shiners could maintain similar species. The sand shiner forage fish model was intended to determine habitat flow needs to sustain an adequate supply of forage fish on which the interior least tern feeds.

The HSI (Habitat Suitability Indices) depth and velocity curves for the spawning, fry, juvenile and adult warm season and adult cold season life stages were developed in the July 1986 workshop (Fannin and Nelson, 1986). The adult cold season curve was modified in the April 1988 workshop. It was agreed upon by the April 1988 workshop participants that HSI curves from a recent fish study on the lower Platte River could be used to update and refine the 1986 curves (Peters et al. 1988). Juvenile and adult depth and velocity warm season curves were derived from this study.

The PHABSIM (Physical Habitat Simulation) analysis was performed for all study sites from Lexington to Chapman. Habitat/flow relationships were developed for all life stages of the sand shiner.

Habitat ratios for each life stage were determined by the FWS and NG&PC (Pers. comm. 1988). These ratios were: spawning 0.40; fry 0.16; juveniles 0.29; and adults 1.0.

After habitat ratios were applied, it was determined that available adult warm season habitat was limiting, therefore, further analysis was performed only on this life stage.

The present condition habitat discharge relationship (KWUA) for the 17 study sites was used to display an optimum adult sand shiner warm season flow requirement of 750 cfs. The flow requirement was estimated by using the discharge that produced the amount of habitat for which the maximum KWUA occurs. The maximum adult habitat values and associated discharges for each segment are shown in Table I.

Habitat discharge relationships were developed for the three hydrologic reaches A, B, and C. Maximum habitat values and the associated discharge are shown in Table II.

The range of discharges and associated habitat values for sand shiner for each study site and reach are displayed in Appendix A.

The computations previously described provide weighted usable area values in thousands (KWUA) for each discharge simulated at a study site. These values were then adjusted to represent KWUA per river reach (KWUA/reach).

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An instream flow of 450 cfs provides approximately the same KWUA (109,382) of forage fish habitat as the 1500 cfs requested each spring and fall. There has, however, been documentation of fish kills in the Platte River at flows at or above 500 cfs when temperatures exceed 100 degrees Fahrenheit. Therefore, a flow rate of 600 cfs is proposed as the flow necessary to maintain adequate forage fish for the interior least tern during the time period when temperatures frequently get to 100 degrees Fahrenfeit. Six hundred cfs provides approximately 93 percent (Appendix A) of the habitat that would be provided at the maximizing flow of 750 cfs.

INSTREAM FLOWS
PURPOSE AND DESCRIPTION

Following is a brief description of the timing, purpose and amount of water proposed for the segment:

<u>August 23 - December 31 - Food Source Maintenance for Interior Least Tern and Piping Plover - 500 cfs. (J-2 Return to Columbus)</u>

The purpose of this flow is to maintain adequate habitat for forage fish and aquatic macroinvertebrates which serve as food items for terns and plovers respectively. Least terns feed on the plains killifish, sand shiner, flathead minnows and other small fish species. As part of the ongoing studies of the Platte River by the U. S. Bureau of Reclamation and U. S. Fish and Wildlife Service, a habitat model development workshop was held in July, 1986 to describe the habitat occupied by forage fish in the Platte River. Among the fish species of interest were sand shiner, plains killifish and flathead chub. The workshop participants identified the following as important components of forage fish habitat:

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Habitat Maintenance Flow Regime

Chapter III of the Prairie Bend Biological Assessment dated December 1988

CHAPTER III
HABITAT MAINTENANCE FLOW REGIME

A. Stream Habitat Analysis Using Instream Flow Incremental Methodology

The Bureau employed the Instream Flow Incremental Methodology (IFIM), developed by the U.S. Fish and Wildlife Service (FWS 1982), as part of the Feasability Study for the Prairie Bend Unit. The objective of this IFIM study was to identify instream flow rates required to maintain or optimize habitat for threatened and endangered species on the Big Bend area of the Platte River. To date, IFIM and PHABSIM (Physical Habitat Simulation) have been used to evaluate habitat for two species appearing in this assessment: the whooping crane and sand shiner. The sand shiner represents the forage fish base used by the least tern.

The physical habitat simulation process for the Platte River relates changes in discharge or channel geometry to changes in physical habitat availability. Involved in this process are three major work steps: (1) data collection and preparation at the study sites selected to be representative; (2) calibration of the hydraulic model; and (3) simulation and analysis of available habitat for changes in river discharge.

This process was performed two or more times at 16 study sites. Multiple data sets were collected so hydraulic simulation could be made for a range of flows typically experienced in the Platte River. A total of 46 study site measurements were run through this process.

The hydraulic simulation of a PHABSIM analysis can vary somewhat depending on the type of river system for which it is used (FWS 1978). The braided and multi-branched channels of the Platte River, which have the characteristics of a shifting bed, make it necessary to do a hydraulic simulation using both the WSP (Water Surface Profile) and IFG4 models. The WSP analysis was used to simulate the water surface elevation-discharge relationship for transects within a study for a range of flows that are between 0.4 and 2.5 times the measured discharge. The WSP model is calibrated for each discharge measured at all study sites. The IFG4 model uses the water surface elevation-discharge relationship and the measured velocities to compute the hydraulic parameters necessary to do a habitat analysis. The area that is computed in the hydraulic simulation is the surface area of a representative stream tube. The stream tube is defined by the segmentation of the transects and distance between transects in the study site. The wetted areas for a given flow defines the total-discharge relationship.

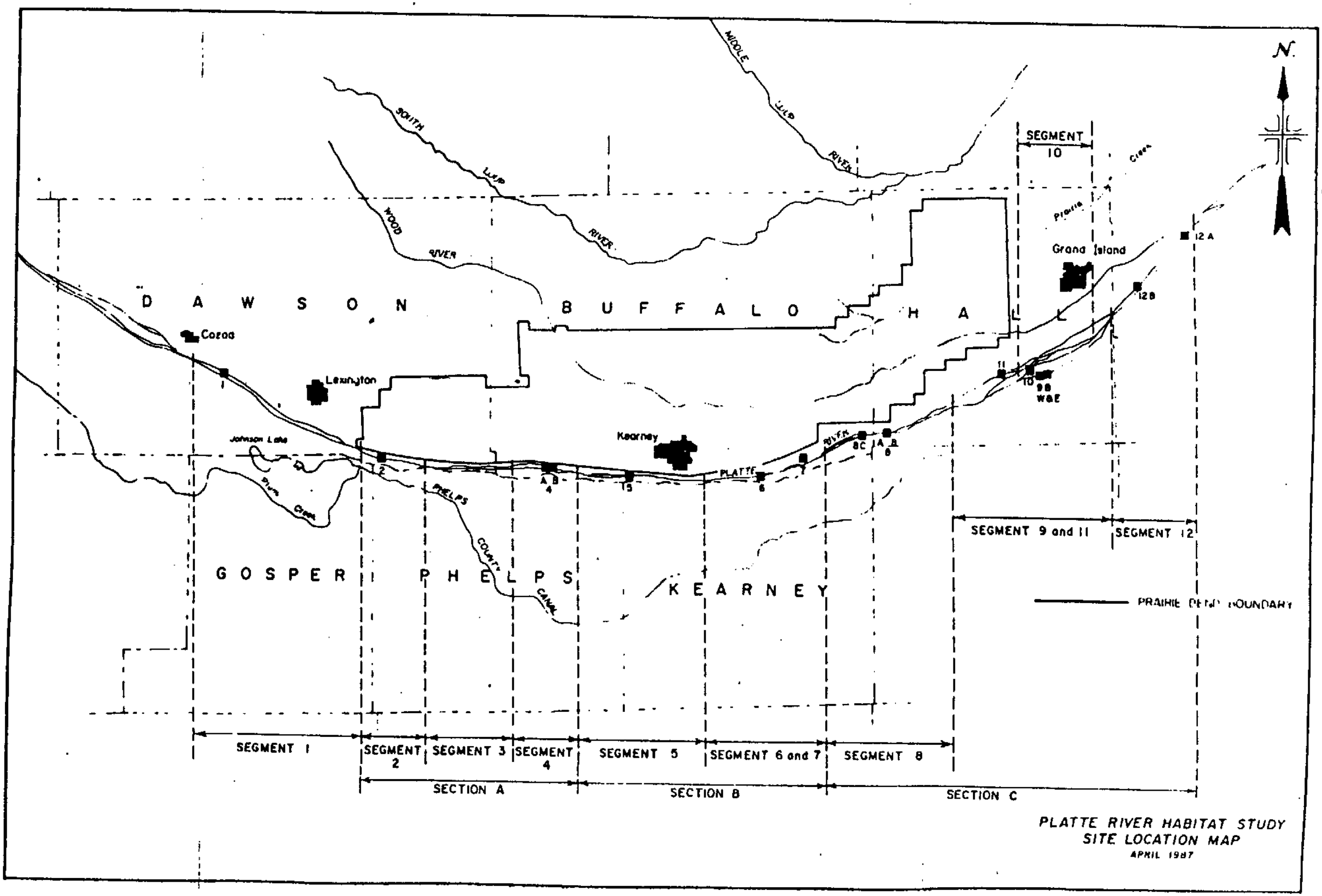
1. Study Area and Site Selection

The study area (Figure III-1) used in this analysis is an 89 mile section of the Platte River, also known as the Big Bend area, between the towns of Lexington and Chapman, Nebraska. A 54 mile segment of the Platte River which is designated critical habitat for the whooping crane lies within the study area (50 C.F.R. 43(94): 20938-20942).

An interagency team comprised of members of the Bureau, FWS and the Nebraska Game and Parks Commission (NGPC) divided the 89 miles of Platte River between Lexington and Chapman into study segments. Representative reaches were established in the river segments and a study site selected for each representative reach. This segmentation accounted for inflows and outflows and for the various differences in channel geometry. The approach to study site selection followed published guidelines (FWS 1982). Occurrence of major island groups and multiple channels were used to distinguish the 12 river segments ultimately identified (Figure III-1). The location of bridges, areas of disturbance and other, non-morphologic, factors were also considered in site selection.

Segment 1, which extends from Cozad to Lexington, is located upstream of both Prairie Bend Unit plans and was not used in the habitat analyses, therefore, 11 of the 12 segments were used in this assessment. A total of 17 study sites were established in the 11 segments from Lexington to Chapman. Because there are multiple channels in several segments, the 116 total miles of river channel represented by the 17 study sites exceed the 89-mile linear distance of the Platte River from Lexington to Chapman in this area. Site 3,

Figure III-1. Map Showing the Location of Study Sites, River Segments, and Hydrologic Sections within the Study Area.



which represented 8.0 miles of river channel, is very similar to the reach of river represented by site 5. The Bureau, FWS and NGPC agreed that river reach 3 could be represented by study site 5, therefore, data was collected only at site 5. The 8.0 miles of reach 3 is included in the 116 total miles which are now represented by 16 study sites.

Three hydrologically distinct sections were also identified within the 89 mile study area. Section A begins at the J-2 power return near Lexington and continues to the Kearney Canal diversion near Elm Creek. Section B begins at the Kearney Canal diversion and continues to the downstream end of Fort Farm Island near Gibbon. The flow in Section B is affected by Kearney Canal diversions. Return flow from the Kearney Canal re-enters the north channel of the Platte several miles west of Gibbon and rejoins the main channel at the lower end of Fort Farm Island. Section C begins at the downstream end of Fort Farm Island and continues through the remaining length of the study area to Chapman. Each section is monitored by a USGS gaging station. River sections A, B, and C are as follows:

River Section		Study Sites	Gage Station
A	Lexington to Kearney Diversion	2-3	Overton
B	Kearney Diversion to Gibbon	4A-7	Odessa
C	Gibbon to Chapman	8A-12B	Grand Island

Collection of hydraulic data at the study sites commenced in the fall of 1984 and continued through June 1986. The number of flow sets collected at any one site varied from two to eight and depended upon accessibility of the site, the range of flows that needed to be simulated, and the desire to monitor possible changes in hydraulic parameters (i.e., Manning's N, stage/discharge relationships, and changes in bed profile). The hydraulic data sets were processed by the Bureau.

Forty-six weighted usable area versus flow relationships were developed for the whooping crane using the physical habitat simulation program developed by Ziewitz (1987), and for the sand shiner using the PHABSIM method established by the Service's National Ecology Research Center. Multiple weighted useable area versus flow curves were averaged to produce a single habitat-discharge relationship at each site. Habitat-discharge curves for each site are assumed to be representative of the segment of river in which the site occurs.

2. Habitat Analysis -- Whooping Crane (model B)

In evaluating the usefulness of an area at a given flow, quantitative habitat suitability criteria for the species in question have to be available or developed. Initial habitat suitability index curves used in the IFIM model were developed in a workshop held in May, 1986, in Grand Island, Nebraska, and facilitated by the National Ecology Research Center, Fort Collins, Colorado.

Individuals representing eleven organizations participated in the May workshop and included: (1) species authorities who had field and research experience in the study of habitats used by migrating whooping cranes; (2) State and Federal resource agencies responsible for the maintenance of whooping crane habitat within the Platte River; (3) individuals who were familiar with the Geographical Information System and hydraulic models being applied to the central Platte River; and (4) representatives of water development interests. The May workshop reviewed sources of available data, identified criteria which influenced whooping crane use of migratory habitat and began to construct suitability curves (Shenk and Armbruster, 1986).

In November, 1986, the Service reconvened species authorities and agency representatives involved in habitat model development to refine suitability criteria for instream roosting, and to construct an operational riverine roosting habitat model. The workshop was facilitated by representatives of the Services's National Ecology Research Center, Ft. Collins, Colorado, with expertise in model construction and in the use of IFIM. The suitability criteria developed in the workshop and applied in the model have been documented by the Service's Grand Island Field Office (1987) and are used in this assessment.

The participants identified four criteria which appear to explain observed use of riverine roosting sites by whooping cranes and are compatible with IFIM. These are: (1) unobstructed channel width, (2) water width, (3) percent water width shallow, and (4) velocity.

Participants in the November, 1986, workshop believed that a relationship between whooping crane roosting suitability and factors associated with velocity was difficult to quantify and further believed that a sound relationship could not now be defined or established for the whooping crane. At this time, velocity has not been incorporated in the habitat analysis of the whooping crane.

The habitat criteria take the form of individual suitability indices with values ranging from 0.0 to 1.0. The whooping crane habitat suitability index curves for the three criteria are shown in Figure III-2. The product of the individual suitability indices and the wetted surface area of the channel at a site were used to derive a variable called WUA (Weighted Usable Area). For the whooping crane, the procedure can be summarized as follows:

WUA = area * SI(UW) * SI(WW) * SI(PWWS) in which
WUA = weighted usable area (for the site)
area = wetted surface area
SI(UW) = suitability index of unobstructed width on a transect perpendicular to the flow
SI(WW) = suitability index of water width within the unobstructed width
SI(PWWS) = suitability index of percent water width shallow

The sum of the WUA Values for all transects at a site is the total WUA for that flow. The total WUA for the study site is adjusted for the total length of a study site so WUA values are expressed per

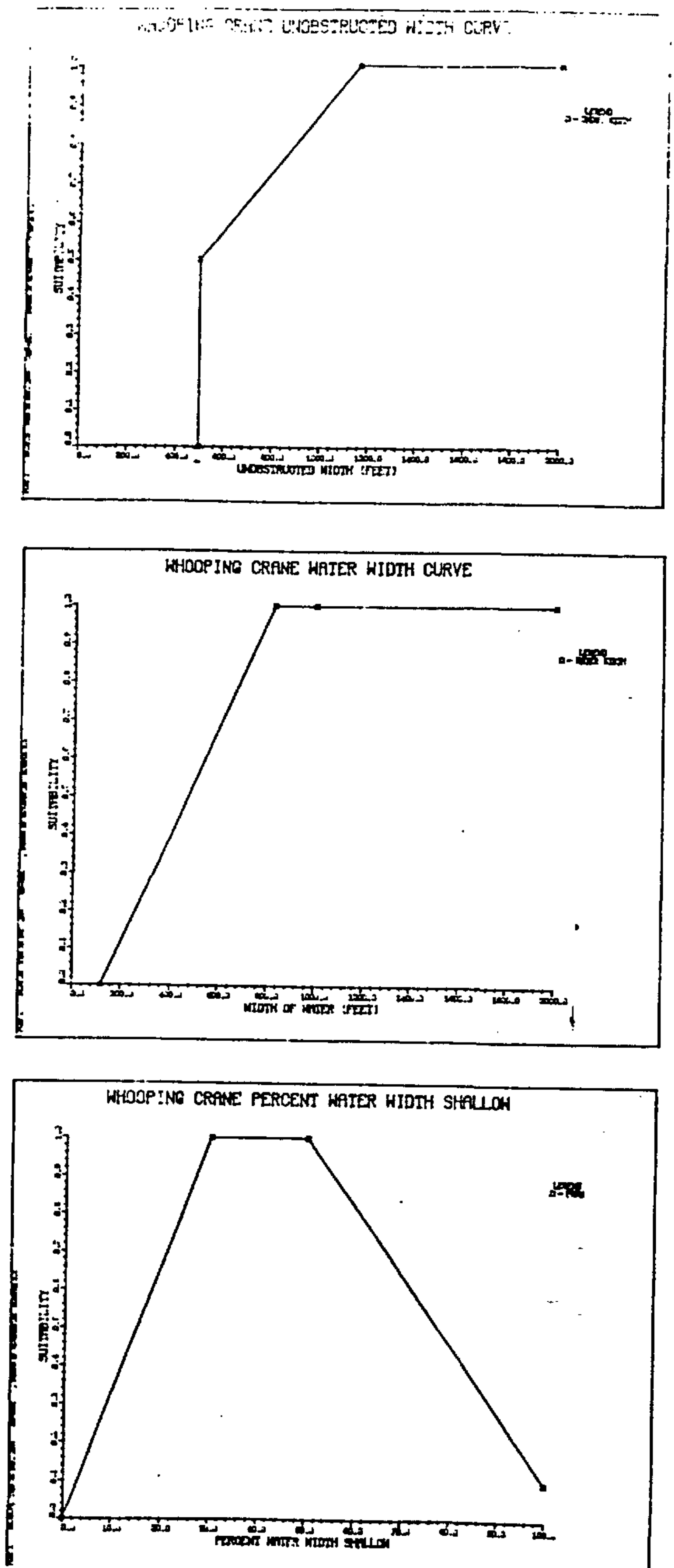


Figure III-2 Habitat Suitability (Preference) Curves for the Endangered

1,000 linear feet of stream. The WUA per river reach was computed by multiplying WUA and representative reach miles and a conversion factor to obtain KWUA (Weighted Usable Area in thousands) per reach.

a. Unobstructed Channel Width

Unobstructed channel width is the distance between visual obstructions less than three feet tall along IFIM transects. The widest unobstructed channel width in which whooping cranes recently were documented to use on the Platte River was 1158 feet (Lingle et al. 1986). The suitability curve for unobstructed width was constructed with a suitability value of 0.0 for channels less than 500 feet wide, a suitability of 0.5 was given to channels with unobstructed widths of 500 feet, and optimum suitability of 1.0 was given to channels with unobstructed widths of 1158 feet or greater. Whooping crane use of channels with unobstructed widths greater than 500 feet is substantiated by general observations made at a number of other riverine roosting sights (Lock pers. comm.).

b. Water Width

Water width is defined as the summation of all wetted widths within the unobstructed width. The suitability curve constructed for this criterion begins at wetted widths of 121 feet, the smallest riverine width in which whooping crane roosting was observed (Johnson unpub. data, presented in Shenk and Armbruster 1986). Optimum suitability of 1.0 is reached when total water width is 826 feet or greater. The greatest water width which whooping cranes recently were documented to use in the Platte River was 826 feet (Lingle et al. 1986).

c. Percent Water Width Shallow

The criterion is defined as the percentage of water width within the unobstructed channel which is less than some specified depth. The May 1986 workshop reviewed and discussed information indicating whooping cranes roost in water ranging in depth from less than one inch to 18 inches (Shenk and Armbruster, 1986). Twenty-five of the 27 depths identified at that workshop occurred at depths of less than eight inches of water; depths less than eight inches were, therefore, selected in the November, 1986, workshop as the range of depths commonly used by whooping cranes.

The optimum "percentage of wetted width shallow" was based on data collected at three whooping crane sightings on the Platte River (Lingle et al. 1984, Currier unpub. data). The average percentage of wetted widths less than eight inches at these sites was computed as 42.9 percent (Ziewitz pers. comm.). An optimal range of 30 to 50 percent shallow was determined to represent these observations. The ascending limb was constructed as a straight line relationship with zero percent of the water width shallow (less than eight inches) given a suitability of zero and thirty percent of the water width shallow given a suitability of 1.0. The descending limb of the suitability curve was structured as a straight line relationship from 50 percent of the total water width shallow at at suitability of 1.0 to 100 percent of total water width shallow given a suitability of 0.1.

The physical habitat simulation program, which interpretes the habitat suitability index curves and the hydraulic portion of the model, was developed by Ziewitz (1987). The mechanics and logic of this computer program were reviewed by the Service's National Ecology Center, Aquatic Systems Modeling Section (Milhous 1987).

d. Summary of Study Results

The PHABSIM analysis was performed for 16 study sites. The results indicated that 8 of the 16 site (representing 37.4 miles of the 116 miles within the study area) met the unobstructed view criterion for whooping cranes. The present condition KWUA discharge relationship for the 8 study sites were used to estimate optimum whooping crane roosting flow requirement of 2000 ft3/sec (cfs). This flow requirement was estimated by using the peak discharge at which the maximum KWUA occurs. Habitat discharge relationships were developed for each of the 8 study segments and the maximum habitat obtained are shown in Table III-1.

Table III-1. Whooping Crane Maximum Habitat Discharge Relationship for 8 Study Sites

Study Site	Maximum KWUA	Discharge (cfs)
2	3,207	1650
4A	2,430	1100
6	11,475	3000
8B	7,760	1600
8C	608	2500
9BE	14,977	2500
9BW	14,026	2000
12A	26,130	1850
River total	76,645	2000

Table III-2. Whooping Crane Maximum Habitat Discharge Relationship for the Hydrologic Reaches and Critical Habitat

Reach	Maximum KWUA	Discharge (cfs)
A	3,207	1650
B	13,187	2500
C	61,817	2000
A & B	16,363	2500
A, B & C	76,645	2000

Habitat discharge relationships were developed for the three hydrologic reaches A, B, and C. Maximum habitat values and the associated discharge is shown in Table III-2.

Whooping crane habitat versus discharge relationship curves are displayed in Appendix B. Also in Appendix B are the range of discharges and associated habitat values for each study site and reach.

3. Habitat Analysis -- Sand Shiner

A model development workshop was held in July 1986 to describe the habitat occupied by game and forage fish in the Platte River. Among the fish species of interest were channel catfish, common carp, sand shiner, plains killifish and flathead chub. Workshop participants identified the following as important components of forage fish habitat:

Velocity - the velocity of the water column

Depth - the measure of the water column from the surface to the substrate

Substrate - measure of the wetted channel bottom at a given flow

Cover - consists of four classes

1) no cover
2) bank cover
3) object cover
4) overhead cover

Periodicity - describes the portion of the year when a particular life stage of a species is present

In April, 1988, a second workshop was held in which certain fish species were selected to represent habitat needs of other similar fish species. The channel catfish was selected to represent the habitat needs of game fish in the Big Bend area. It was believed by species authorities that habitat which can sustain a population of channel catfish will probably maintain other game fish species. This model has not been fully developed and will not be used in this assessment.

The sand shiner was selected to represent the habitat needs of other forage fish species such as the plains killifish and flathead chub. It was believed by species authorities that habitat which can maintain a population of sand shiners could probably maintain similar species. The sand shiner forage fish model was intended to determine habitat flow needs to sustain an adequate supply of forage fish on which the interior least tern feeds.

a. Habitat Suitability Indices

The HSI depth and velocity curves for the spawning, fry, juvenile and adult warm season and adult cold season life stages were developed in the July 1986 workshop (Fannin and Nelson, 1986). The adult cold season curve was modified in the April 1988 workshop. It was agreed upon by the April 1988 workshop participants that HSI curves from a recent fish study on the lower Platte River could be used to update and refine the 1986 curves (Peters et al. 1988). Juvenile and adult depth and velocity warm season curves were derived from this study. The HSI curves are displayed in Figure III-3.

The equation used to derive habitat values is summarized below:

$$WUA = \sum_{n=1}^{\text{total cells}} area * SI(D) * SI(V) * SI(C)$$

WUA = weighted usable area

area = surface area of a cell

SI(D) = suitability index of depth of a cell

SI(V) = suitability index of velocity of a cell

SI(C) = suitability index of cover of a cell

The WUA, area, depth and velocity were used in the same way as previously described. The cover suitability index was developed by using codes for each of the four classes of cover and adjusting the codes for use in the IFIM.

Figure III-3. Habitat Suitability (Preference) Curves for the Sand Shiner in Central Nebraska

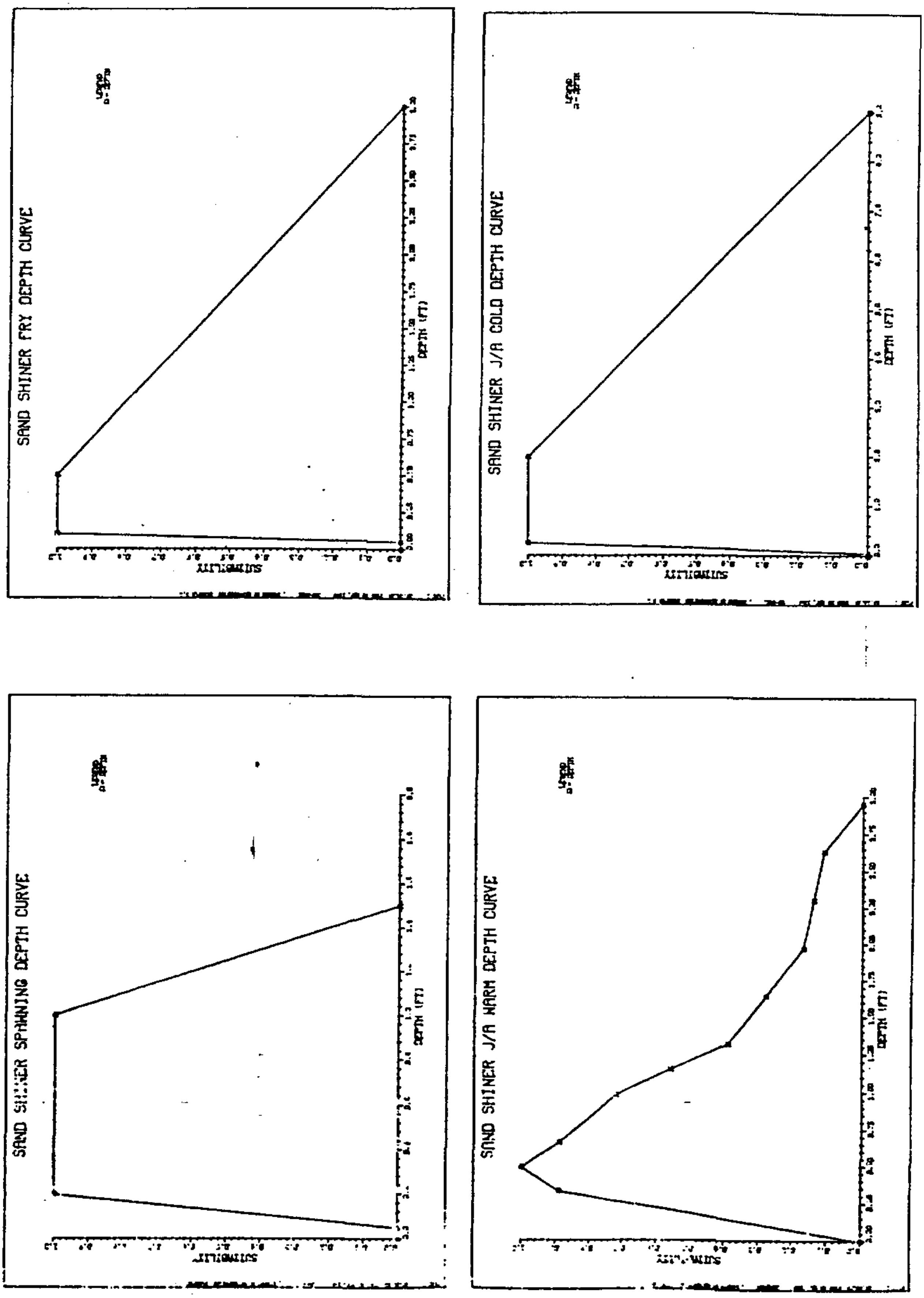
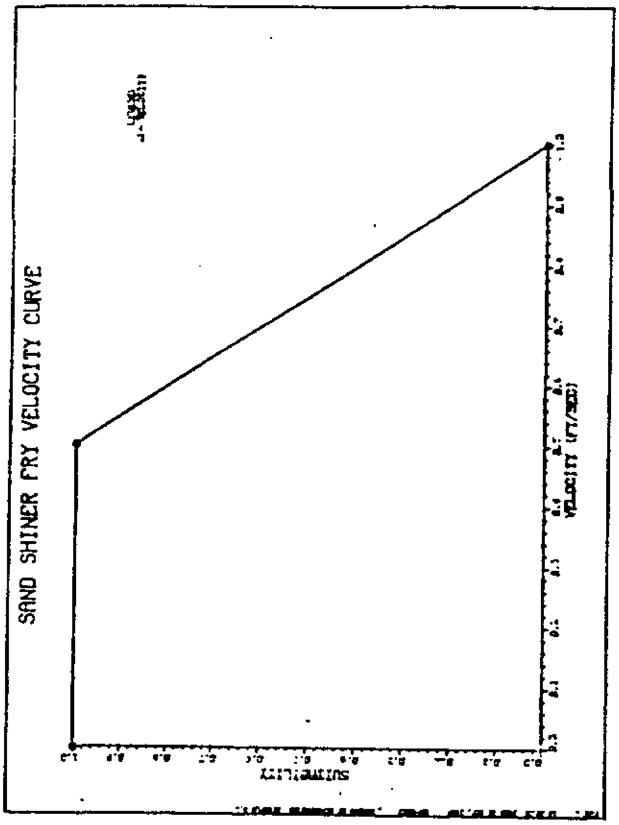
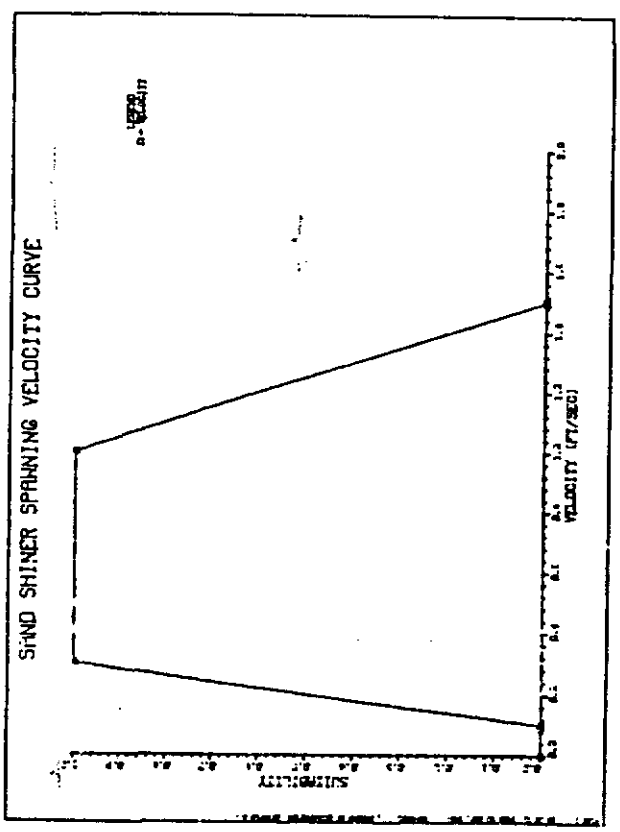
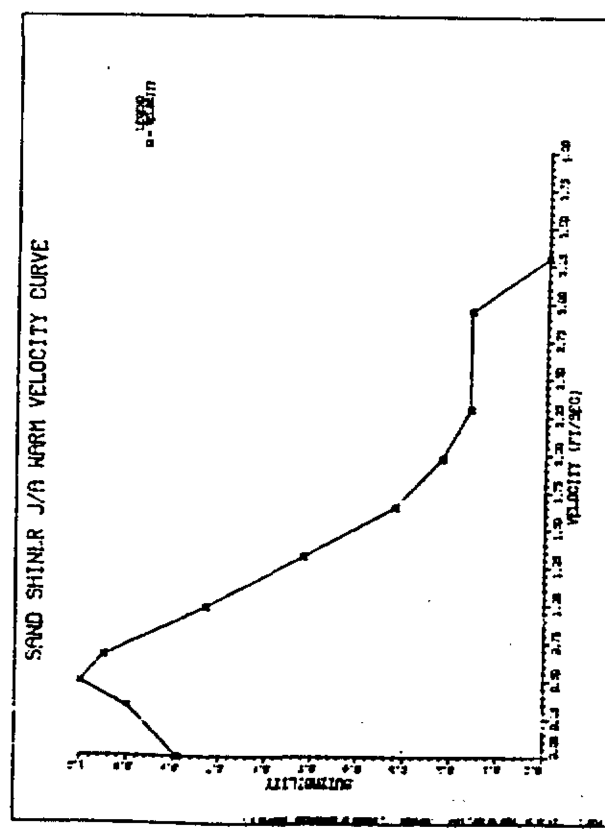


Figure III-3 - continued







b. Summary of Study Results

The PHABSIM analysis was performed for all 16 study sites for the sand shiner to allow for migration up and down the river. Habitat analyses were also performed for all life stages of the sand shiner. The periodicity of each life stage developed is shown in Figure III-4. Habitat ratios for each life stage were determined by the FWS and NGPC (Pers. comm. 1988). These ratios were: spawning 0.40; fry 0.16; juveniles 0.29; and adults 1.0.

After habitat ratios were applied, it was determined that available adult warm season habitat was limiting, therefore, further analysis was performed only on this life stage.

The present condition KWUA discharge relationship for the 16 study sites were used to estimate optimum adult sand shiner warm season flow requirement of 750 cfs. The flow requirement was estimated by using the discharge that produced the amount of habitat for which the maximum KWUA occurs. The maximum adult habitat values and associated discharges for each segment are shown in Table III-3.

Habitat discharge relationships were developed for the three hydrologic reaches A, B, and C. Maximum habitat values and the associated discharge are shown in Table III-4.

Sand shiner habitat versus discharge curves are displayed in Appendix C. Also in Appendix C are the range of discharges and associated habitat values for each study site and reach.

The computations previously described provide weighted usable area values in thousands (KWUA) for each discharge simulated at a study site. These values were then adjusted to represent KWUA per river reach (KWUA/reach).

Figure III-4. Species Periodicity for Sand Shiner (*Notropis stramineus*) Life Stages in the Central Platte River Study Area (From Fannin, 1986)

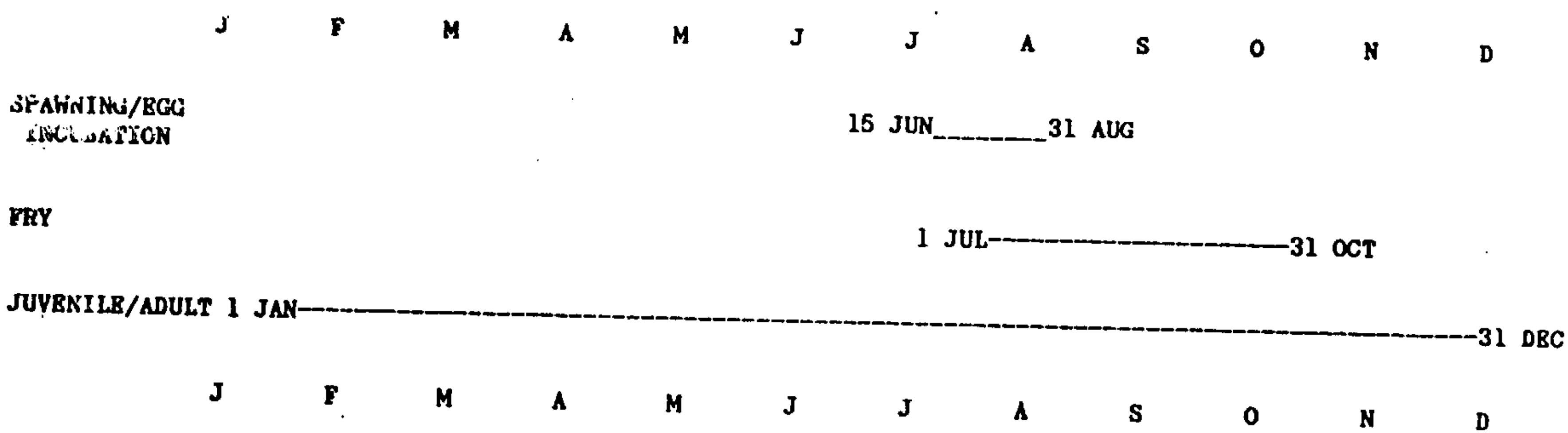


Table III-3. Sand Shiner Maximum Habitat Discharge Relationship for all Study Sites

Study Site	Maximum KWUA	Discharge (cfs)
2	3,717	900
3	10,824	700
4A	4,164	550
4B	6,577	500
5	14,477	700
6	13,115	750
7	4,243	900
8AS	4,879	500
8AN	5,729	850
8B	4,758	700
8C	4,085	550
9BE	10,230	1300
9BW	10,015	850
10	3,404	1750
11	9,599	400
12A	19,625	400
12B	8,171	700
River total	123,477	750

Table III-4. Sand Shiner Maximum Habitat Discharge Relationship for the Hydrologic Reaches

Reach	Maximum KWUA	Discharge (cfs)
A	14,501	800
B	40,997	550
C	70,082	850
A, B & C	123,477	750

B. Channel Forming Characteristics

The Platte River channel characteristics were studied by the Bureau's Engineering and Research Center in 1987. Their 1988 report titled "Platte River Channel Characteristics in the Big Bend Reach" is summarized in this section.

Historically, the Platte River has been described as a wide, shallow, and braided channel. Since the 1860's, the channel has narrowed and deepened. Two principal factors have been identified as causing these changes: (1) the tremendous reduction in sand supplied to the Platte, and (2) less frequent occurrence of flows between 1,000 and 10,000 ft^3/sec during part of the period. Both factors have created the current channel morphology of the Platte River. Current channel geometry may also be influenced by riparian vegetation.

In terms of sediment transport, the Platte River from Overton to Grand Island, Nebraska has recently achieved a quasi-equilibrium condition, as indicated by the close agreement of the annual sand-load estimates for the Overton and Grand Island gauges. For a given discharge, less sand was transported by the river during 1958-86 than was transported by the river during the 1926-39 period.

The Platte River channel from Overton to Grand Island should maintain a state of quasi-equilibrium in the future if the mean annual sand load remains similar to that of the 1958-86 period. If sand loads are reduced in the future, then the channel will likely narrow and deepen. If sand loads were somehow increased, aggradation and channel widening could occur. Present-day sand loads are much lower than those estimated for 1926-39. These historic loads would be difficult to match under current conditions of flow and sediment availability.

The quasi-equilibrium condition of the Platte has occurred during the 1958-86 period, which has a similar flow-duration curve to that of the 1926-39 period in the range of the effective sediment transport discharges (1,000 to 10,000 ft^3/sec). Although the flow conditions in this range for these two time periods are similar, the current morphology of the Platte is much different than that represented on aerial photography taken in 1938. Thus, discharge alone does not determine the channel geometry of the Platte. The frequency of flows between 1,000 and 10,000 ft^3/sec was less during the 1940-57 period than the frequency during the 1926-39 period. Channel narrowing occurred at the same time the frequency of these flows decreased. However, the 1958-86 period experienced an increase in the frequency of flows in the 1,000 to 10,000 ft^3/sec range, with no corresponding increase in channel width.

The riparian vegetation may be preventing high flows from widening the channel. However, under the current conditions of quasi-equilibrium, the channel might not widen even if the vegetation were removed unless the sand load increased. Any artificial clearing of vegetation might require continual maintenance if the frequency of low flows remained unchanged.

For the 1926-39 period, the North Platte contributed about 60 percent (1.3 million tons per year) of the sand load transported by the Platte near Overton (2.1 million tons per year). Presently, the Platte carries about 30 percent of its historic sand load (603,000 tons per year for 1953-85) which is about equal to the estimated sand load for the South Platte (710,000 tons per year for 1953-85).

These, and perhaps conclusions from other studies, provide the basis for a qualitative and quantitative assessment of the two Prairie Bend Unit plans.

C. Biological Assessment Flow Regime

The biological assessment flow regime used to assess Prairie Bend Unit effects on threatened and endangered species and associated habitats is shown in Table III-5. The flow regime, time periods and river reaches are taken from two recent biological opinions rendered by the FWS (Deer Creek and Two Forks Projects, 1987). The monthly volumes of water required to meet this flow regime at Overton and Grand Island are shown in Table III-6. The future without Prairie Bend Unit development conditions (baseline conditions), based on the biological assessment flow regime and habitat/flow relationships for whooping crane and forage

Table III-5 - Biological Assessment Flow Regime for Prairie Bend Unit

Species/Activity	Period of Concern	Recommended Flow (ft^3/sec)	River Reach
Whooping Crane/Roosting	March 23 - May 10	2000 1/	Lexington to Chapman
Whooping Crane/Roosting	Sept. 16 - Nov. 15	2000 1/	Lexington to Chapman
Bald Eagle/Feeding	Dec. 10 - Feb. 25	1100	J-2 to Elm Creek
Interior Least Tern/Nesting/Feeding	May 15 - Sept. 15	800-2500 2/	Lexington to Chapman
Piping Plover/Nesting/Feeding	May 15 - Sept. 15	800-2500	Lexington to Chapman
Forage Fish Maintenance	Base Flow Entire Year	400	Lexington to Chapman
Wet Meadow Maintenance	Febr. 1 - March 22	1100	Lexington to Chapman
Maintenance of Channel Width	Annually	8000 (five consecutive days)	Lexington to Chapman

1/ Flow that produces maximum weighted usable area of whooping crane roost habitat based on whooping habitat vs. flow model used by FWS in Deer Creek and Two Forks opinions. FWS considered 1200 ft^3/sec to be the minimum roosting habitat flow.

2/ 800 ft^3/sec is the minimum flow requirement to protect nesting habitat of terns and plovers and to sustain forage fish populations for least terns. 2500 ft^3/sec is the maximum flow level to prevent inundation of tern and plover nests.

Table III-6. Monthly Volumes of Water in Acre-feet Required to Meet Biological Assessment Flow Regime at Overton and Grand Island

	Overton		Grand Island	
Month	Flow (ft^3/sec)	Acre-Feet	Flow (ft^3/sec)	Acre-feet
January	1100	67,600	400	24,600
February	1100	61,000	1100	61,000
March	22 days @ 1100 9 days @ 2000	83,700	22 days @ 1100 9 days @ 2000	83,700
April	2000	119,000	2000	119,000
May	10 days @ 2000 4 days @ 400 17 days @ 800	69,800	10 days @ 2000 4 days @ 400 17 days @ 800	69,800
June	800	47,600	800	47,600
July	800	49,200	800	49,200
August	800	49,200	800	49,200
September	15 days @ 800 15 days @ 2000	83,300	15 days @ 800 15 days @ 2000	83,300
October	2000	123,000	2000	123,000
November	15 days @ 2000 15 days @ 400	71,400	15 days @ 2000 15 days @ 400	71,400
December	9 days @ 400 22 days @ 1100	55,100	31 days @ 400	24,600
TOTAL		879,900		806,400

fish, are presented in the following chapter. The effects of operating the two Prairie Bend Unit plans, as compared to the baseline condition, are presented in Chapter V.

Figure C-1. Sand Shiner Habitat versus Flow Relationship for All Life Stages from Lexington to Chapman, Nebraska. Adult Habitat Is Limiting

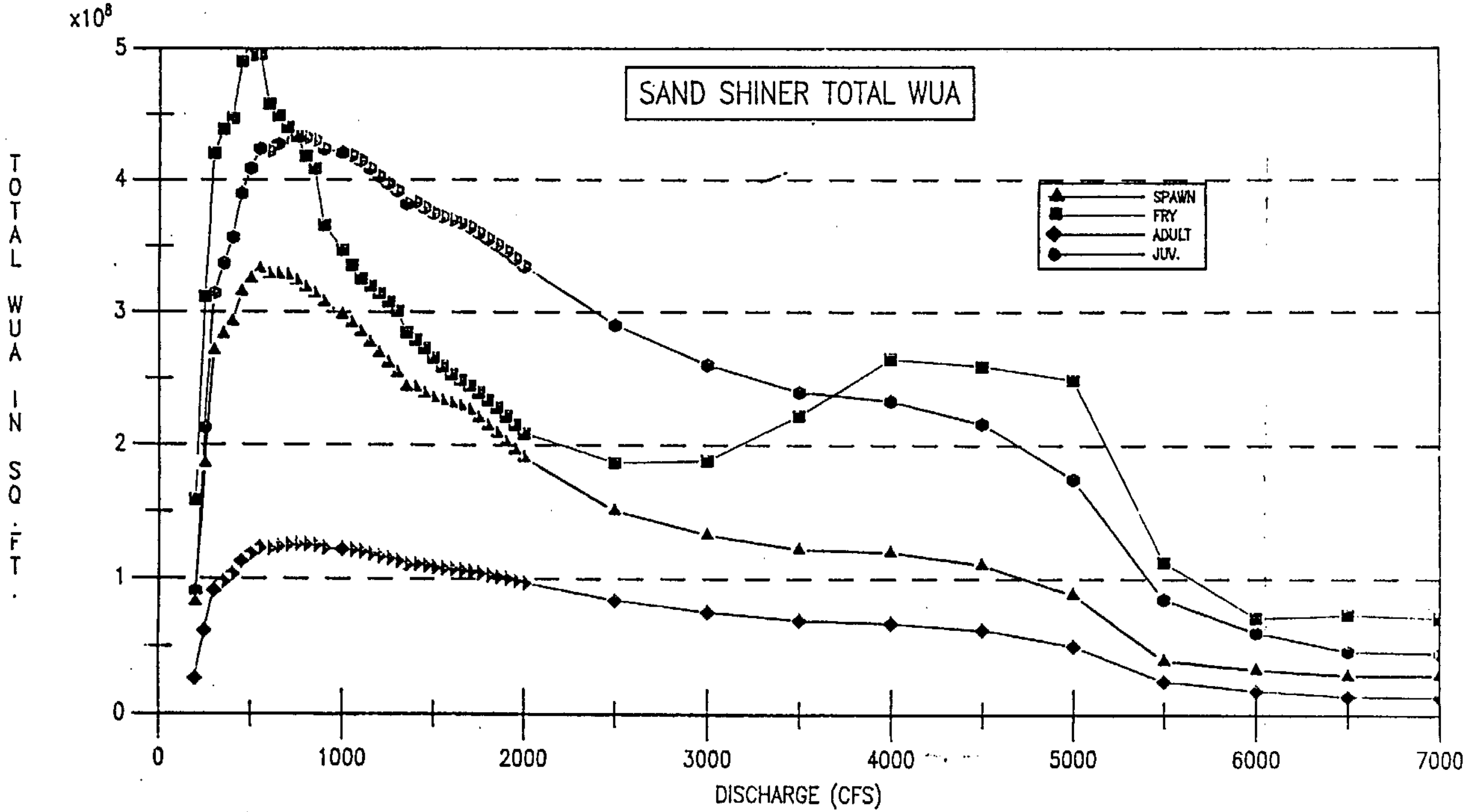


Table C-1. Sand Shiner Weighted Usable Area Expressed in Thousands (KWUA) for Each IFIM Study Site

SAND SHINER JUV/AD WARM MID CURVE 31-OCT-88

SAND SHINER JUVENILE AND ADULT WARM MID CURVE KWUA PER REACH WITHOUT RATIO

FLOW CFS	KWUA STUDY REACH 2	KWUA STUDY REACH 3	KWUA STUDY REACH 4A	KWUA STUDY REACH 4B	KWUA STUDY REACH 5	KWUA STUDY REACH 6	KWUA STUDY REACH 7	KWUA STUDY REACH 8AS	KWUA STUDY REACH 8AN	KWUA STUDY REACH 8B	KWUA STUDY REACH 8C	KWUA STUDY SITE 9BE	KWUA STUDY REACH 9BW	KWUA STUDY REACH 10	KWUA STUDY REACH 11	KWUA STUDY REACH 12A	KWUA STUDY REACH 12B	TOTAL KWUA
200			2029	4744					3439	2488						13726		26426
250	2790	7326	2380	5321	9798			3671	3977	2870	3103					15662	4823	61721
300	2933	8152	2850	5895	10903	9365	3643	4044	4421	3218	3470				9499	17243	5712	91349
350	3018	8870	3209	6281	11864	10043	3706	4387	4750	3471	3687				9551	18732	6347	9791[illegible]
400	3104	9588	3539	6439	12824	10721	3769	4672	5040	3770	3904				9577	19625	6981	1035[illegible]
450	3189	9949	3837	6512	13307	11352	3832	4810	5282	4052	3987		3718		9551	18691	7313	109382
500	3274	10310	4037	6577	13790	11902	3866	4879	5390	4267	4069		5073		9525	18900	7644	113505
550	3339	10580	4164	6405	14151	12394	3883	4862	5559	4447	4085		6428		9401	19032	7805	116537
600	3405	10789	3951	5954	14430	12719	3900	4846	5618	4568	4083		7321		9236	16307	7964	115091
650	3472	10806	3512	5504	14454	12940	3961	4783	5642	4688	4068		8176		9073	16694	8067	115839
700	3543	10824	3072	5179	14477	13068	4065	4692	5664	4758	4053		8869		8961	17080	8171	116476
750	3630	10804	2633	5178	14450	13115	4170	4588	5677	4248	4017	7274	9492		8685	17466	8047	123477
800	3717	10784	2193	5178	14424	13111	4236	4469	5711	4218	3982	7730	9732		8415	17464	8017	123380
850	3685	10567	2204	5177	14133	12964	4239	4359	5729	4156	3923	8186	10015		8197	17461	8055	123051
900	3717	10604	2215	5176	14183	12814	4243	4264	5729	4100	3864	8634	9194		8040	17459	8094	122331
1000	3714	10622	2238	5026	14206	12550	4095	4019	5684	4001	3711	9275	9499		7797	17269	8142	121848
1050	3681	10641	2249	4950	14233	12381	3976	3887	5636	3910	3637	9596	9651		7684	17174	8137	121424
1100	3647	10661	2260	4875	14259	12168	3849	3759	5583	3660	3563	9821	9736		7598	16876	8132	120446
1150	3592	10602	2196	4800	14180	11978	3689	3637	5380	3410	3489	9923	9735		7511	16492	8117	118732
1200	3538	10543	2131	4696	14101	11859	3535	3558	5161	3160	3415	10026	9735		7425	16107	8103	117092
1250	3479	10440	2066	4593	13963	11730	3380	3500	4941	3189	3340	10128	9735		7339	15747	8102	115671
1300	3419	10336	2002	4489	13825	11578	3268	3471	4722	3217	3264	10230	9662		7252	15387	8102	114225
1350	3345	9750	1960	4385	13040	11425	3156	3437	4503	3246	3167	10222	9574		7192	15027	8071	111501
1400	3271	9163	1918	4282	12256	11298	3044	3397	4283	3275	3089	10175	9486	3140	7135	14707	8040	111959
1450	3196	9171	1876	4170	12267	11177	2962	3370	4064	3255	3011	10099	9403	3179	7078	14392	8030	110700
1500	3121	9179	1834	4058	12278	11052	2885	3349	3844	3235	2934	9910	9384	3219	7020	14077	7939	1093[illegible]
1550	3046	9188	1792	3945	12288	10927	2807	3574	3686	3215	2911	9721	9364	3258	6961	13793	7878	1083[illegible]
1600	2970	9196	1750	3833	12299	10816	2731	3799	3668	3195	2888	9532	9345	3297	6901	13510	7818	107550
1650	2861	9204	1734	3721	12310	10688	2656	4025	3651	3140	2866	9351	9310	3336	6839	13234	7758	106683
1700	2752	9212	1717	3619	12321	10555	2581	4044	3633	3086	2843	9175	9263	3376	6777	12984	7697	105631
1750	2643	9129	1700	3508	12210	10423	2512	3967	3615	3025	2817	8999	9216	3404	6699	12735	7637	104238
1800	2534	9046	1683	3402	12099	10267	2447	3890	3598	2965	2790	8823	9168	3402	6619	12485	7577	102794
1850	2504	8963	1666	3295	11988	10101	2381	3813	3580	2907	2779	8645	9094	3401	6536	12273	7516	101443
1900	2474	8879	1639	3189	11876	9935	2326	3735	3563	2850	2767	8467	9019	3400	6329	12102	7431	99983
1950	2444	8796	1608	3083	11765	9764	2281	3658	3545	2821	2756	8289	8805	3399	6107	11932	7341	98394
2000	2414	8713	1578	2992	11654	9590	2236	3581	3528	2791	2744	8117	8588	3397	5843	11761	7252	96778
2500	2268	7895	1231	2190	10560	10397	1553	2635	2096	2591	2647	6874	6709	3364	3873	10227	6357	84467
3000	1881	7380	946	1723	9871	10957	1814	2099	1903	2365	2445	5917	5569	3004	2981	9324	5838	76017
3500	1804	7447	808	1466	9960	10012	1475	2123	1368	1869	2402	4893	4844	2331	2774	8736	5417	69729
4000	1781	8139	713	1518	10886	9477	1197	2651	1019	1430	2575	4171	4143	1953	3063	8006	4942	67664
4500	1738	8860	621		11877	9291	1026		807	1128	2798	3721	3586	1754	3738	7328	4513	62805
5000	1496	9401			12574	9454	905		[illegible]	944	2946	3366	3070	1658	4521			51005
5500	1264					9760	430		571			3039	2683	1629	5407			25285
6000						10182	434		497			2759	2319	1625				18206
6500						10741	[illegible]		[illegible]					1606				13743
7000						11349			[illegible]					1572				13273

Figure C-2. Sand Shiner Habitat versus Flow Relationship for Hydrology Reach A. Adult Habitat Is Limiting.

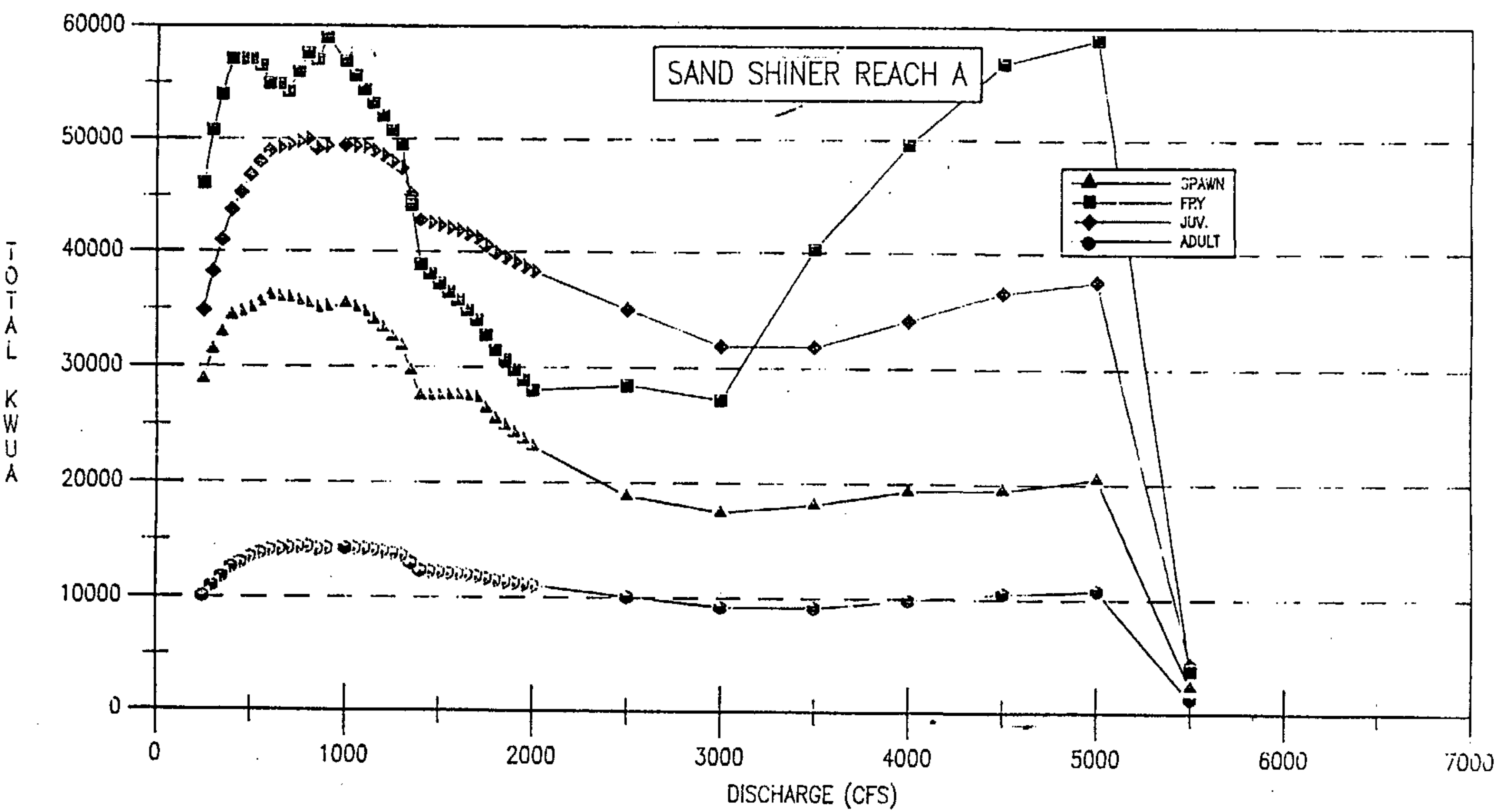


Figure C-3. Sand Shiner Habitat versus Flow Relationship for Hydrology Reach B. Adult Habitat Is Limiting.

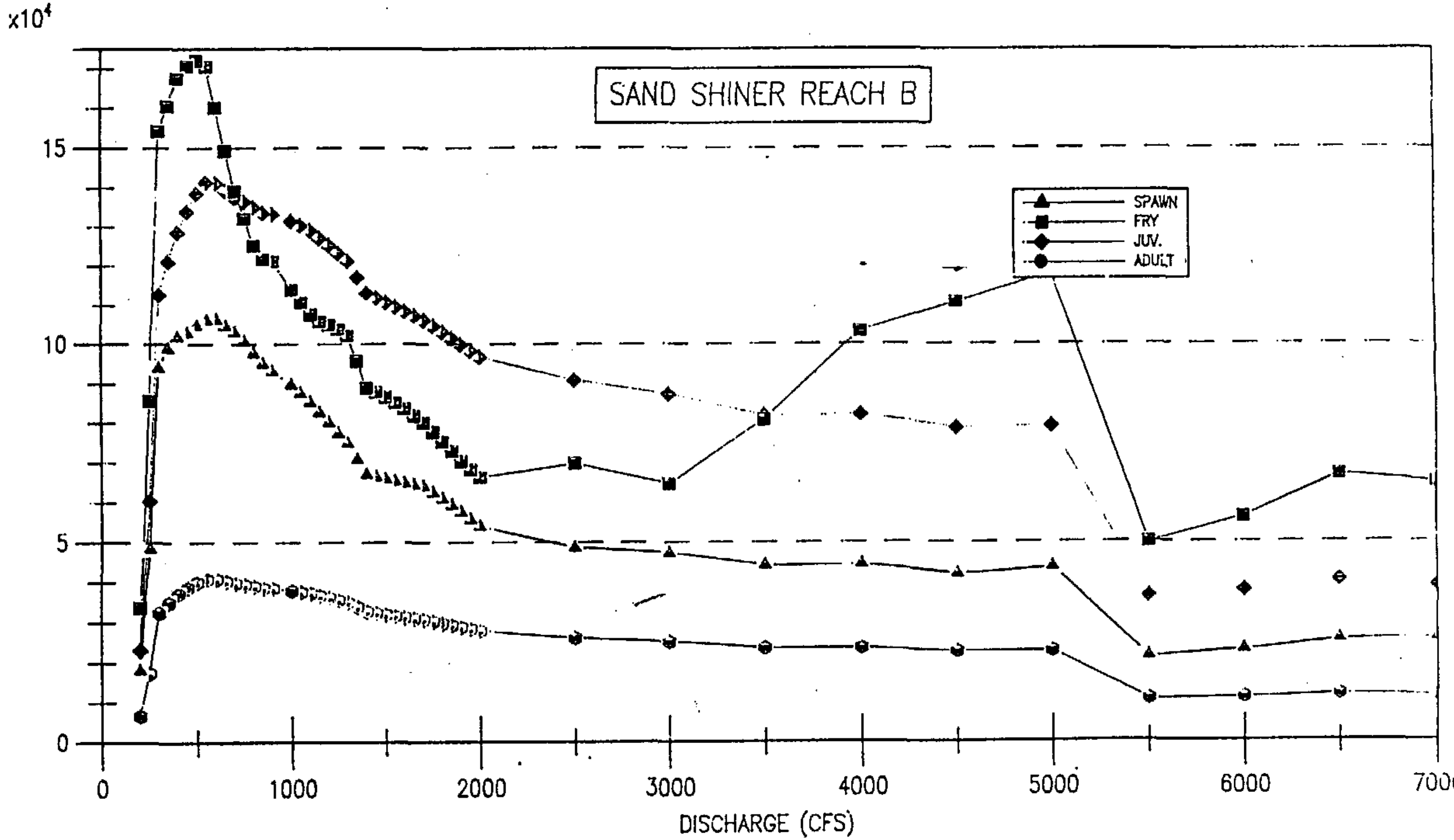


Figure C-4. Sand Shiner Habitat versus Flow Relationship for Hydrology Reach C. Adult Habitat Is Limiting.

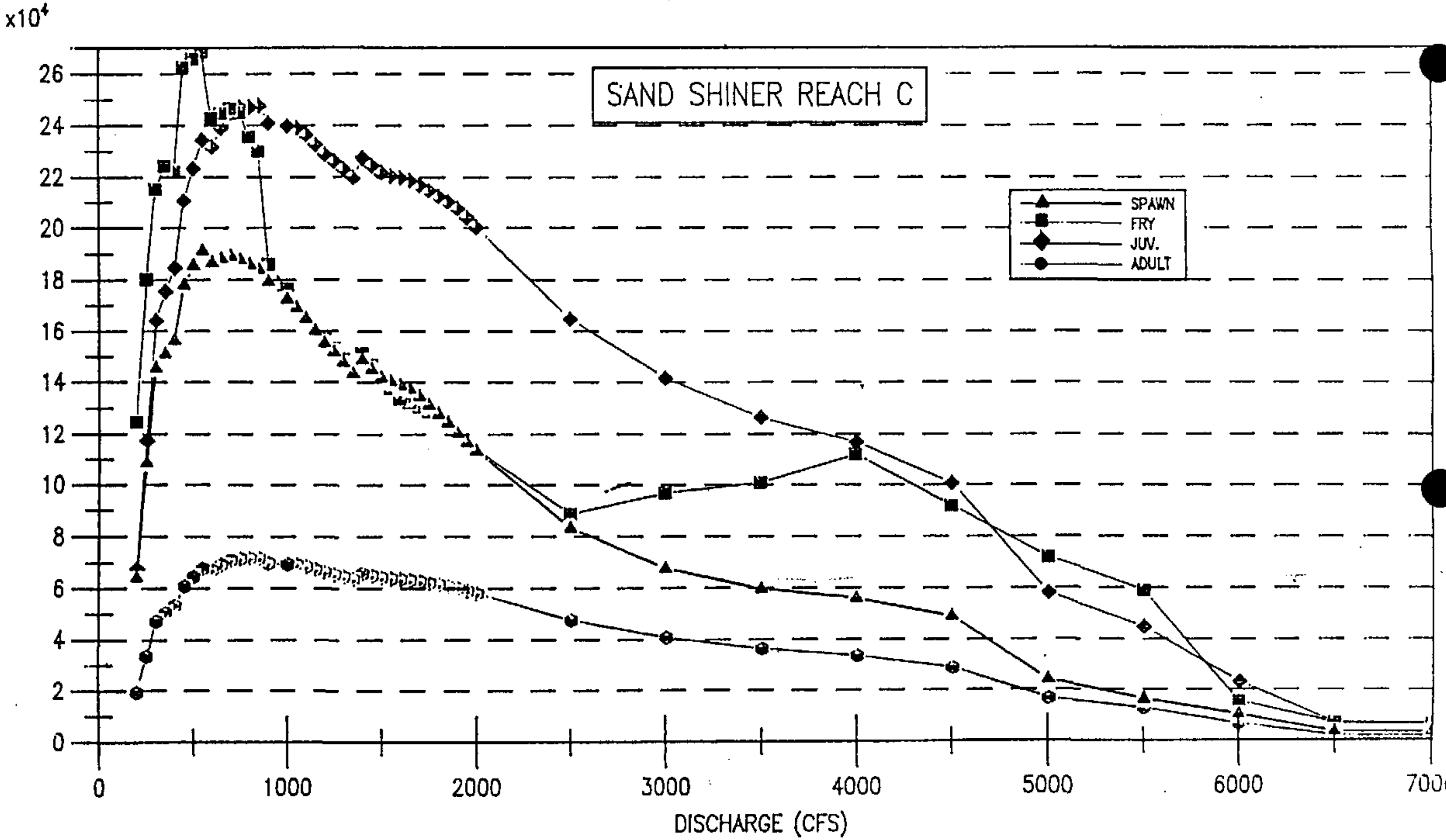


Table C-2. Sand Shiner Weighted Usable Are Expressed in Thousands (KWUA) for Each Hydrologic Reach

SAND SHINER JUV/AD WARM MID CURVE

FLOW CFS	REACH A SITES 2 & 3	REACH B SITES 4A - 7	REACH C SITES 8AS-12B
200		6773	19653
250	10116	17499	34106
300	11085	32656	47608
350	11888	35102	50926
400	12692	37292	53570
450	13138	38841	57404
500	13584	40173	59747
550	13920	40997	61620
600	14194	40955	59942
650	14278	40370	61191
700	14367	39862	62247
750	14434	39546	69496
800	14501	39141	69738
850	14252	38717	70082
900	14321	38631	69379
1000	14336	38115	69397
1050	14322	37789	69313
1100	14307	37412	68727
1150	14194	36842	67695
1200	14081	36322	66690
1250	13918	35732	66020
1300	13756	35162	65308
1350	13095	33967	64439
1400	12434	32797	66728
1450	12368	32451	65881
1500	12301	32106	64909
1550	12233	31760	64362
1600	12165	31431	63954
1650	12065	31109	63509
1700	11964	30788	62879
1750	11772	30353	62114
1800	11580	29897	61317
1850	11467	29432	60545
1900	11353	28965	59664
1950	11240	28501	58652
2000	11127	28049	57602
2500	10164	26331	47972
3000	9261	25310	41445
3500	9250	23721	36757
4000	9920	23791	33953
4500	10618	22815	29472
5000	10897	22933	17174
[illegible]	1266	10590	13329
6000		11017	7190
6500		11726	2017
7000		11349	1925

Figure C-5. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 2

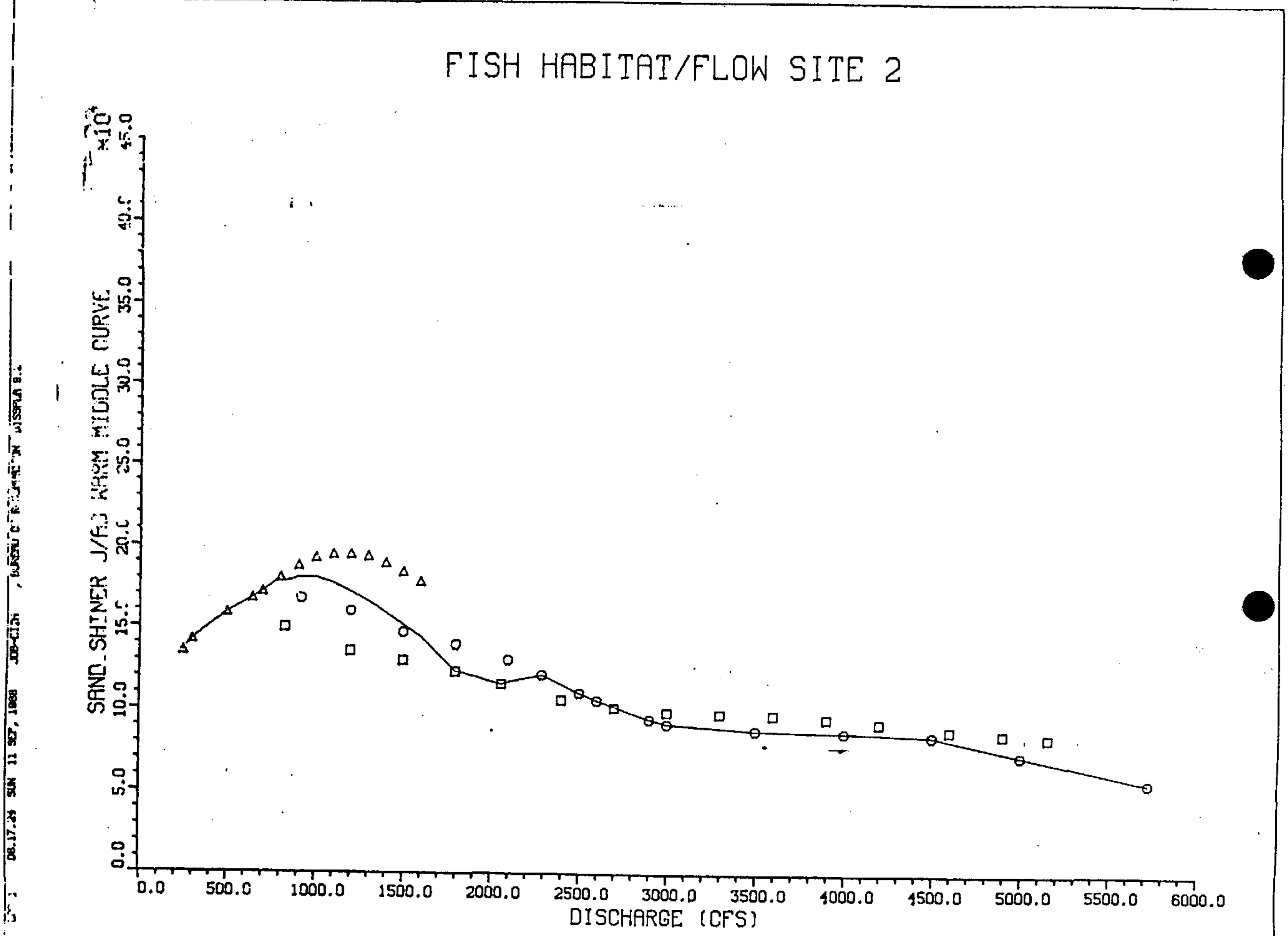


Figure C-6. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 4A

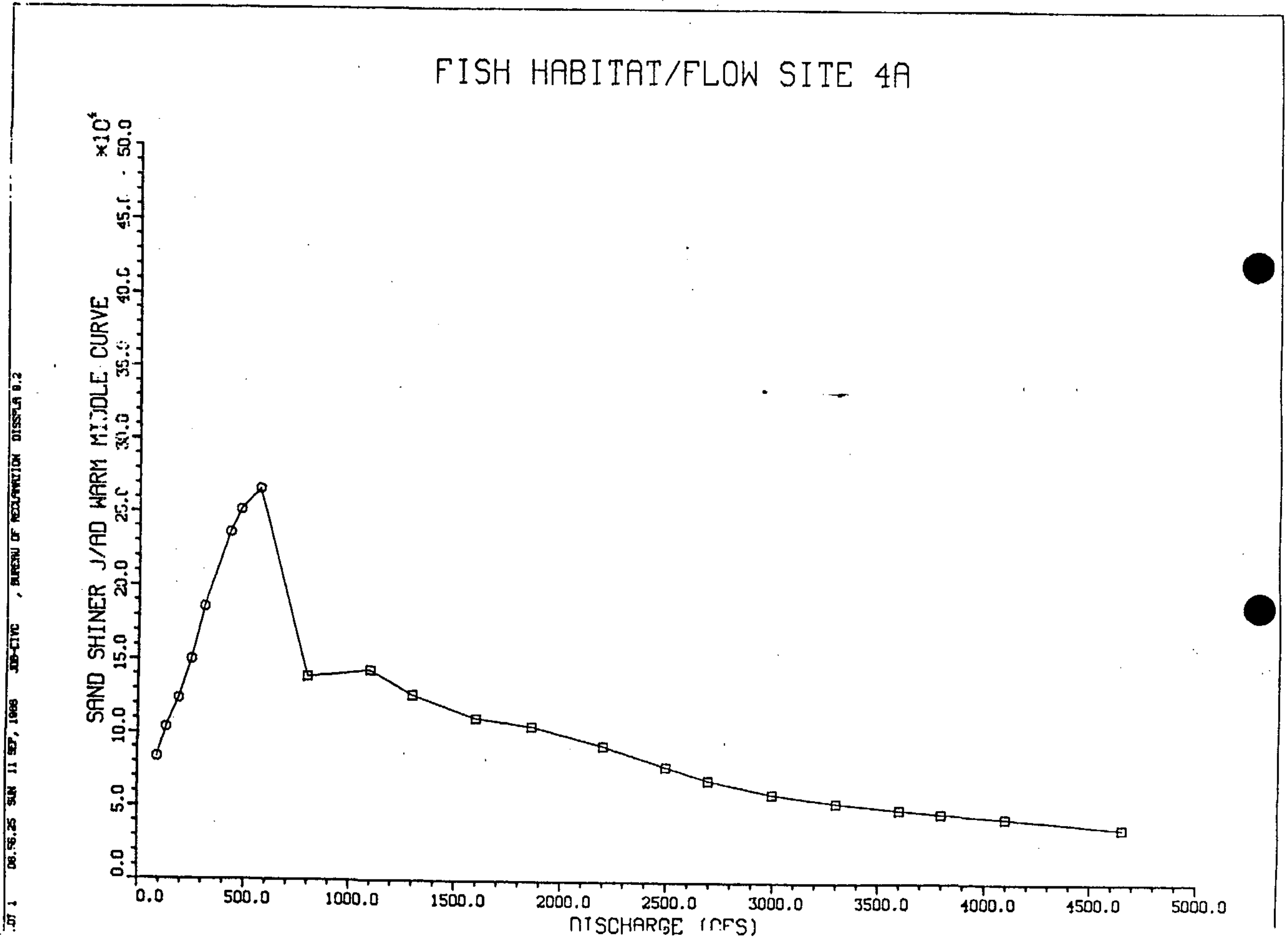


Figure C-7. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 4B

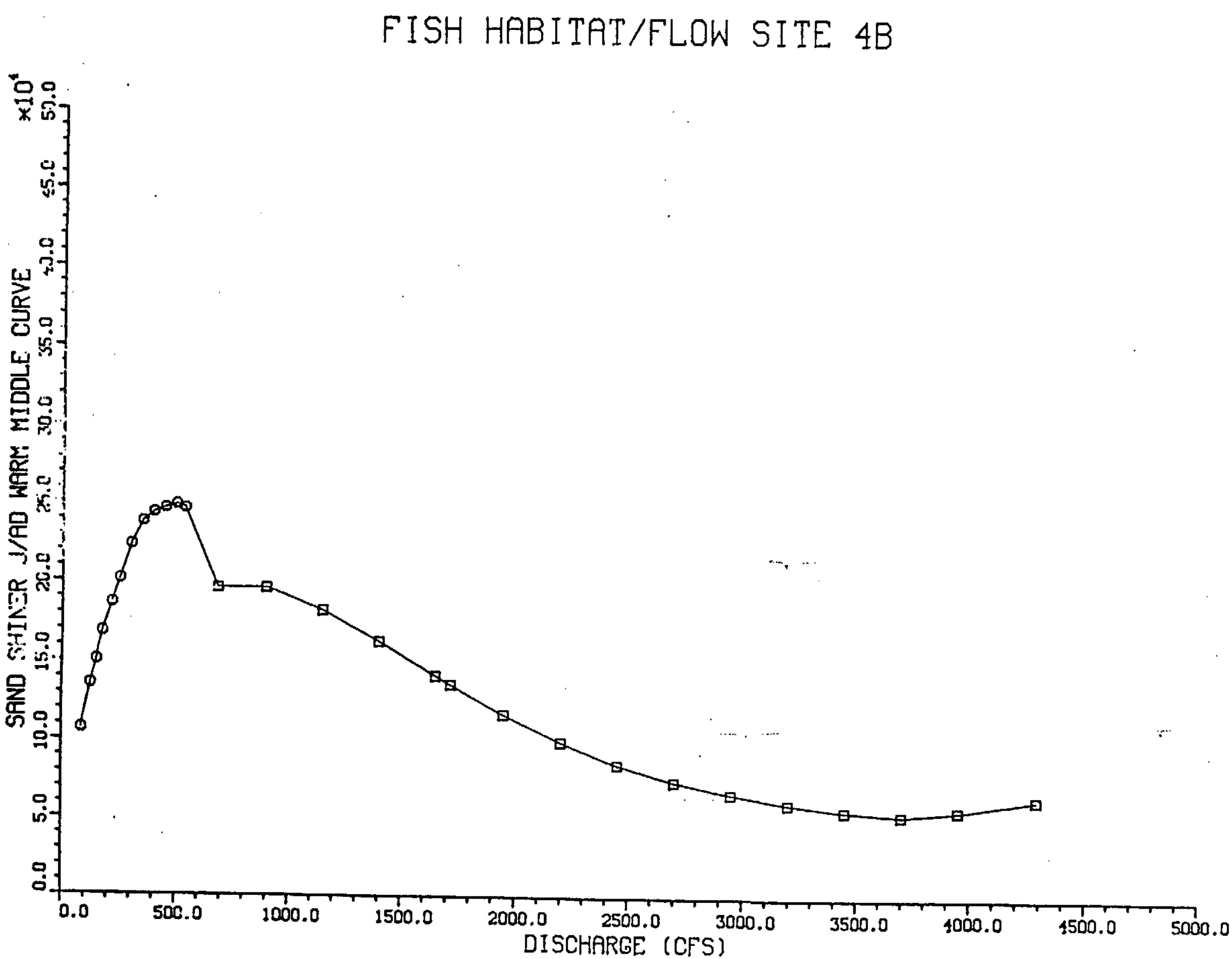


Figure C-8. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 5

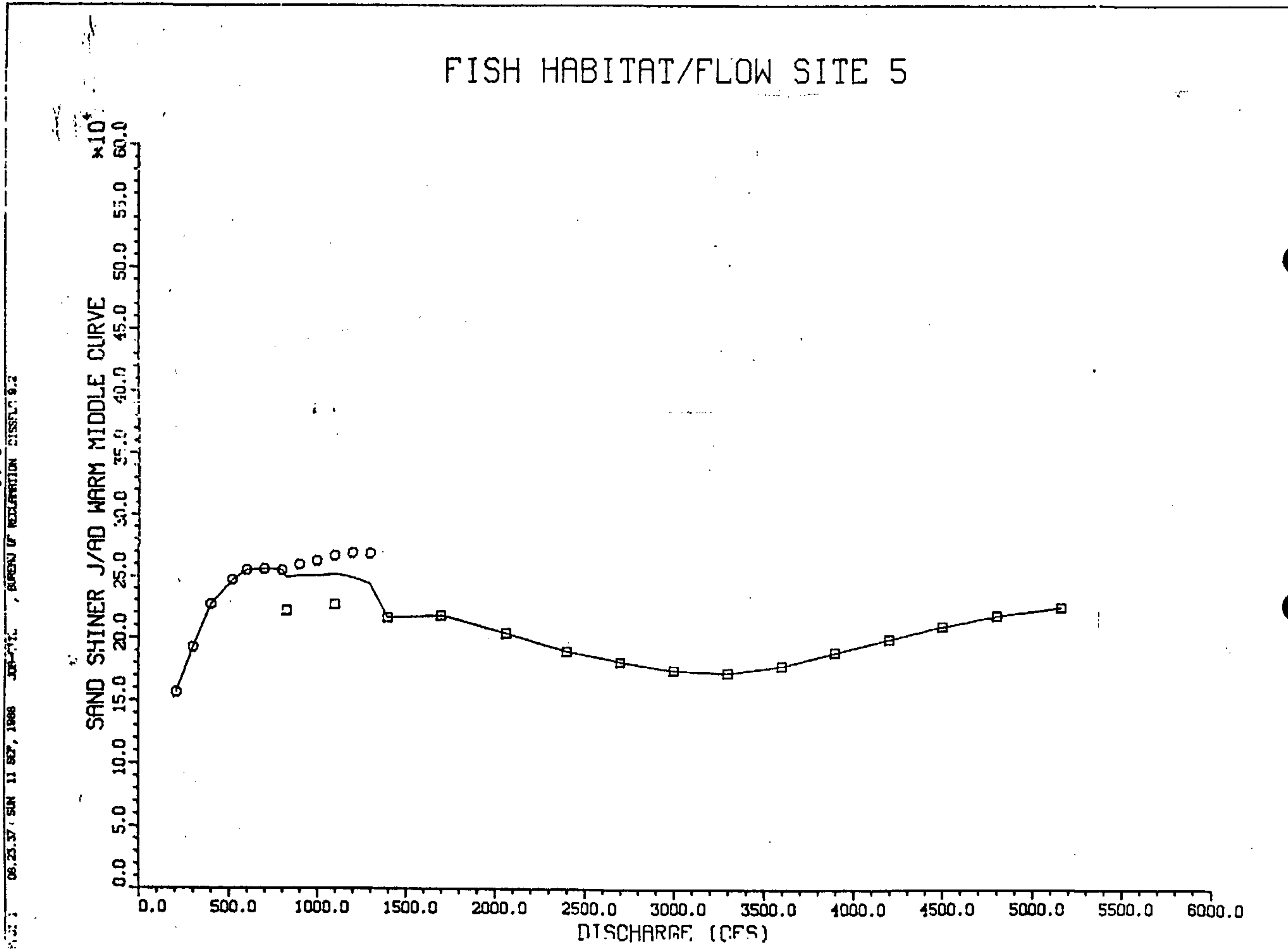


Figure C-9. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 6

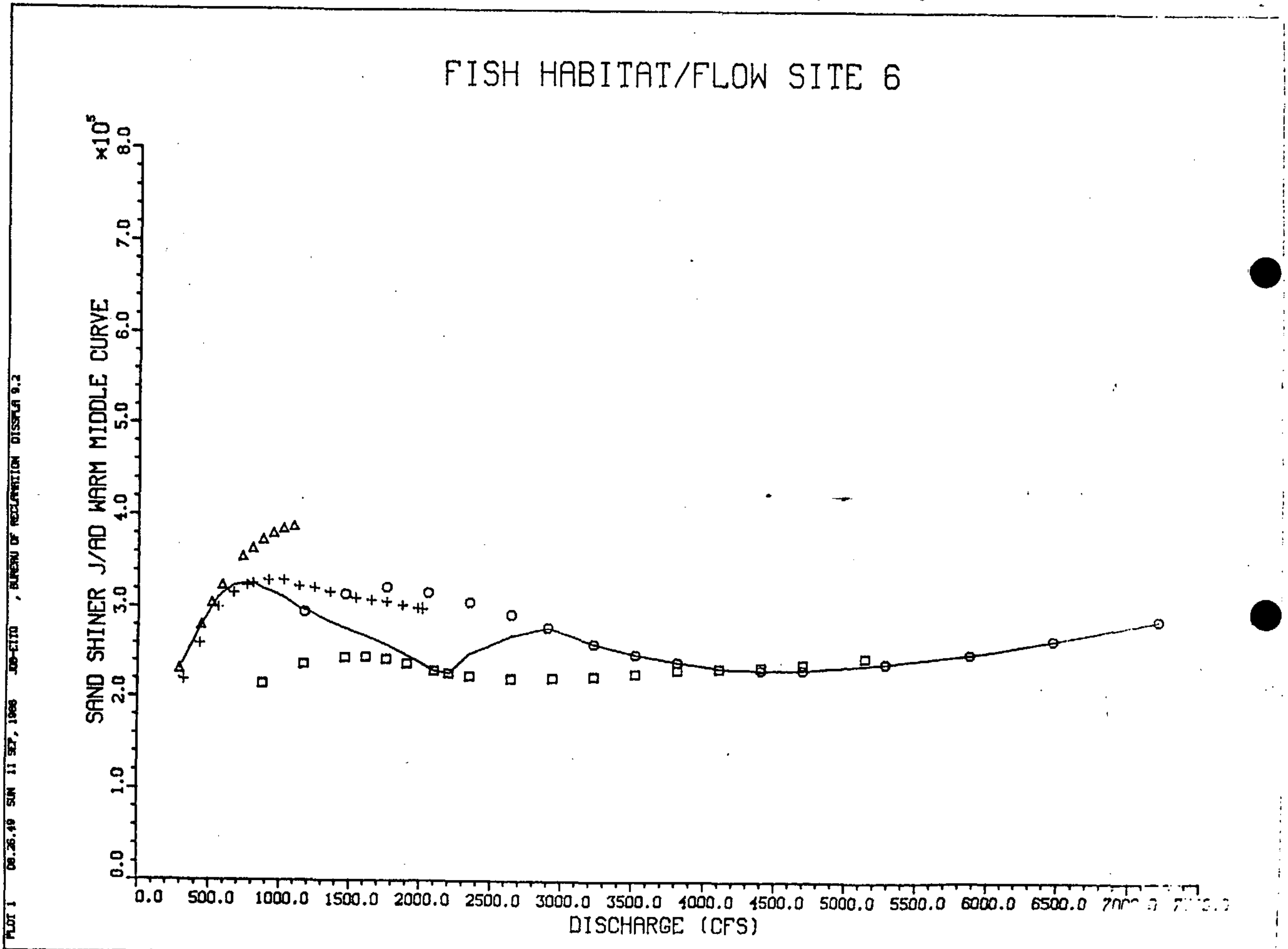


Figure C-10. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 7

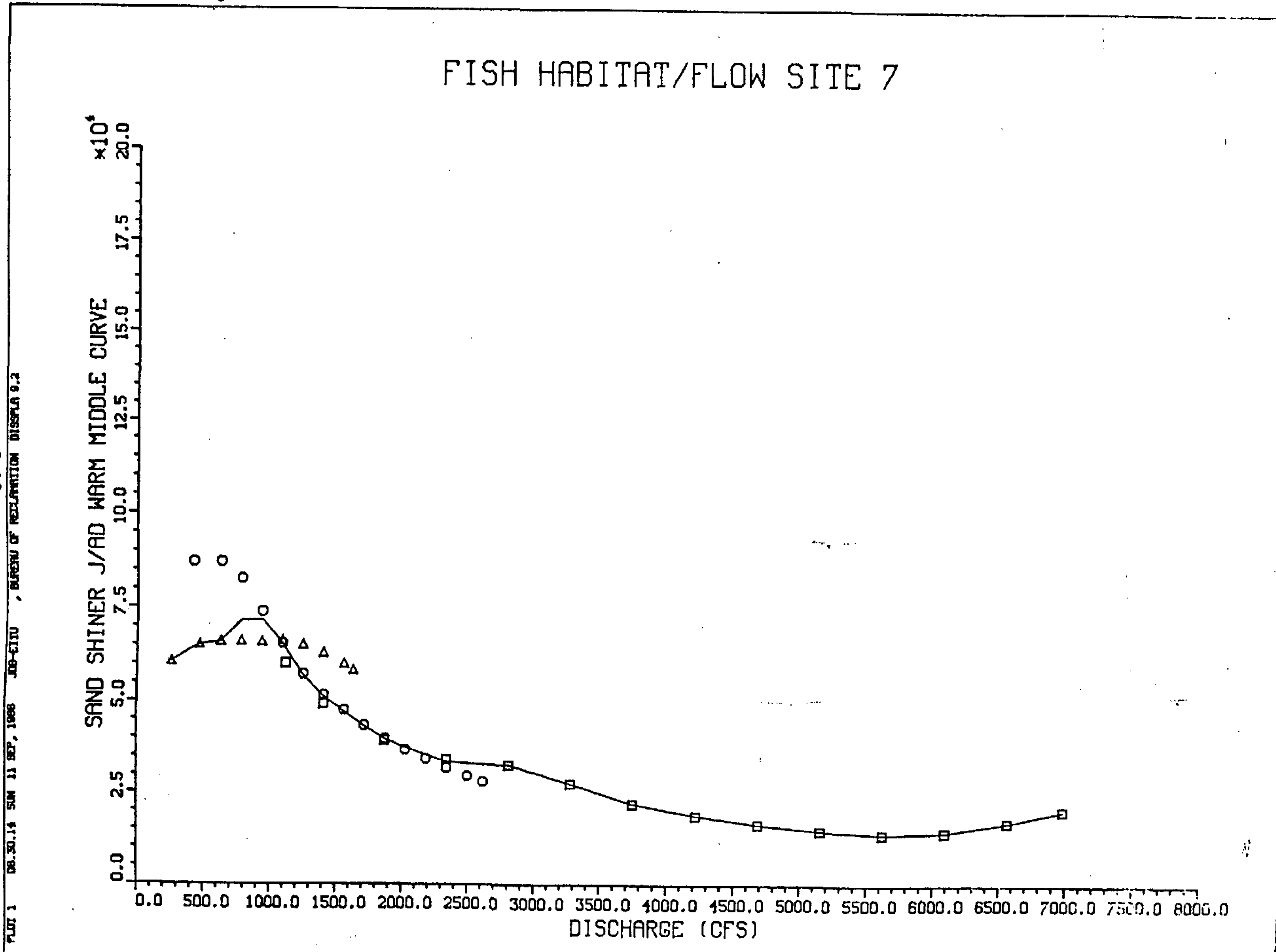


Figure C-11. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 8AS

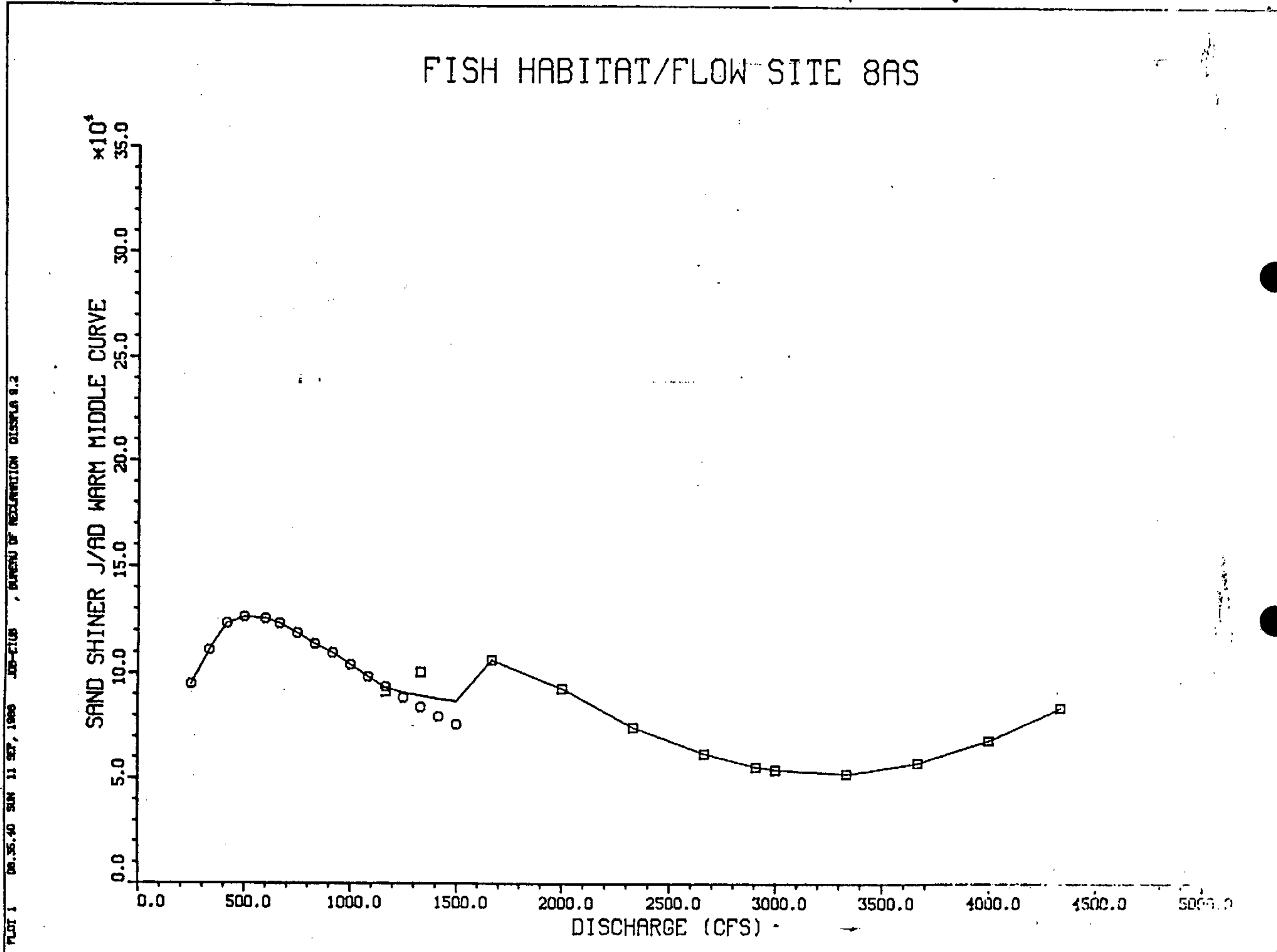


Figure C-12. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 8AN

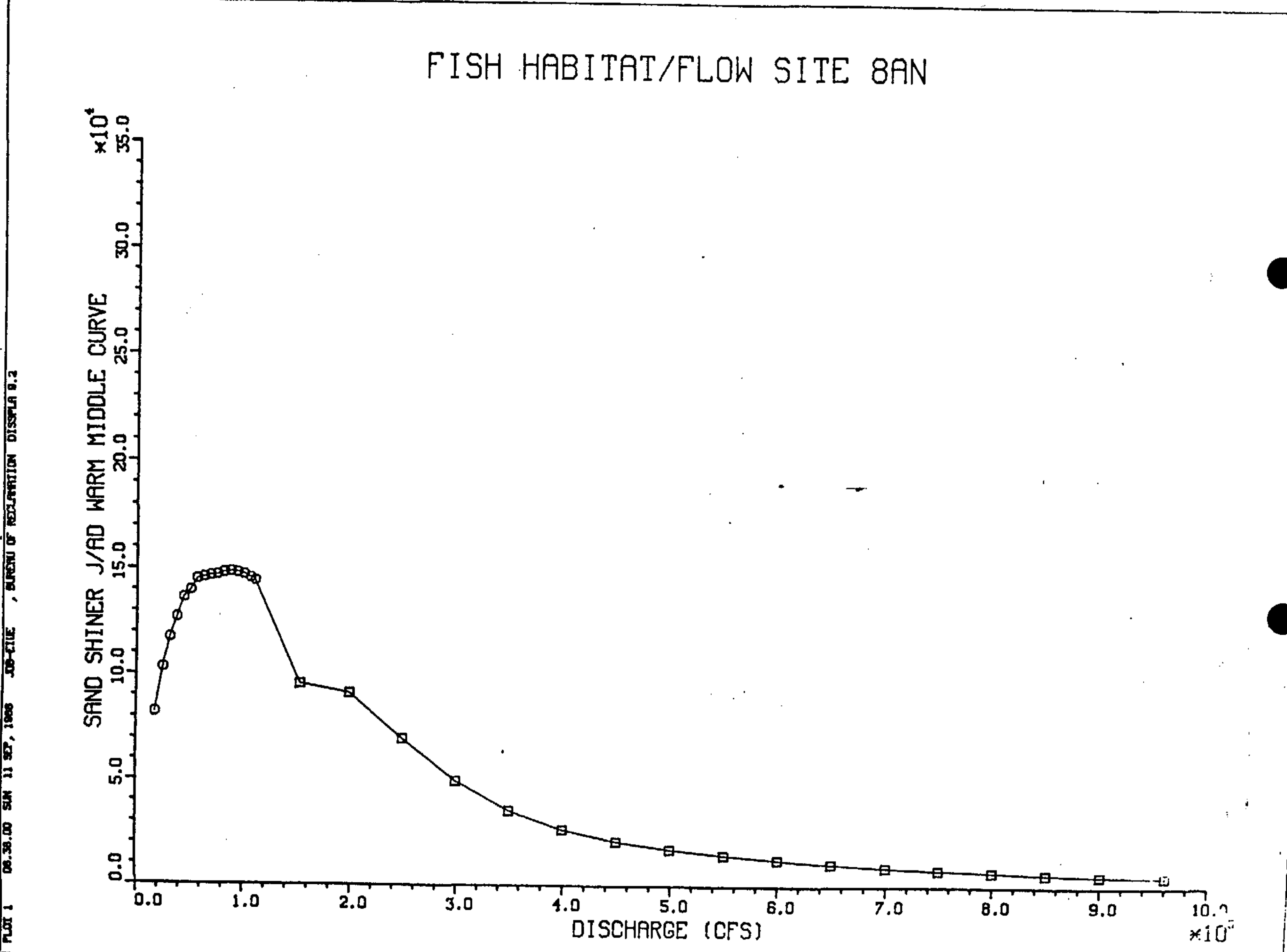


Figure C-13. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 8B

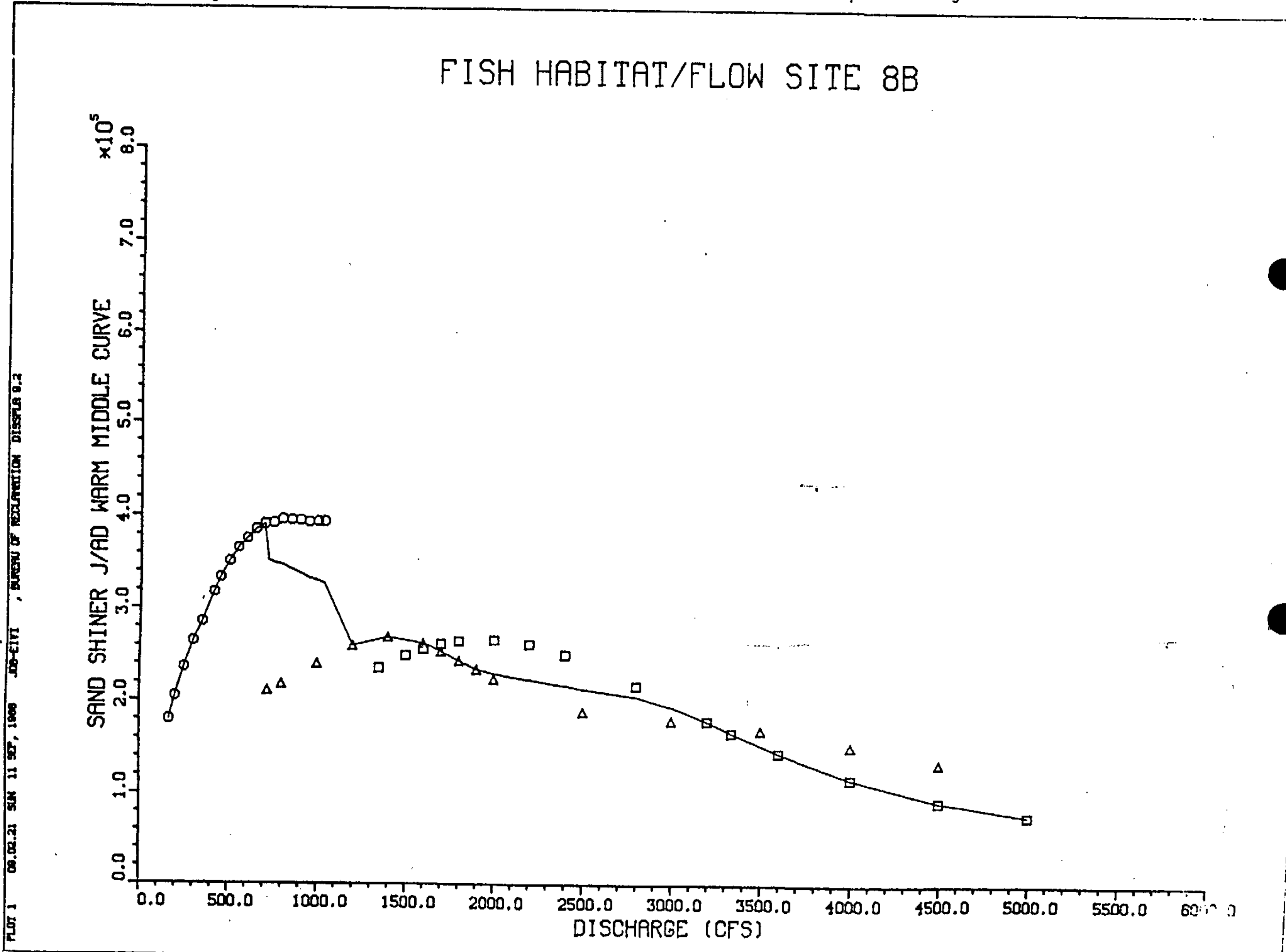


Figure C-14. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 8C

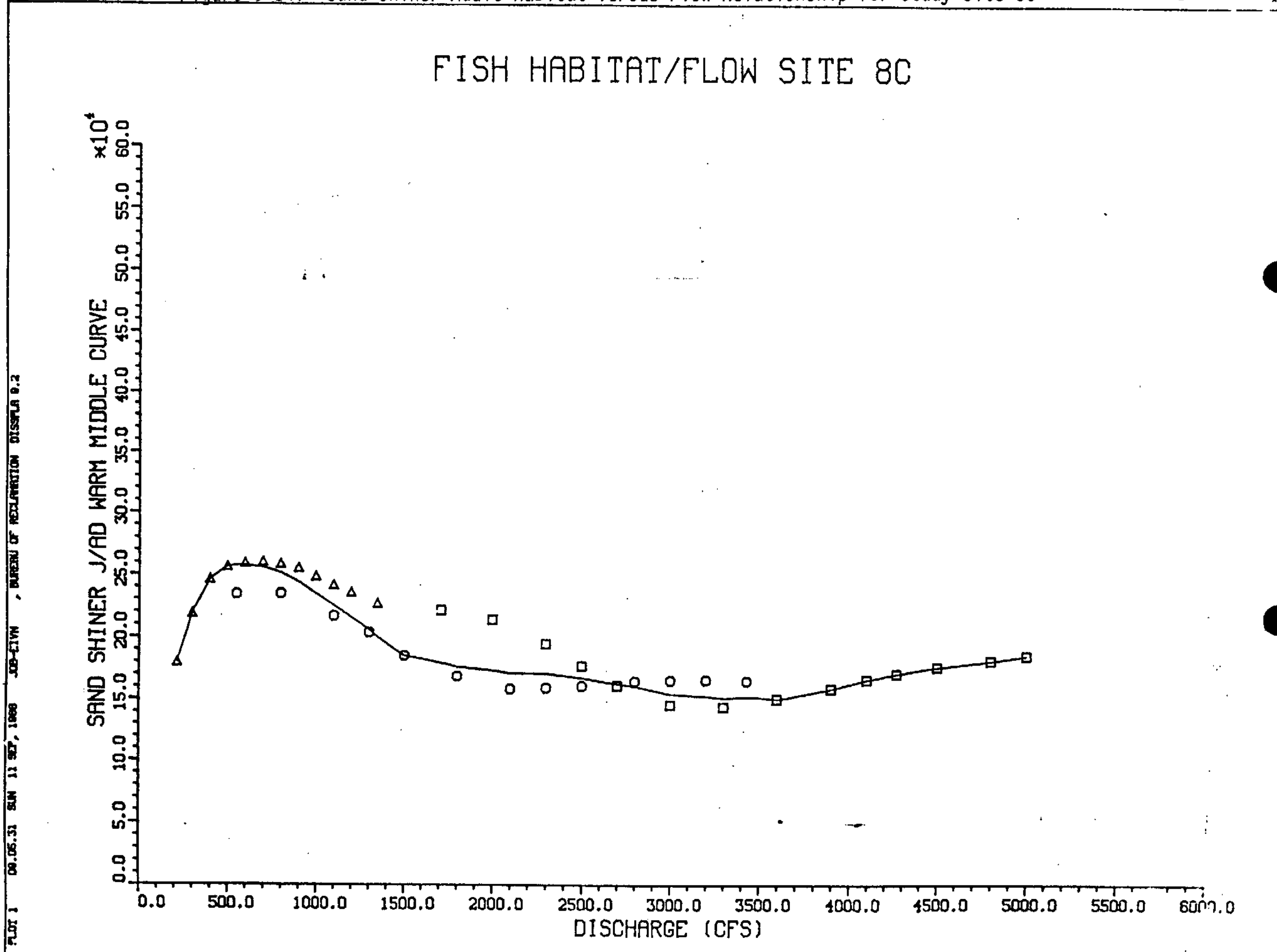


Figure C-15. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 9BW

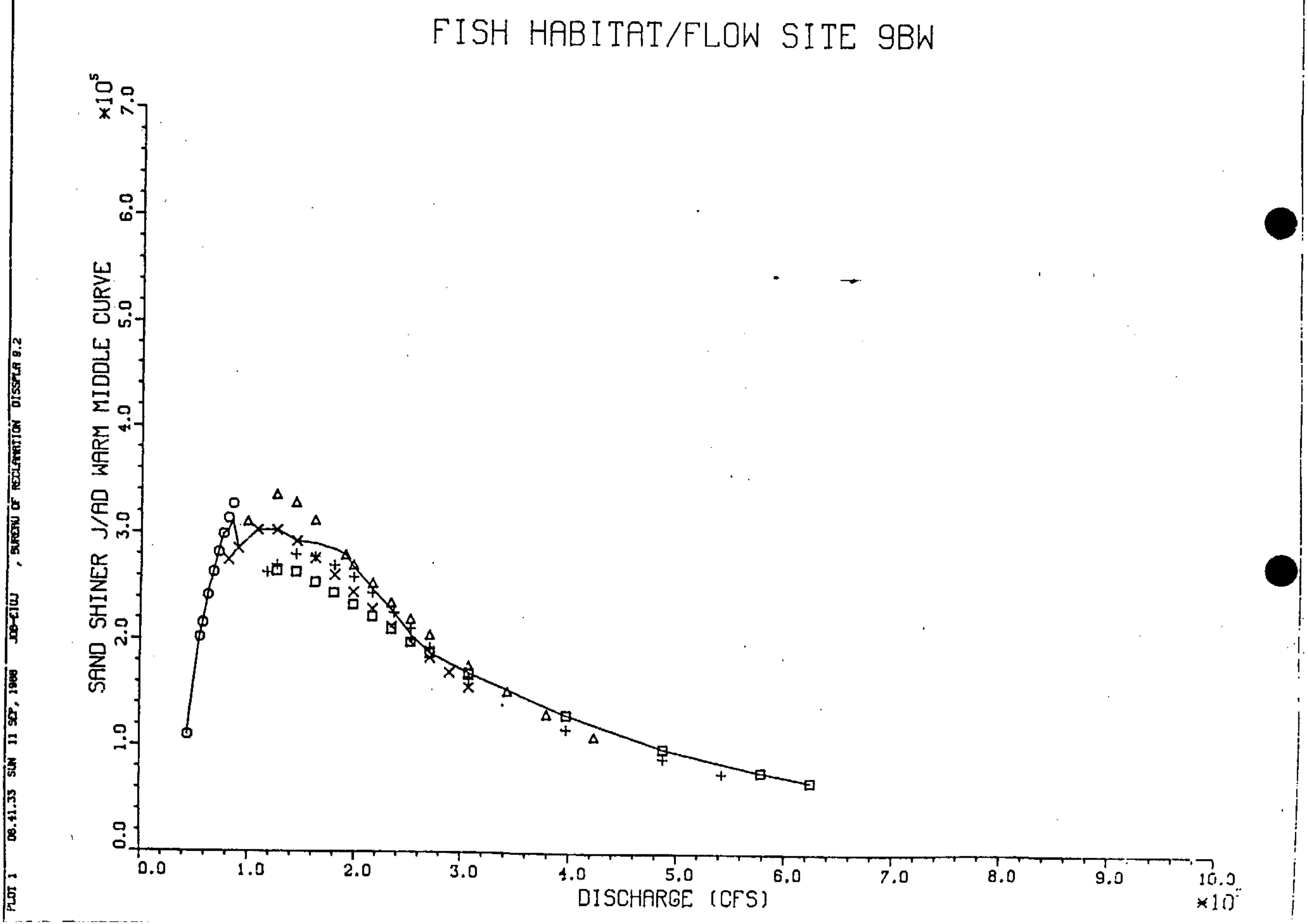


Figure C-16. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 9BE

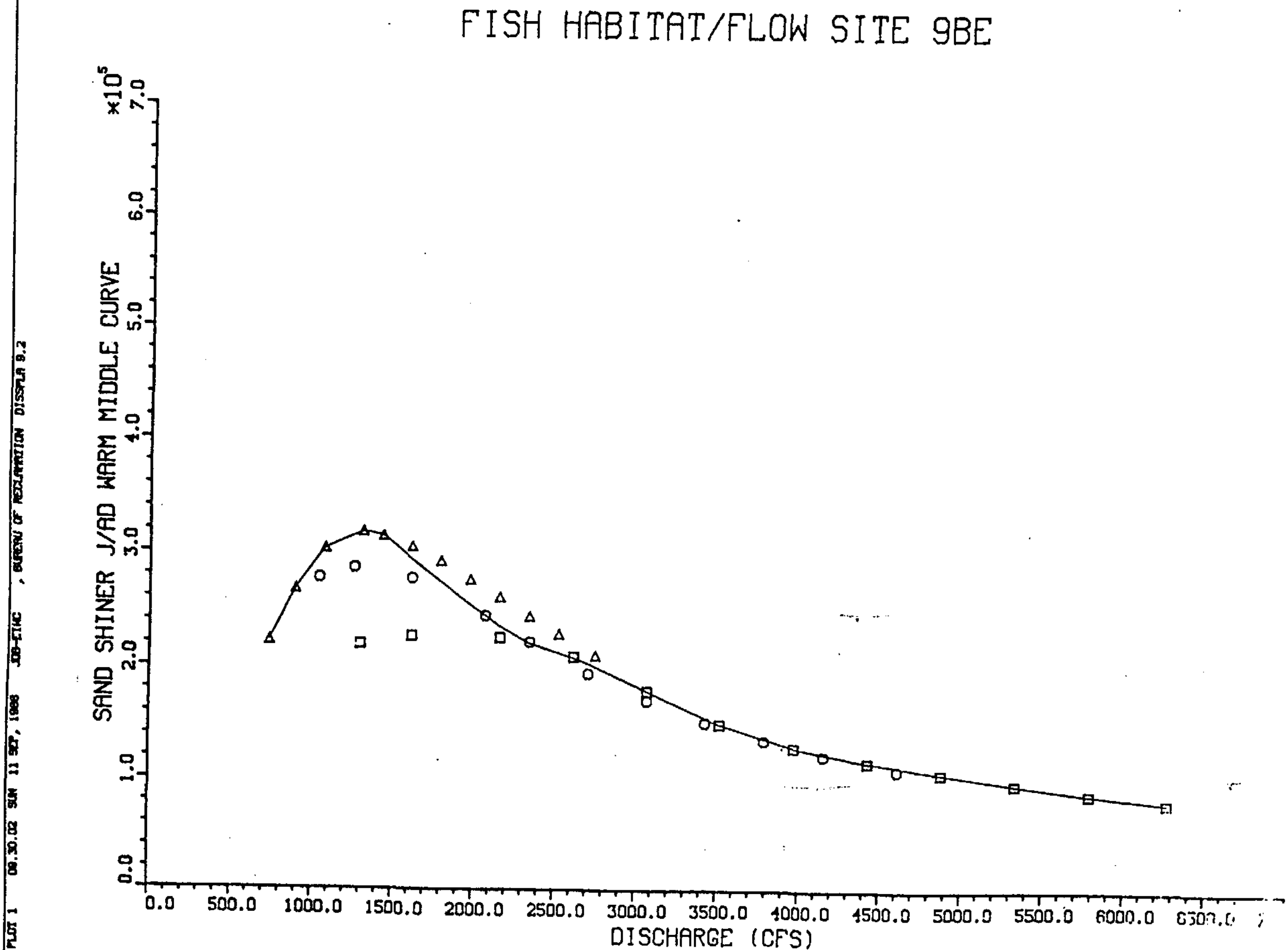


Figure C-17. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 10

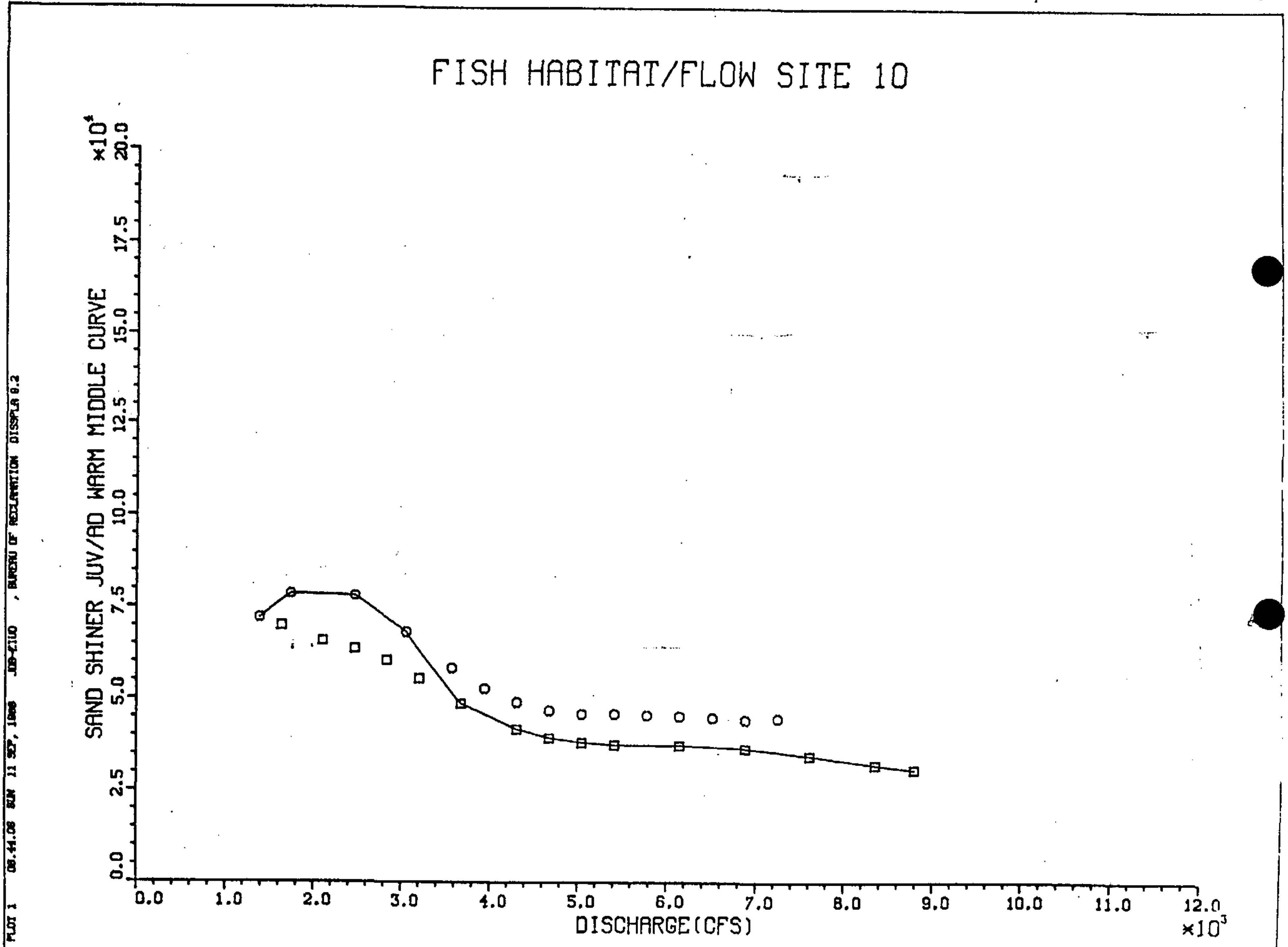


Figure C-18. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 11

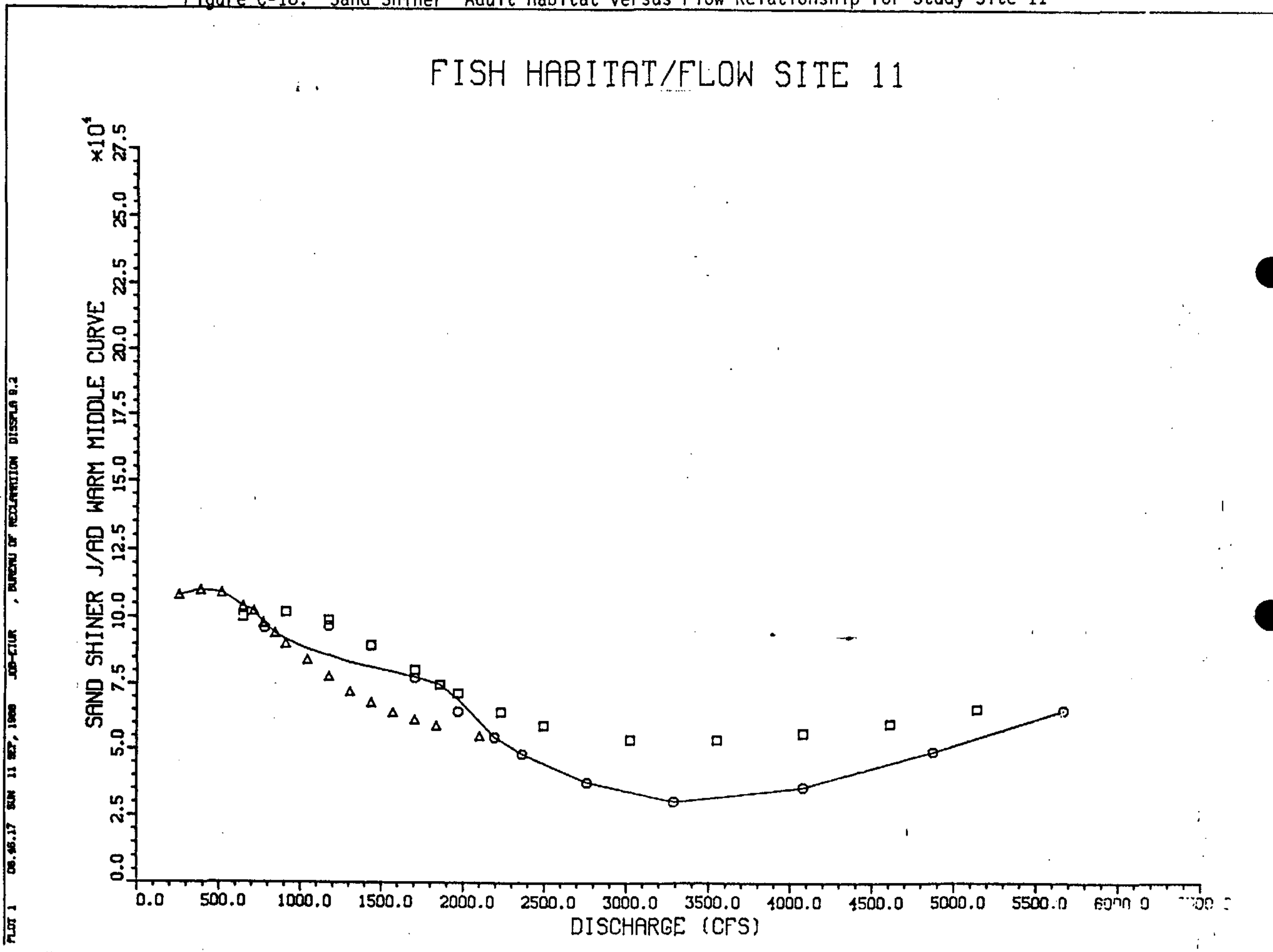


Figure C-19. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 12A

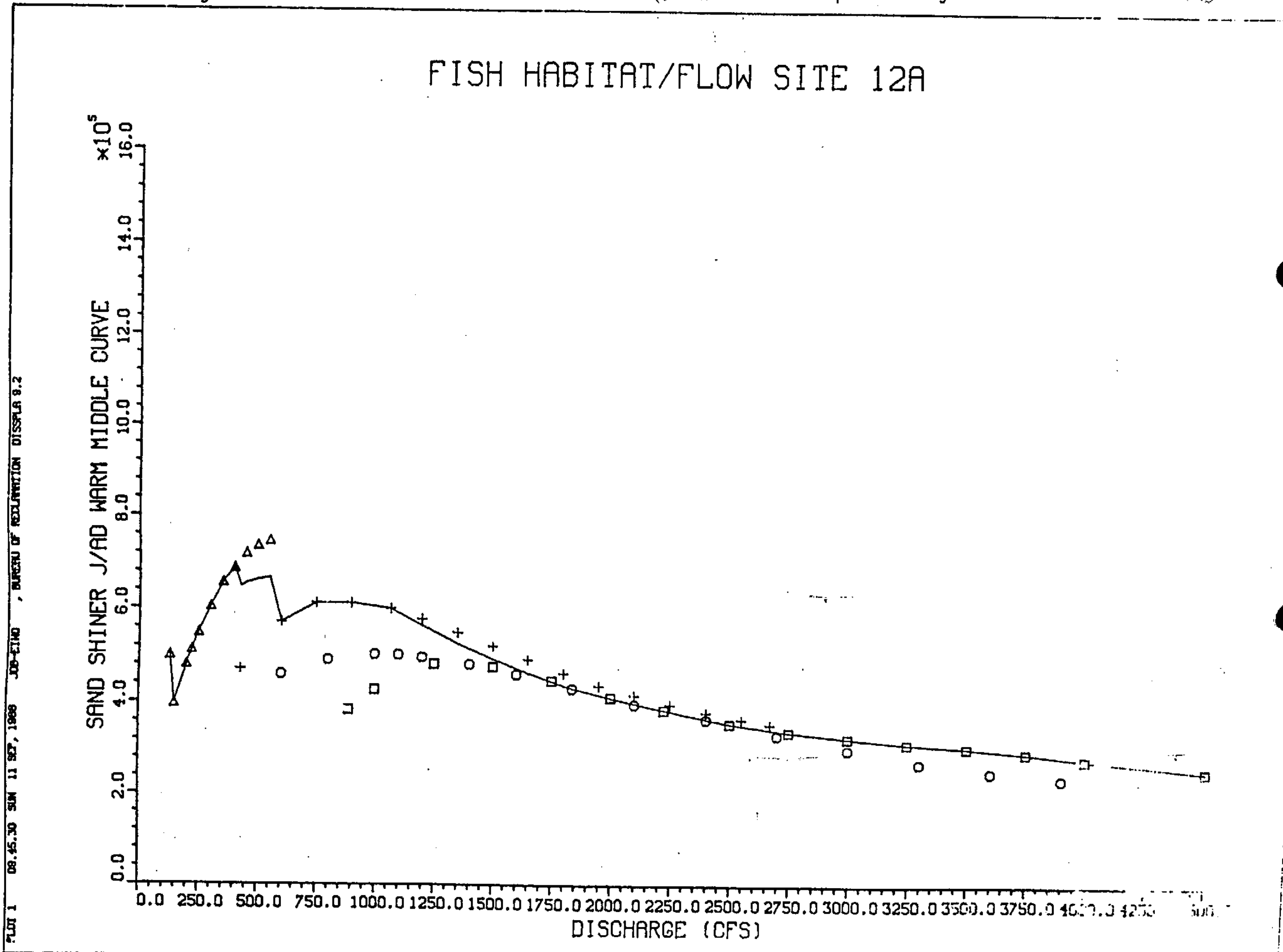
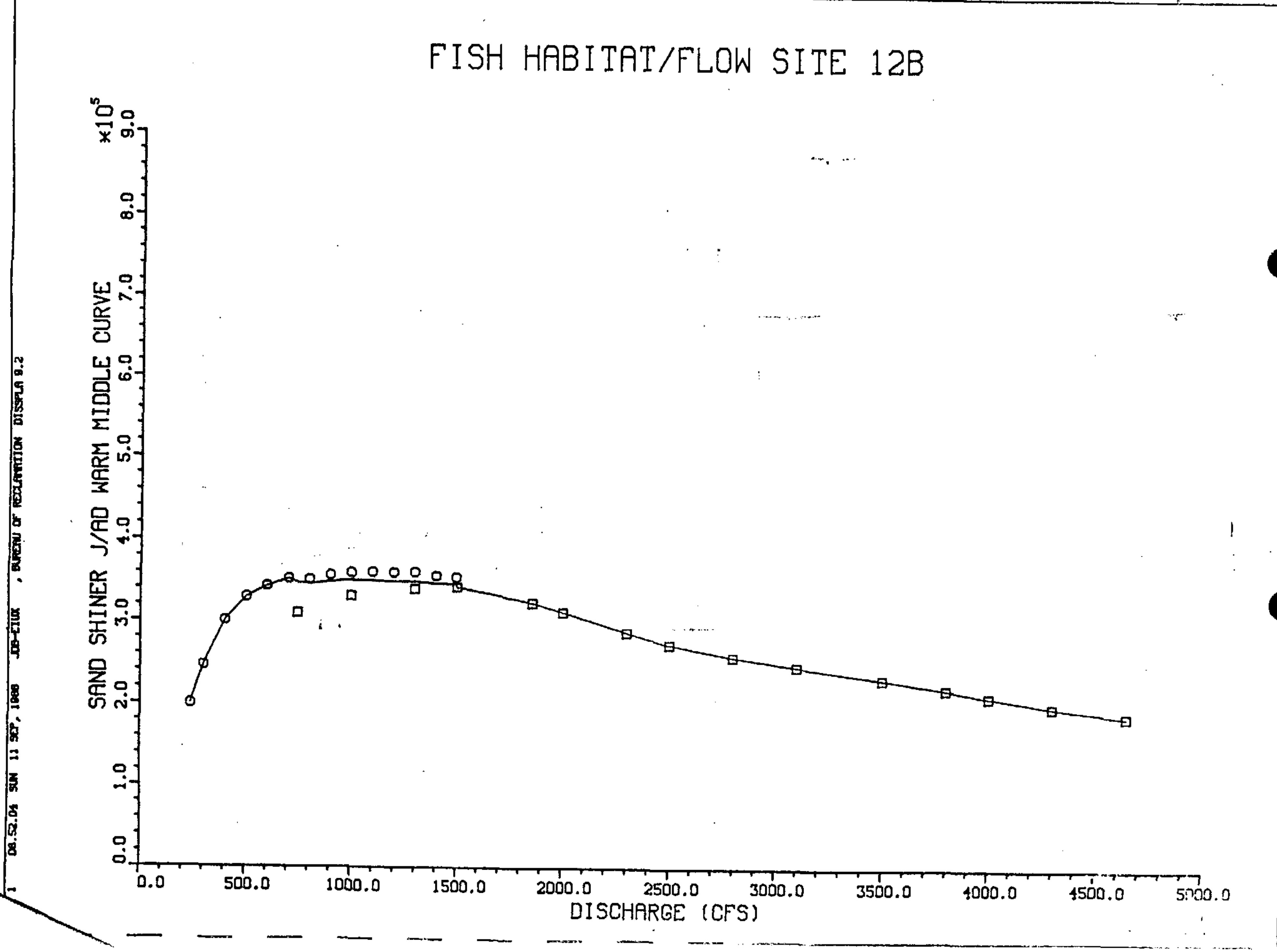


Figure C-20. Sand Shiner Adult Habitat versus Flow Relationship for Study Site 12B



PUBLIC HEARING ON THE

PROPOSED INSTREAM FLOW WATER RIGHT APPLICATION

ON THE PLATTE RIVER

FOR THE CENTRAL PLATTE NATURAL RESOURCES DISTRICT

March 23, 1989

Names and addresses of persons who testified at the hearing:

Dick Mercer, RR 4, Kearney, Nebraska 58847

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Jerry Brabander, U.S. Fish and Wildlife Service, 2604 St. Patrick #7, Grand Island, Nebraska 68803

Gary Mader, City of Grand Island, 208 North Pine, Grand Island, Nebraska 68801

Richard Frogge, P.E. with Miller & Associates, 816 East 25th Street, Kearney, Nebraska 68847

Glen Murray, Sierra Club, 307 East Hall, Grand Island, Nebraska 68801

Monte McKillip, Nebraska Wildlife Federation, 412 South 11th, Lincoln, Nebraska 68508

Joe Jeffrey, RR 2, Lexington, Nebraska 68805

John Turnbull, Upper Big Blue NRD, 105 Lincoln Avenue, York, Nebraska 68467

Ralph Knepper, Central Nebraska Public Power and Irrigation District, Box 740, Holdrege, Nebraska 68949

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Chuck Frith, Platte River Representative, National Audubon Society, 4603 Deva Drive, Grand Island, Nebraska 68801

Cindy Mazour, Deweese, Nebraska 68934

Tim Knott, 4310 Waterbury Lane, Lincoln, Nebraska 68516

Carole Closter, 1900 F Street, #B-10, Lincoln, Nebraska 68510

Grant Newbold, Rural Route, Minden, Nebraska 68959

Gary Lingle, Route 2, Box 203A, Grand Island, Nebraska 68801

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Bill Garthright, 4204 Madison Avenue, Lincoln, Nebraska 68847

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Marie Strom, Route 2, Box 122-A, Gibbon, Nebraska 68840

Dr. Robert I. Price, 1005 West 21st Street, Kearney, Nebraska 68847

Names and addresses of persons who submitted written testimony after March 23, 1989 prior to the April 13, 1989 deadline:

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Linda Valenziano, 2709 Arlington Avenue, Lincoln, Nebraska 68502

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Bill Cita, 1029 C Street #4, Lincoln, Nebraska 68502

W. V. Kuehner, Box 163, Doniphan, Nebraska 68832

Mayor Justus Dobesh, City of Kearney, Box 1180, Kearney, Nebraska 68847

Jerry J. Brabander, Acting Field Supervisor, U.S. Dept. of Interior, Fish and Wildlife Service, 2604 St. Patrick, Suite 7, Grand Island, Nebraska 68803

Monica Usasz, 2835 Everett, Lincoln, Nebraska 68502

Bruce Trindle, President, Nebraska Chapter - The Wildlife Society, Rt. 4, Darberry Road, Norfolk, Nebraska 68701

Kenneth J. Strom, Sanctuary Manager, National Audubon Society, Lillian Annette Rowe Sanctuary, Rt. 2, Box 112-A, Gibbon, Nebraska 68840

Following are tables of the number and percentage of days of 500 cubic feet per second of flow at Overton, Odessa, Grand Island, and Duncan for the time periods January 1 through June 23 and August 23 through December 31 for the study period 1951 through 1980.

A table of the number and percentage of days of 600 cubic feet per second of flow at Overton, Odessa, Grand Island, and Duncan for the time period June 24 through August 22 for the study period 1951 through 1980 follows.

Flow duration tables and curves are attached for the dates January 1 through June 23 at Overton, Odessa, Grand Island, and Duncan; June 24 through August 22 for the same stations; and August 23 through December 31 for the same stations.

This material was prepared by the Bureau of Reclamation using the U.S. Geological Survey streamflow data and the U.S. Fish and Wildlife Service flow duration program.

Number and percentage of days 500 cfs minimum flow was met for forage fish maintenance from January 1 through June 23.

	OVERTON	ODESSA	GRAND ISLAND	DUNCAN
1951	174/100%	174/100%	171/ 98%	174/100%
1952	174/ 99%	173/ 99%	175/100%	174/ 99%
1953	169/ 97%	167/ 96%	167/ 96%	166/ 95%
1954	150/ 86%	133/ 76%	150/ 86%	156/ 90%
1955	132/ 76%	127/ 73%	123/ 71%	129/ 74%
1956	122/ 70%	117/ 67%	112/ 64%	121/ 69%
1957	159/ 91%	130/ 75%	129/ 74%	131/ 75%
1958	172/ 99%	170/ 98%	172/ 99%	174/100%
1959	148/ 85%	144/ 83%	137/ 79%	144/ 83%
1960	162/ 93%	161/ 92%	162/ 93%	166/ 95%
1961	168/ 97%	162/ 93%	167/ 96%	167/ 96%
1962	163/ 94%	159/ 91%	160/ 92%	160/ 92%
1963	141/ 81%	133/ 76%	139/ 80%	149/ 86%
1964	139/ 79%	138/ 79%	139/ 79%	140/ 80%
1965	151/ 87%	150/ 86%	159/ 91%	171/ 98%
1966	140/ 80%	141/ 81%	142/ 82%	147/ 84%
1967	145/ 83%	129/ 74%	139/ 80%	146/ 84%
1968	157/ 90%	154/ 88%	154/ 88%	161/ 92%
1969	167/ 96%	166/ 95%	168/ 97%	173/ 99%
1970	174/100%	174/100%	174/100%	174/100%
1971	174/100%	174/100%	174/100%	174/100%
1972	164/ 94%	162/ 93%	165/ 94%	168/ 96%
1973	174/100%	174/100%	174/100%	174/100%
1974	164/ 94%	167/ 96%	174/100%	174/100%
1975	163/ 94%	154/ 89%	170/ 98%	171/ 98%
1976	151/ 86%	151/ 86%	156/ 89%	156/ 90%
1977	161/ 93%	159/ 91%	171/ 98%	171/ 98%
1978	155/ 89%	136/ 78%	157/ 90%	160/ 92%
1979	161/ 93%	152/ 87%	165/ 95%	168/ 97%
1980	175/100%	175/100%	175/100%	175/100%
Total	4749/ 91%	4606/ 88%	4720/ 90%	4816/ 92%

Number and percentage of days 600 cfs minimum flow was met for forage fish maintenance from June 24 through August 22.

	OVERTON	ODESSA	GRAND ISLAND	DUNCAN
1951	54/ 90%	44/ 73%	47/ 78%	51/ 85%
1952	36/ 60%	26/ 43%	27/ 45%	25/ 42%
1953	0/ 0%	0/ 0%	0/ 0%	0/ 0%
1954	6/ 10%	4/ 7%	0/ 0%	0/ 0%
1955	2/ 3%	1/ 2%	0/ 0%	2/ 3%
1956	0/ 0%	0/ 0%	0/ 0%	0/ 0%
1957	13/ 22%	9/ 15%	13/ 22%	15/ 25%
1958	13/ 22%	17/ 28%	21/ 35%	22/ 37%
1959	0/ 0%	3/ 5%	2/ 3%	5/ 8%
1960	8/ 13%	10/ 17%	21/ 35%	18/ 30%
1961	12/ 20%	7/ 12%	7/ 12%	7/ 12%
1962	25/ 42%	28/ 47%	44/ 73%	48/ 80%
1963	1/ 2%	0/ 0%	0/ 0%	0/ 0%
1964	10/ 17%	5/ 8%	0/ 0%	2/ 3%
1965	25/ 42%	25/ 42%	29/ 48%	28/ 47%
1966	11/ 18%	7/ 12%	3/ 5%	3/ 5%
1967	40/ 67%	39/ 65%	44/ 73%	46/ 77%
1968	17/ 28%	13/ 22%	18/ 30%	19/ 32%
1969	27/ 45%	25/ 42%	37/ 62%	45/ 75%
1970	26/ 43%	21/ 35%	21/ 35%	20/ 33%
1971	36/ 60%	27/ 45%	33/ 55%	33/ 55%
1972	22/ 37%	15/ 25%	20/ 33%	23/ 38%
1973	50/ 83%	46/ 77%	49/ 82%	43/ 72%
1974	14/ 23%	5/ 8%	0/ 0%	1/ 2%
1975	21/ 35%	15/ 25%	22/ 37%	19/ 32%
1976	5/ 8%	7/ 12%	2/ 3%	0/ 0%
1977	5/ 8%	0/ 0%	3/ 5%	4/ 7%
1978	12/ 20%	4/ 7%	1/ 2%	0/ 0%
1979	27/ 45%	23/ 38%	38/ 63%	36/ 60%
1980	12/ 20%	10/ 17%	20/ 33%	15/ 25%
Total	530/ 29%	436/ 24%	522/ 29%	530/ 29%

Number and percentage of days 500 cfs minimum flow was met for forage fish maintenance from August 23 through December 31.

	OVERTON	ODESSA	GRAND ISLAND	DUNCAN
1951	131/100%	131/100%	131/100%	129/ 98%
1952	99/ 76%	80/ 61%	78/ 60%	69/ 53%
1953	79/ 60%	76/ 58%	60/ 46%	55/ 42%
1954	91/ 69%	83/ 63%	63/ 48%	65/ 50%
1955	88/ 67%	49/ 37%	27/ 21%	30/ 23%
1956	59/ 45%	22/ 17%	5/ 4%	5/ 4%
1957	111/ 85%	97/ 74%	99/ 76%	85/ 65%
1958	95/ 73%	88/ 67%	74/ 56%	63/ 48%
1959	105/ 80%	101/ 77%	93/ 71%	91/ 69%
1960	96/ 73%	92/ 70%	72/ 55%	67/ 51%
1961	101/ 77%	94/ 72%	90/ 69%	81/ 62%
1962	116/ 89%	103/ 79%	105/ 80%	101/ 77%
1963	122/ 93%	111/ 85%	102/ 78%	103/ 79%
1964	109/ 83%	94/ 72%	83/ 63%	69/ 53%
1965	131/100%	131/100%	129/ 98%	118/ 90%
1966	110/ 84%	107/ 82%	95/ 73%	91/ 69%
1967	118/ 90%	108/ 82%	106/ 81%	101/ 77%
1968	122/ 93%	121/ 92%	110/ 84%	114/ 87%
1969	124/ 95%	123/ 94%	122/ 93%	122/ 93%
1970	120/ 92%	115/ 88%	109/ 83%	108/ 82%
1971	121/ 92%	117/ 89%	105/ 80%	97/ 74%
1972	123/ 94%	118/ 90%	111/ 85%	110/ 84%
1973	131/100%	131/100%	131/100%	131/100%
1974	123/ 94%	119/ 91%	106/ 81%	90/ 69%
1975	119/ 91%	117/ 89%	114/ 87%	93/ 71%
1976	115/ 88%	105/ 80%	96/ 73%	77/ 59%
1977	130/ 99%	113/ 86%	125/ 95%	119/ 91%
1978	108/ 82%	86/ 66%	83/ 63%	71/ 54%
1979	114/ 87%	63/ 48%	63/ 48%	63/ 48%
1980	118/ 90%	68/ 52%	90/ 69%	68/ 52%
Total	3329/ 85%	2963/ 75%	2777/ 71%	2586/ 66%

Platte River near O[illegible]ton
Flow Duration Table For 01/01-06/23

Class Number	Mid-point	Class Limit	Count	% Frequency
1	26.50	53.00	5228	100.000
2	62.93	68.82	5222	99.885
3	74.72	81.72	5221	99.866
4	88.72	97.03	5215	99.751
5	105.34	115.20	5202	99.503
6	125.07	136.78	5189	99.254
7	148.50	162.41	5162	98.738
8	176.32	192.84	5134	98.202
9	209.35	228.96	5103	97.609
10	248.57	271.86	5069	96.959
11	295.14	322.79	5008	95.792
12	350.43	383.26	4911	93.936
13	416.08	455.06	4812	92.043
14	494.03	540.31	4690	89.709
15	586.58	641.53	4543	86.897
16	696.47	761.71	4365	83.493
17	826.95	904.41	4100	78.424
18	981.87	1073.84	3619	69.223
19	1165.81	1275.02	2920	55.853
20	1384.22	1513.88	2199	42.062
21	1643.54	1797.49	1628	31.140
22	1951.44	2134.23	1225	23.432
23	2317.02	2534.06	834	15.953
24	2751.10	3008.79	578	11.056
25	3266.49	3572.46	433	8.282
26	3878.43	4241.72	342	6.542
27	4605.02	5036.37	241	4.610
28	5467.72	5979.88	189	3.615
29	6492.05	7100.16	158	3.022
30	7708.27	8430.30	113	2.161
31	9152.34	10009.64	90	1.721
32	10866.94	11884.85	47	0.899
33	12902.76	14111.36	23	0.440
34	15319.96	16754.98	8	0.153
35	18190.01	18800.00	1	0.019

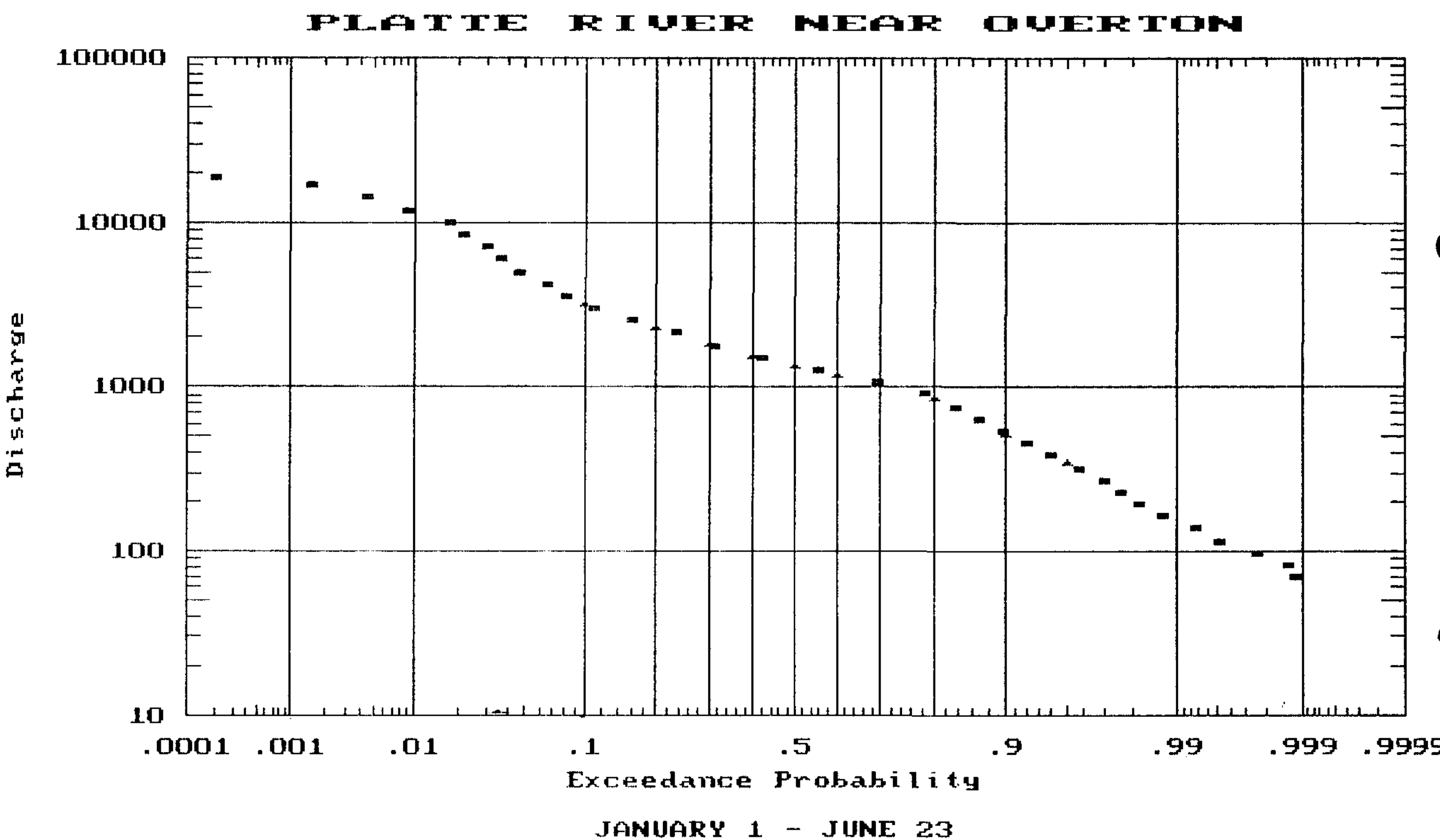
# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
0	53.0	53.0	18800.0	1864.6

Interpolated Values for Specified Frequencies

.10	3193.8	.20	2290.6	.30	1838.4	.40	1558.0	.50	1363.4
.60	1204.0	.70	1057.5	.80	856.4	.90	528.7	.95	347.2

Interpolated Frequencies

400.00	93.46
800.00	82.01
1000.00	72.90
1100.00	67.17
1200.00	60.25
2000.00	26.09


PLATTE RIVER NEAR OVERTON
Discharge
100000
10000
1000
100
10
.0001
.001
.01
.1
.5
.9
.99
.999
.9999
Exceedance Probability
JANUARY 1 - JUNE 23

platte river near odessa
Flow Duration Table For 01/01-06/23

Class Number	Mid-point	Class Limit	Count	% Frequency
1	0.00	0.00	5228	100.000
2	1.00	2.00	5219	99.828
3	2.63	3.05	5216	99.770
4	3.47	4.02	5213	99.713
5	4.57	5.29	5210	99.656
6	6.02	6.97	5209	99.637
7	7.93	9.18	5206	99.579
8	10.44	12.09	5203	99.522
9	13.75	15.93	5199	99.445
10	18.11	20.98	5193	99.331
11	23.85	27.63	5185	99.178
12	31.41	36.39	5170	98.891
13	41.37	47.93	5159	98.680
14	54.49	63.12	5134	98.202
15	71.76	83.14	5111	97.762
16	94.51	109.50	5087	97.303
17	124.48	144.21	5042	96.442
18	163.95	189.94	4986	95.371
19	215.93	250.16	4914	93.994
20	284.39	329.47	4809	91.985
21	374.55	433.93	4686	89.633
22	493.31	571.51	4514	86.343
23	649.71	752.71	4255	81.389
24	855.71	991.36	3763	71.978
25	1127.02	1305.68	2669	51.052
26	1484.34	1719.65	1727	33.034
27	1954.96	2264.88	1135	21.710
28	2574.80	2982.98	643	12.299
29	3391.15	3928.75	382	7.307
30	4466.34	5174.38	225	4.304
31	5882.42	6814.95	166	3.175
32	7747.48	8975.67	104	1.989
33	10203.87	11821.47	34	0.650
34	13439.07	15569.54	10	0.191
35	17700.01	17900.00	1	0.019

# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
9	0.0	2.0	17900.0	1826.0

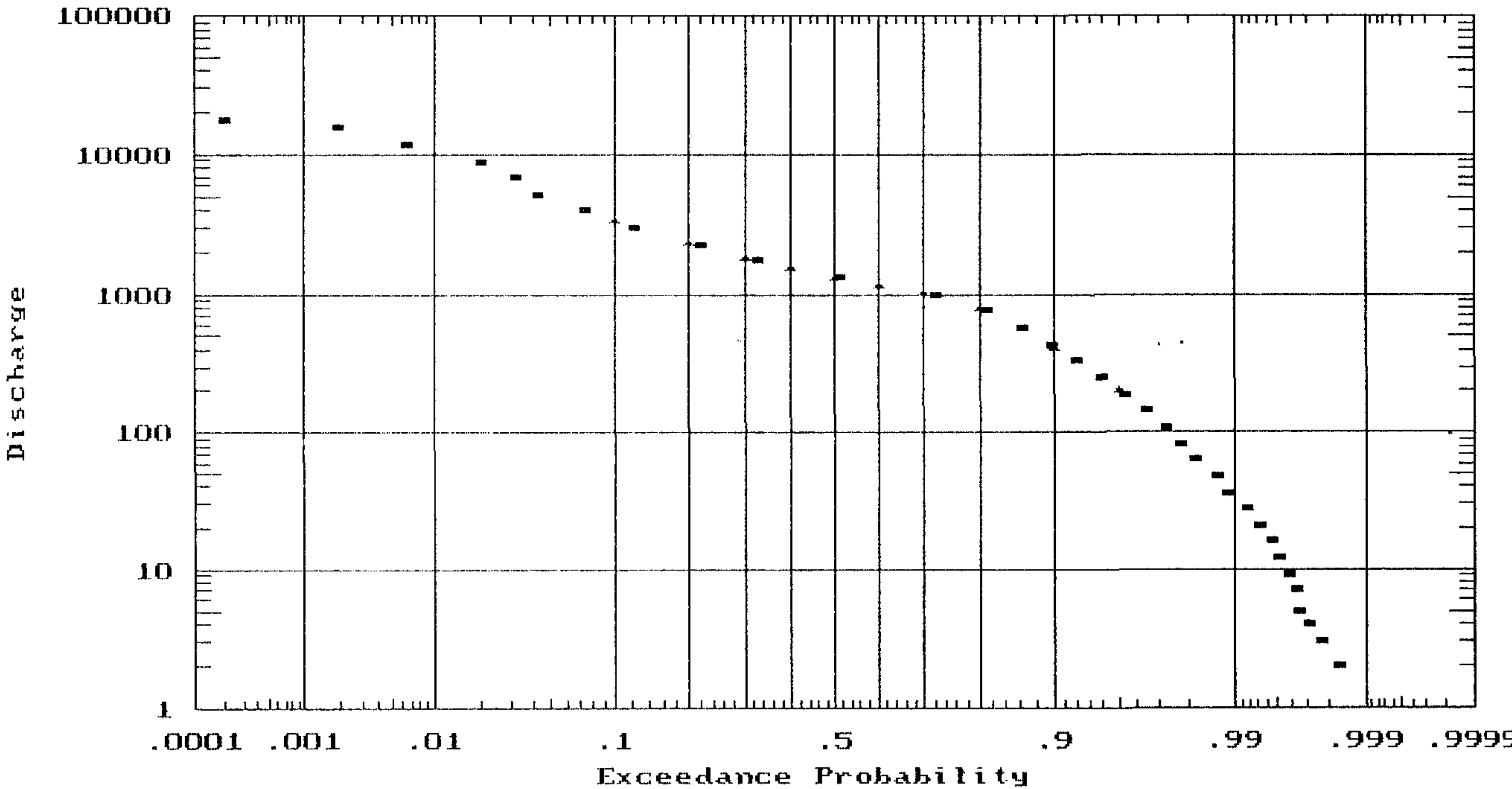
Interpolated Values for Specified Frequencies

.10	3328.0	.20	2356.8	.30	1831.8	.40	1523.6	.50	1323.0
.60	1147.1	.70	1013.8	.80	782.3	.90	415.5	.95	204.5

Interpolated Frequencies

400.00	90.32
800.00	79.21
1000.00	71.20
1100.00	63.22
1200.00	56.72
2000.00	26.24

PLATTE RIVER NEAR ODESSA



JANUARY 1 - JUNE 23

Platte River near Grand Island
Flow Duration Table For 01/01-06/23

Class Number	Mid-point	Class Limit	Count	% Frequency
1	0.00	0.00	5228	100.000
2	0.50	1.00	5199	99.445
3	1.34	1.58	5197	99.407
4	1.81	2.12	5197	99.407
5	2.43	2.85	5197	99.407
6	3.27	3.83	5197	99.407
7	4.40	5.16	5197	99.407
8	5.91	6.93	5197	99.407
9	7.95	9.32	5196	99.388
10	10.70	12.54	5190	99.273
11	14.38	16.86	5187	99.216
12	19.34	22.68	5180	99.082
13	26.01	30.50	5175	98.986
14	34.98	41.01	5166	98.814
15	47.04	55.15	5148	98.470
16	63.26	74.16	5128	98.087
17	85.07	99.74	5115	97.839
18	114.40	134.12	5098	97.513
19	153.84	180.37	5067	96.920
20	206.89	242.55	5009	95.811
21	278.22	326.18	4928	94.262
22	374.14	438.64	4796	91.737
23	503.14	589.88	4592	87.835
24	676.61	793.26	4219	80.700
25	909.90	1066.76	3482	66.603
26	1223.62	1434.56	2580	49.350
27	1645.50	1929.17	1651	31.580
28	2212.84	2594.31	968	18.516
29	2975.78	3488.78	551	10.539
30	4001.78	4691.65	307	5.872
31	5381.52	6309.24	179	3.424
32	7236.97	8484.56	103	1.970
33	9732.14	11409.88	33	0.631
34	13087.61	15343.80	13	0.249
35	17599.98	17700.00	1	0.019

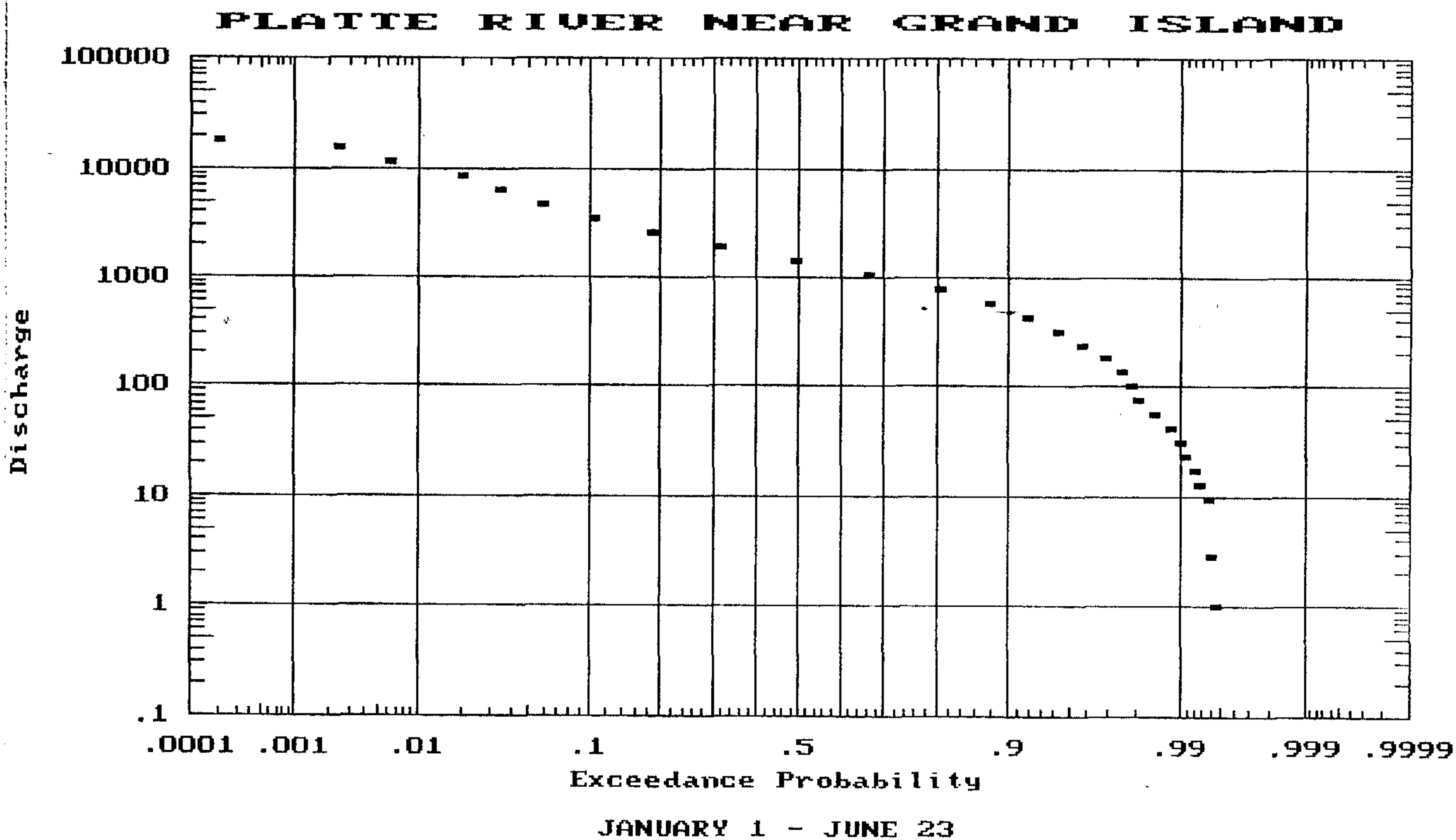
# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
29	0.0	1.0	17700.0	1903.8

Interpolated Values for Specified Frequencies

.10	3582.9	.20	2485.6	.30	1984.9	.40	1649.1	.50	1416.1
.60	1182.7	.70	987.9	.80	804.0	.90	499.7	.95	283.1

Interpolated Frequencies

400.00	92.52
800.00	80.26
1000.00	69.45
1100.00	64.57
1200.00	59.12
2000.00	29.59


PLATTE RIVER NEAR GRAND ISLAND
100000
10000
1000
100
10
1
.1
Discharge
.0001
.001
.01
.1
.5
.9
.99
.999
.9999
Exceedance Probability
JANUARY 1 - JUNE 23

platte river near duncan
Flow Duration Table For 01/01-06/23

Class Number	Mid-point	Class Limit	Count	% Frequency
1	0.10	0.20	5228	100.000
2	0.28	0.34	5227	99.981
3	0.40	0.48	5226	99.962
4	0.56	0.67	5223	99.904
5	0.79	0.95	5220	99.847
6	1.11	1.33	5217	99.790
7	1.56	1.88	5215	99.751
8	2.19	2.64	5210	99.656
9	3.09	3.72	5207	99.598
10	4.35	5.23	5200	99.464
11	6.12	7.37	5198	99.426
12	8.61	10.37	5195	99.369
13	12.13	14.60	5189	99.254
14	17.07	20.56	5184	99.158
15	24.04	28.94	5170	98.891
16	33.84	40.75	5164	98.776
17	47.65	57.36	5159	98.680
18	67.08	80.76	5144	98.393
19	94.44	113.70	5120	97.934
20	132.96	160.08	5095	97.456
21	187.20	225.37	5066	96.901
22	263.55	317.29	5017	95.964
23	371.04	446.71	4873	93.210
24	522.38	628.91	4565	87.318
25	735.44	885.43	4040	77.276
26	1035.41	1246.57	3294	63.007
27	1457.73	1755.01	2303	44.051
28	2052.29	2470.83	1360	26.014
29	2889.36	3478.61	706	13.504
30	4067.86	4897.44	413	7.900
31	5727.02	6894.97	200	3.826
32	8062.92	9707.24	88	1.683
33	11351.56	13666.55	28	0.536
34	15981.54	19240.76	5	0.096
35	22499.97	22900.00	1	0.019

# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
0	0.2	0.2	22900.0	2141.7

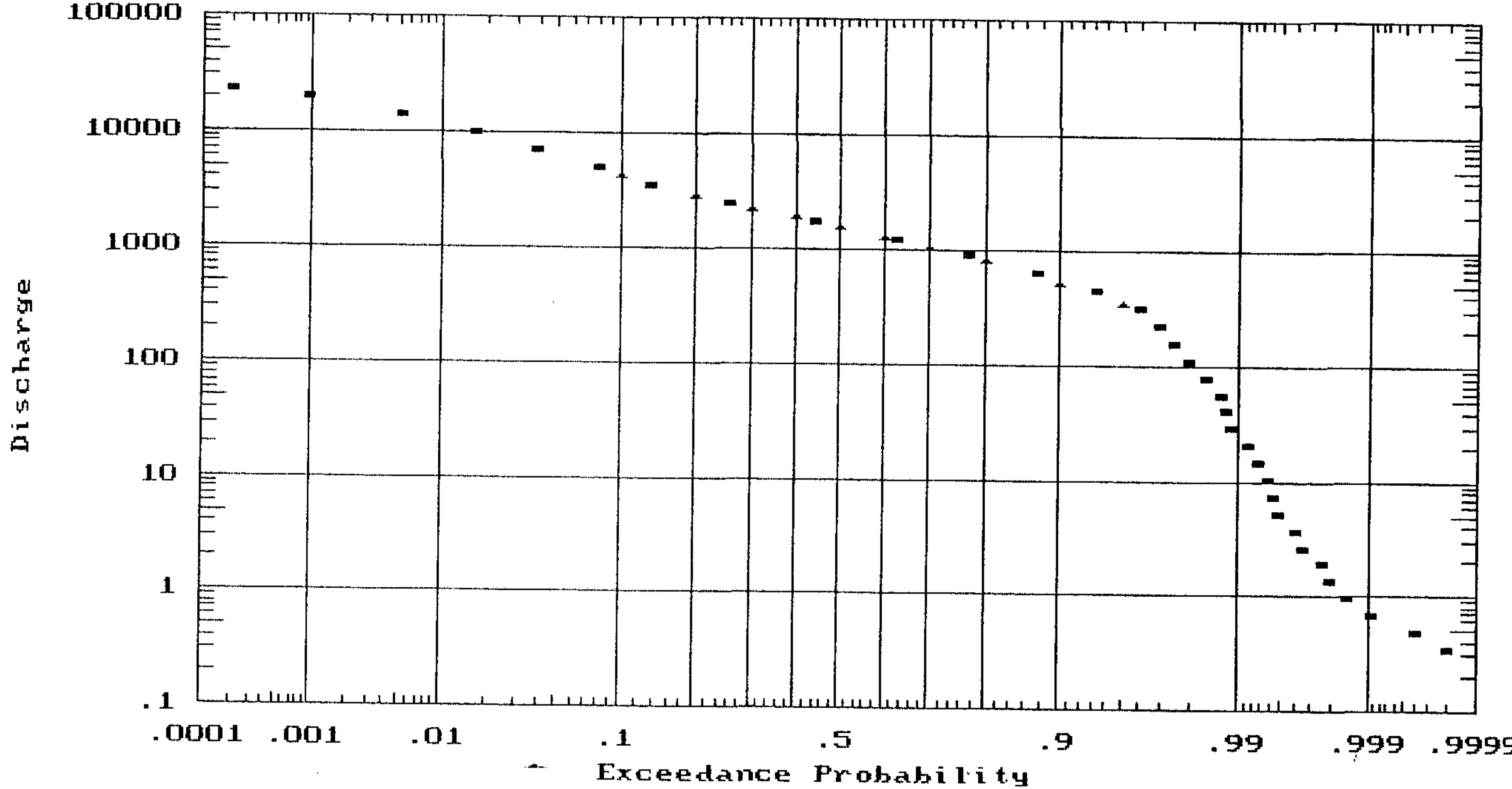
Interpolated Values for Specified Frequencies

.10	4213.5	.20	2834.1	.30	2252.3	.40	1868.5	.50	1554.9
.60	1306.2	.70	1045.0	.80	803.6	.90	536.7	.95	357.2

Interpolated Frequencies

400.00	94.09
800.00	80.13
1000.00	71.86
1100.00	67.89
1200.00	64.45
2000.00	36.02

PLATTE RIVER NEAR DUNCAN



JANUARY 1 - JUNE 23

Platte River near [illegible]rton
Flow Duration Table For 06/24-08/22

Class Number	Mid-point	Class Limit	Count	% Frequency
1	15.50	31.00	1800	100.000
2	36.98	40.55	1798	99.889
3	44.12	48.38	1796	99.778
4	52.63	57.71	1794	99.667
5	62.79	68.85	1791	99.500
6	74.91	82.14	1769	98.278
7	89.36	97.99	1745	96.944
8	106.61	116.90	1704	94.667
9	127.18	139.46	1610	89.444
10	151.73	166.37	1465	81.389
11	181.01	198.47	1352	75.111
12	215.94	236.78	1180	65.556
13	257.61	282.47	1015	56.389
14	307.33	336.98	871	48.389
15	366.64	402.01	775	43.056
16	437.39	479.59	659	36.611
17	521.80	572.15	551	30.611
18	622.50	682.56	463	25.722
19	742.63	814.28	384	21.333
20	885.94	971.42	309	17.167
21	1056.91	1158.89	264	14.667
22	1260.87	1382.53	224	12.444
23	1504.20	1649.34	177	9.833
24	1794.48	1967.63	139	7.722
25	2140.78	2347.35	112	6.222
26	2553.91	2800.34	97	5.389
27	3046.77	3340.76	75	4.167
28	3634.74	3985.46	59	3.278
29	4336.18	4754.58	48	2.667
30	5172.98	5672.13	38	2.111
31	6171.28	6766.75	24	1.333
32	7362.22	8072.61	10	0.556
33	8782.99	9630.47	7	0.389
34	10477.95	11488.97	3	0.167
35	12500.00	14200.00	1	0.056

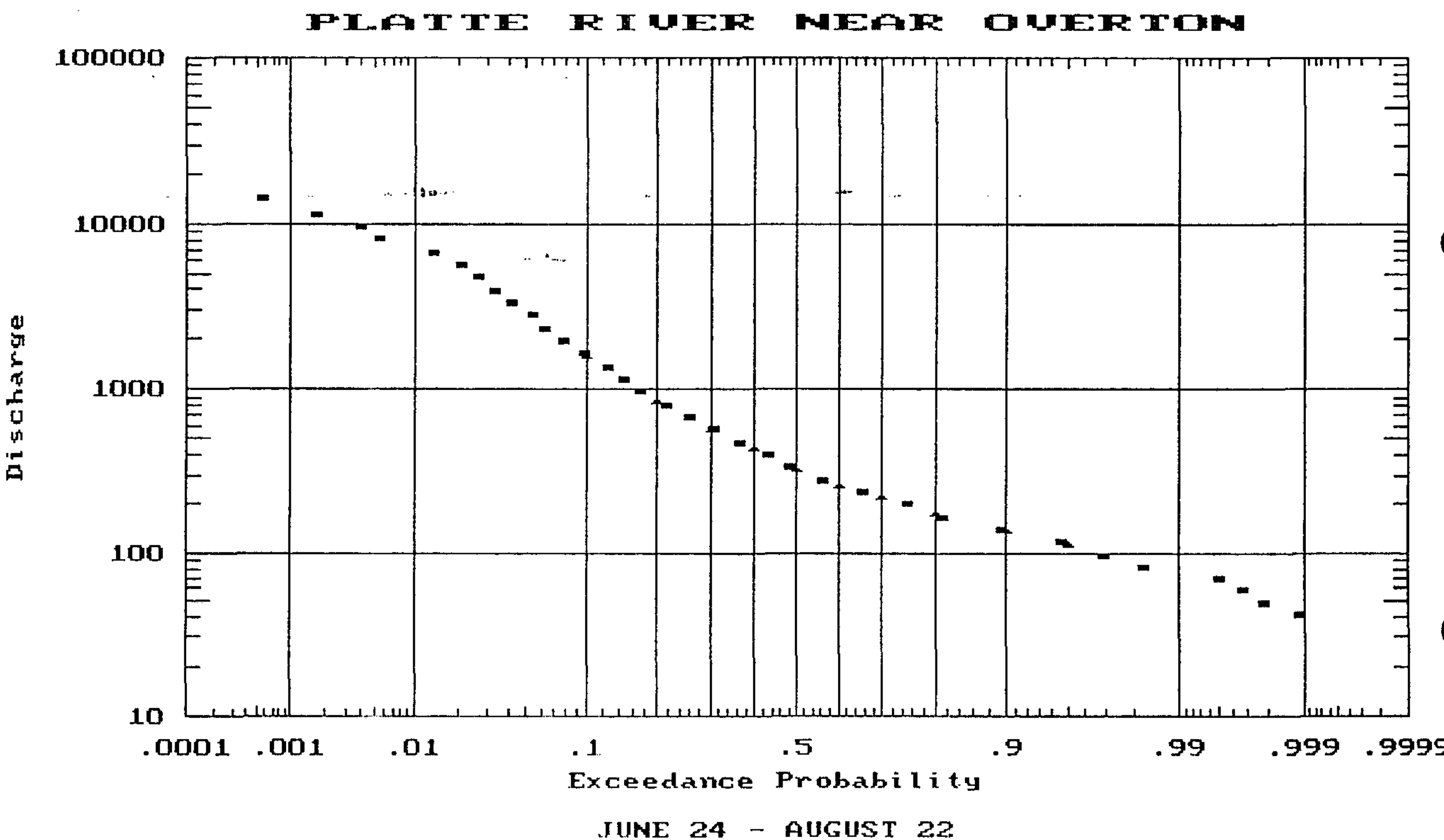
# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
0	31.0	31.0	14200.0	758.7

Interpolated Values for Specified Frequencies

.10	1628.7	.20	858.1	.30	584.0	.40	435.5	.50	324.5
.60	262.7	.70	217.5	.80	172.8	.90	136.8	.95	113.9

Interpolated Frequencies

400.00	43.20
800.00	21.74
1000.00	16.73
1100.00	15.37
1200.00	14.20
2000.00	7.57



PLATTE RIVER NEAR OVERTON
100000
10000
1000
100
10
Discharge
.0001
.001
.01
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.5
.9
.99
.999
.9999
Exceedance Probability
JUNE 24 - AUGUST 22

platte river near odessa
Flow Duration Table For 06/24-08/22

Class Number	Mid-point	Class Limit	Count	% Frequency
1	0.00	0.00	1800	100.000
2	0.05	0.10	1679	93.278
3	0.14	0.17	1677	93.167
4	0.20	0.25	1674	93.000
5	0.29	0.35	1673	92.944
6	0.41	0.50	1667	92.611
7	0.58	0.71	1667	92.611
8	0.83	1.01	1649	91.611
9	1.18	1.44	1644	91.333
10	1.69	2.04	1633	90.722
11	2.40	2.91	1628	90.444
12	3.42	4.14	1604	89.111
13	4.86	5.89	1576	87.556
14	6.92	8.39	1553	86.278
15	9.85	11.94	1506	83.667
16	14.03	17.00	1457	80.944
17	19.97	24.20	1400	77.778
18	28.42	34.44	1328	73.778
19	40.46	49.03	1236	68.667
20	57.59	69.79	1154	64.111
21	81.99	99.35	1072	59.556
22	116.71	141.42	967	53.722
23	166.13	201.31	830	46.111
24	236.48	286.56	711	39.500
25	336.63	407.91	594	33.000
26	479.19	580.66	447	24.833
27	682.12	826.56	338	18.778
28	970.99	1176.60	243	13.500
29	1382.20	1674.87	165	9.167
30	1967.55	2384.17	118	6.556
31	2800.79	3393.84	76	4.222
32	3986.89	4831.10	47	2.611
33	5675.30	6877.02	19	1.056
34	8078.74	9789.37	5	0.278
35	11500.00	12900.00	1	0.056

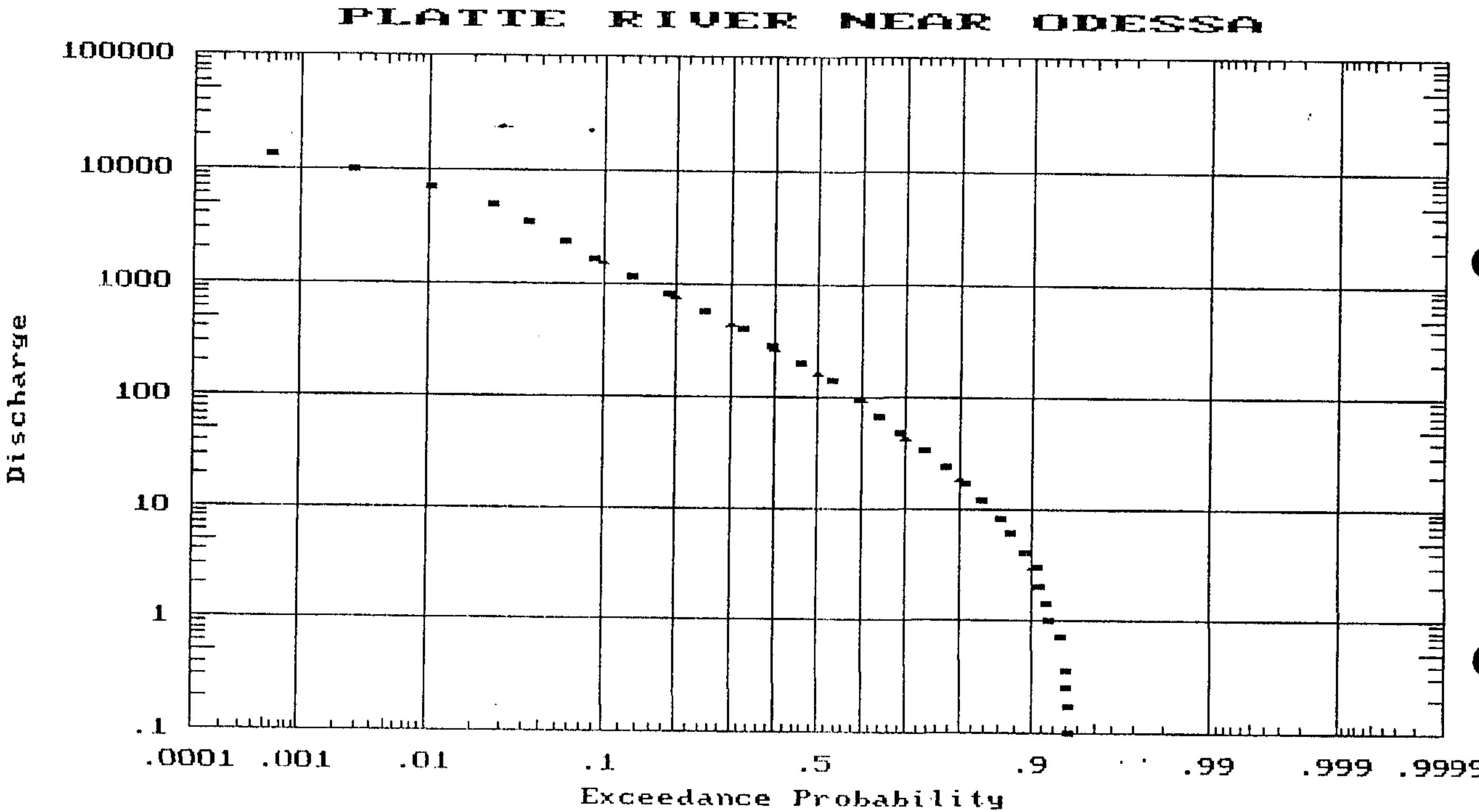
# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
121	0.0	0.1	12900.0	632.9

Interpolated Values for Specified Frequencies

.10	1547.1	.20	763.3	.30	459.2	.40	278.4	.50	166.9
.60	95.9	.70	44.6	.80	18.9	.90	3.3	.95	0.1

Interpolated Frequencies

400.00	33.33
800.00	19.27
1000.00	15.72
1100.00	14.38
1200.00	13.21
2000.00	7.75



JUNE 24 - AUGUST 24

Platte River near Grand Island
Flow Duration Table For 06/24-08/22

Class Number	Mid-point	Class Limit	Count	% Frequency
1	0.00	0.00	1800	100.000
2	0.04	0.08	1457	80.944
3	0.11	0.14	1455	80.833
4	0.16	0.20	1455	80.833
5	0.24	0.29	1455	80.833
6	0.34	0.41	1455	80.833
7	0.48	0.59	1454	80.778
8	0.69	0.84	1453	80.722
9	0.99	1.21	1439	79.944
10	1.42	1.73	1436	79.778
11	2.04	2.48	1423	79.056
12	2.92	3.56	1411	78.389
13	4.19	5.10	1388	77.111
14	6.01	7.31	1371	76.167
15	8.61	10.47	1351	75.056
16	12.34	15.01	1328	73.778
17	17.68	21.51	1307	72.611
18	25.34	30.82	1269	70.500
19	36.31	44.18	1224	68.000
20	52.04	63.31	1180	65.556
21	74.58	90.73	1130	62.778
22	106.88	130.03	1051	58.389
23	153.18	186.36	951	52.833
24	219.53	267.08	813	45.167
25	314.62	382.76	669	37.167
26	450.90	548.55	549	30.500
27	646.20	786.15	427	23.722
28	926.10	1126.68	296	16.444
29	1327.25	1614.69	201	11.167
30	1902.14	2314.09	131	7.278
31	2726.05	3316.44	91	5.056
32	3906.83	4752.95	57	3.167
33	5599.07	6811.68	15	0.833
34	8024.30	9762.15	3	0.167
35	11500.01	11800.00	1	0.056

# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
343	0.0	0.1	11800.0	698.2

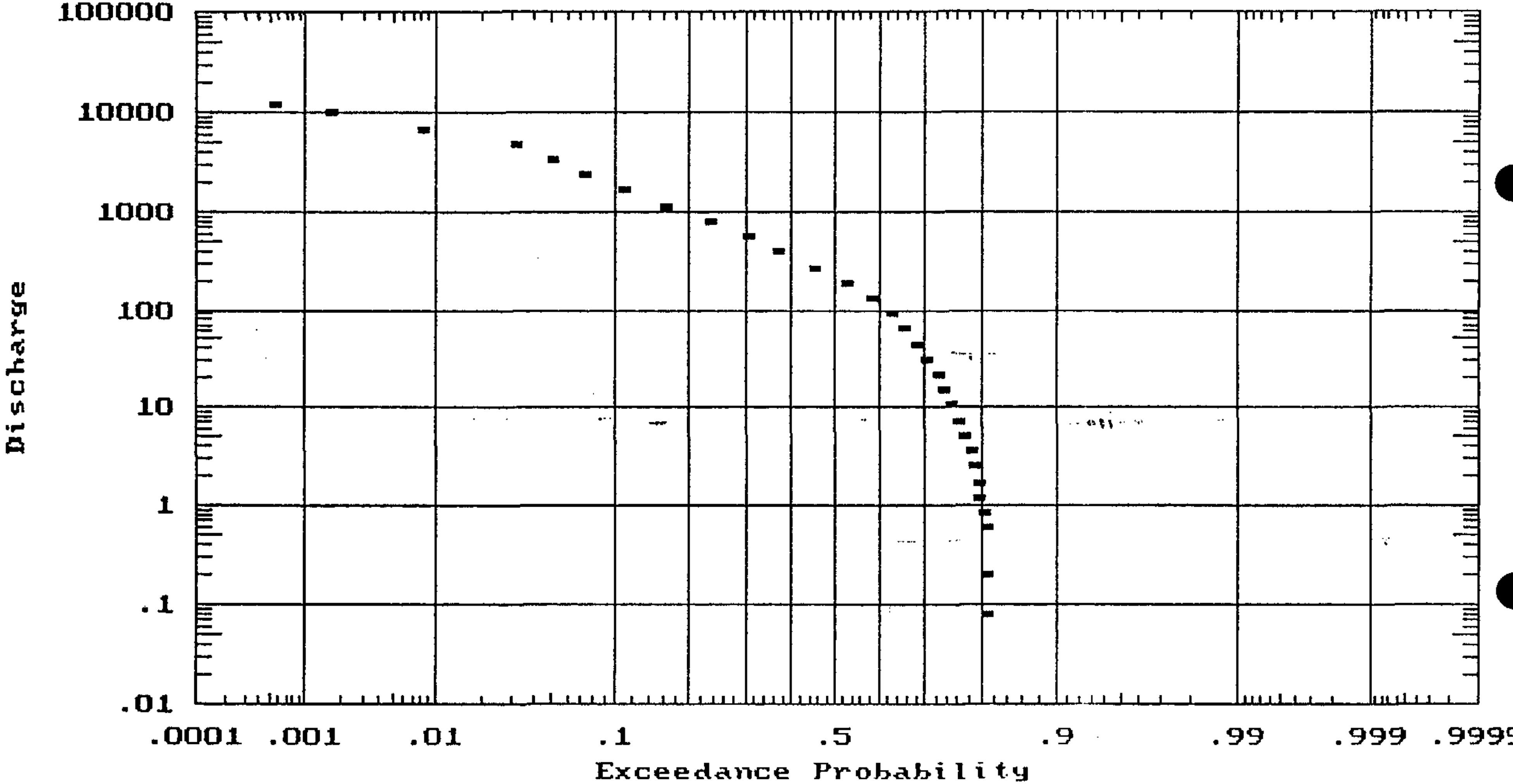
Interpolated Values for Specified Frequencies

.10	1771.6	.20	929.6	.30	561.7	.40	334.2	.50	211.5
.60	113.6	.70	33.1	.80	1.2	.90	0.0	.95	0.0

Interpolated Frequencies

400.00	36.28
800.00	23.30
1000.00	18.57
1100.00	16.85
1200.00	15.37
2000.00	8.66

PLATTE RIVER NEAR GRAND ISLAND



JUNE 24 - AUGUST 22

platte river near duncan
Flow Duration Table For 06/24-08/22

Class Number	Mid-point	Class Limit	Count	% Frequency
1	0.00	0.00	1800	100.000
2	0.01	0.02	1662	92.333
3	0.03	0.04	1660	92.222
4	0.04	0.06	1660	92.222
5	0.07	0.08	1660	92.222
6	0.10	0.12	1653	91.833
7	0.15	0.18	1652	91.778
8	0.22	0.27	1645	91.389
9	0.33	0.41	1645	91.389
10	0.49	0.61	1642	91.222
11	0.73	0.91	1632	90.667
12	1.08	1.35	1604	89.111
13	1.62	2.01	1590	88.333
14	2.41	3.00	1566	87.000
15	3.60	4.48	1535	85.278
16	5.36	6.68	1498	83.222
17	7.99	9.95	1449	80.500
18	11.91	14.84	1376	76.444
19	17.76	22.12	1302	72.333
20	26.48	32.98	1255	69.722
21	39.48	49.17	1214	67.444
22	58.86	73.30	1144	63.556
23	87.75	109.28	1055	58.611
24	130.82	162.92	950	52.778
25	195.03	242.90	834	46.333
26	290.77	362.13	695	38.611
27	433.49	539.88	562	31.222
28	646.28	804.89	439	24.389
29	963.51	1199.99	336	18.667
30	1436.47	1789.02	215	11.944
31	2141.57	2667.19	145	8.056
32	3192.80	3976.41	90	5.000
33	4760.03	5928.29	37	2.056
34	7096.55	8838.27	10	0.556
35	10579.99	12400.00	1	0.056

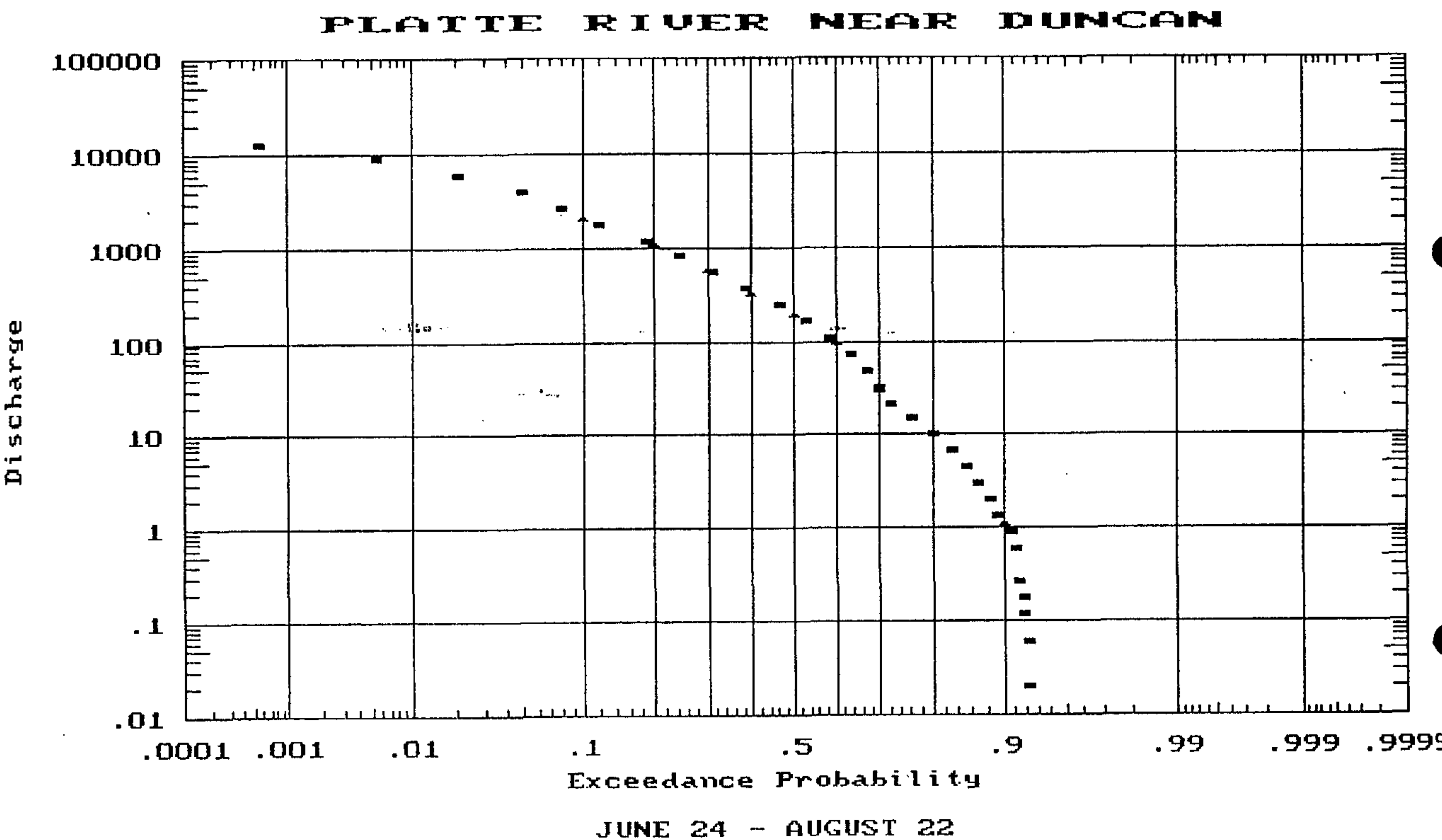
# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
138	0.0	0.0	12400.0	773.2

Interpolated Values for Specified Frequencies

.10	2142.1	.20	1082.5	.30	575.9	.40	335.2	.50	192.3
.60	97.4	.70	31.6	.80	10.4	.90	1.1	.95	0.0

Interpolated Frequencies

400.00	36.62
800.00	24.48
1000.00	21.09
1100.00	19.79
1200.00	18.67
2000.00	10.70


PLATTE RIVER NEAR DUNCAN
100000
10000
1000
100
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1
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Discharge
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.5
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.99
.999
.9999
Exceedance Probability
JUNE 24 - AUGUST 22

Platte River near [illegible]rton
Flow Duration Table For 08/23-12/31

Class Number	Mid-point	Class Limit	Count	% Frequency
1	9.00	18.00	3930	100.000
2	21.56	23.69	3927	99.924
3	25.82	28.37	3925	99.873
4	30.92	33.97	3919	99.720
5	37.02	40.68	3910	99.491
6	44.34	48.72	3904	99.338
7	53.10	58.34	3896	99.135
8	63.59	69.87	3882	98.779
9	76.15	83.67	3856	98.117
10	91.20	100.21	3822	97.252
11	109.21	120.00	3791	96.463
12	130.79	143.71	3758	95.623
13	156.63	172.11	3713	94.478
14	187.58	206.11	3652	92.926
15	224.64	246.83	3593	91.425
16	269.02	295.60	3536	89.975
17	322.17	354.00	3476	88.448
18	385.82	423.94	3401	86.539
19	462.05	507.69	3318	84.427
20	553.34	608.00	3188	81.120
21	662.66	728.12	2982	75.878
22	793.58	871.98	2637	67.099
23	950.37	1044.26	1988	50.585
24	1138.14	1250.57	1266	32.214
25	1363.00	1497.64	865	22.010
26	1632.29	1793.53	581	14.784
27	1954.78	2147.88	291	7.405
28	2340.99	2572.24	134	3.410
29	2803.49	3080.44	112	2.850
30	3357.38	3689.04	90	2.290
31	4020.70	4417.88	50	1.272
32	4815.07	5290.73	45	1.145
33	5766.38	6336.02	19	0.483
34	6905.65	7587.82	4	0.102
35	8270.00	8350.00	1	0.025

# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
0	18.0	18.0	8350.0	1178.4

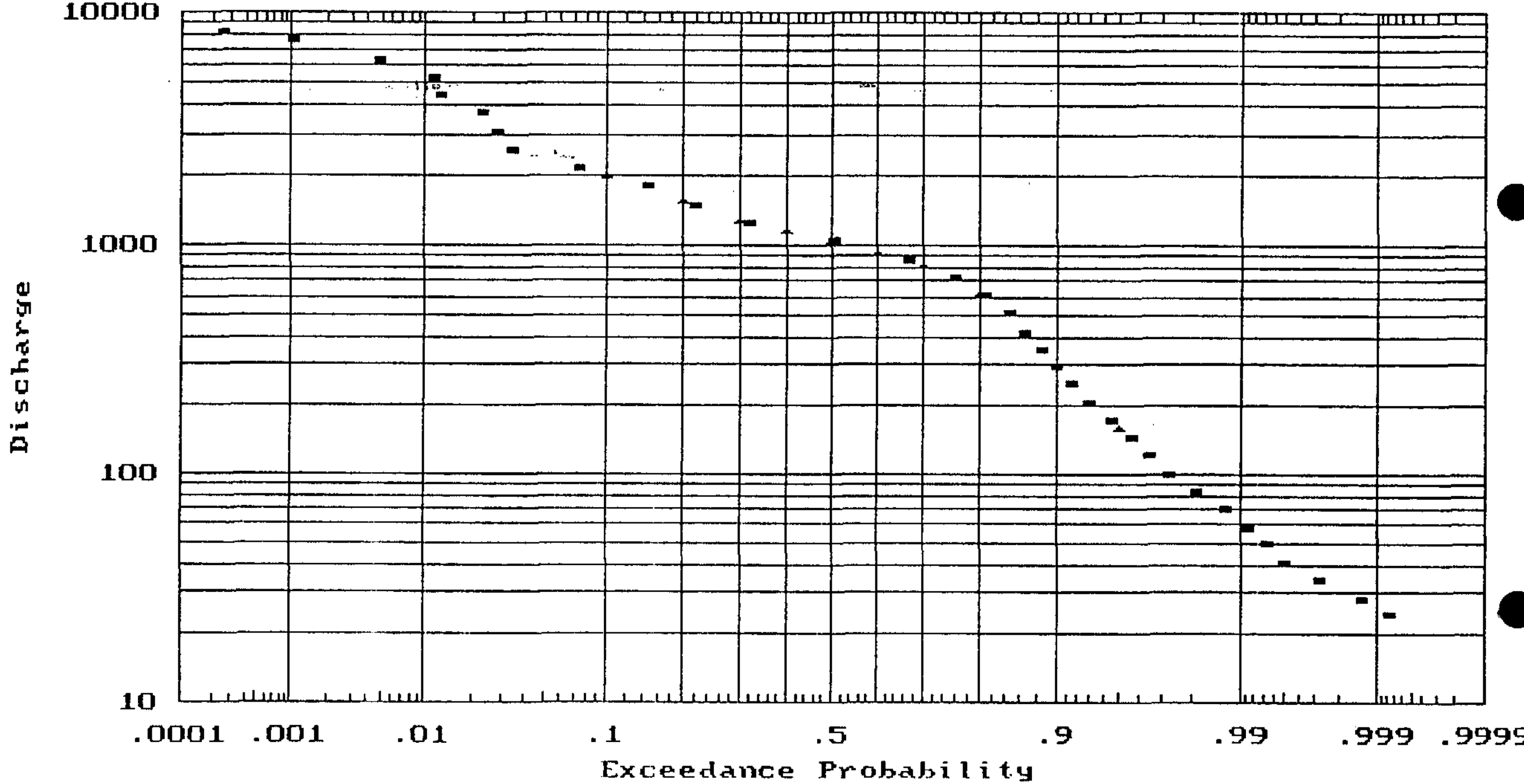
Interpolated Values for Specified Frequencies

.10	1986.0	.20	1564.1	.30	1293.4	.40	1146.9	.50	1049.1
.60	936.5	.70	819.5	.80	631.2	.90	294.7	.95	158.5

Interpolated Frequencies

400.00	87.15
800.00	71.16
1000.00	54.14
1100.00	44.41
1200.00	35.72
2000.00	9.73

PLATTE RIVER NEAR OVERTON



AUGUST 23 - DECEMBER 31

platte river near odessa
Flow Duration Table For 08/23-12/31

Class Number	Mid-point	Class Limit	Count	% Frequency
1	0.00	0.00	3930	100.000
2	0.20	0.40	3798	96.641
3	0.54	0.63	3795	96.565
4	0.73	0.85	3795	96.565
5	0.98	1.15	3784	96.285
6	1.32	1.55	3783	96.260
7	1.78	2.09	3779	96.158
8	2.40	2.82	3777	96.107
9	3.23	3.80	3769	95.903
10	4.36	5.12	3759	95.649
11	5.88	6.90	3757	95.598
12	7.92	9.30	3742	95.216
13	10.68	12.54	3726	94.809
14	14.39	16.90	3707	94.326
15	19.40	22.78	3691	93.919
16	26.15	30.70	3664	93.232
17	35.25	41.39	3647	92.799
18	47.52	55.79	3630	92.366
19	64.06	75.20	3606	91.756
20	86.34	101.37	3572	90.891
21	116.39	136.64	3536	89.975
22	156.89	184.18	3464	88.142
23	211.48	248.27	3363	85.573
24	285.06	334.66	3203	81.501
25	384.26	451.11	3035	77.226
26	517.96	608.07	2784	70.840
27	698.19	819.66	2287	58.193
28	941.13	1104.87	1423	36.209
29	1268.60	1489.31	734	18.677
30	1710.02	2007.53	325	8.270
31	2305.04	2706.07	113	2.875
32	3107.10	3647.67	84	2.137
33	4188.24	4916.91	44	1.120
34	5645.58	6627.79	9	0.229
35	7610.00	7800.00	1	0.025

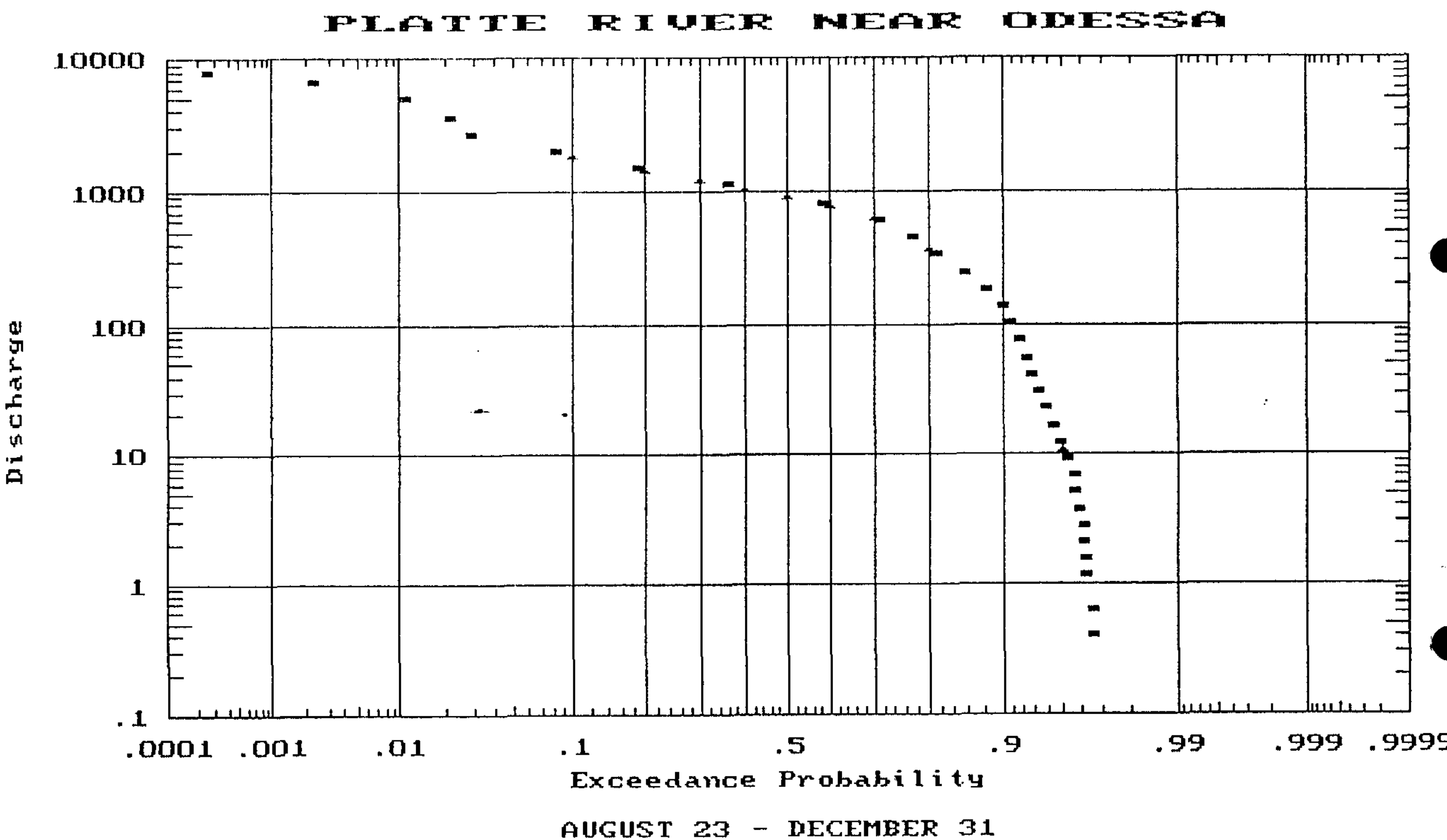
# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
132	0.0	0.4	7800.0	1030.8

Interpolated Values for Specified Frequencies

.10	1872.5	.20	1444.0	.30	1202.7	.40	1037.8	.50	901.8
.60	782.5	.70	619.2	.80	371.0	.90	135.5	.95	10.9

Interpolated Frequencies

400.00	78.92
800.00	59.13
1000.00	42.43
1100.00	36.46
1200.00	30.15
2000.00	8.35


PLATTE RIVER NEAR ODESSA
Discharge
10000
1000
100
10
1
.1
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.9
.99
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Exceedance Probability
AUGUST 23 - DECEMBER 31

Platte River near Grand Island
Flow Duration Table For 08/23-12/31

Class Number	Mid-point	Class Limit	Count	% Frequency
1	0.00	0.00	3930	100.000
2	0.45	0.90	3559	90.560
3	1.19	1.38	3556	90.483
4	1.58	1.83	3556	90.483
5	2.09	2.42	3554	90.433
6	2.76	3.21	3550	90.331
7	3.66	4.25	3545	90.204
8	4.84	5.62	3542	90.127
9	6.41	7.44	3533	89.898
10	8.48	9.85	3524	89.669
11	11.22	13.04	3515	89.440
12	14.85	17.26	3509	89.288
13	19.66	22.84	3502	89.109
14	26.02	30.23	3489	88.779
15	34.44	40.01	3472	88.346
16	45.59	52.96	3460	88.041
17	60.34	70.10	3436	87.430
18	79.86	92.78	3406	86.667
19	105.71	122.81	3361	85.522
20	139.91	162.55	3303	84.046
21	185.19	215.15	3231	82.214
22	245.11	284.77	3139	79.873
23	324.43	376.93	3010	76.590
24	429.42	498.90	2777	70.662
25	568.38	660.34	2433	61.908
26	752.31	874.03	1850	47.074
27	995.75	1156.87	1173	29.847
28	1317.98	1531.23	686	17.455
29	1744.47	2026.73	328	8.346
30	2308.98	2682.58	146	3.715
31	3056.17	3550.65	98	2.494
32	4045.14	4699.64	44	1.120
33	5354.14	6220.44	26	0.662
34	7086.74	8233.37	7	0.178
35	9380.00	9800.00	1	0.025

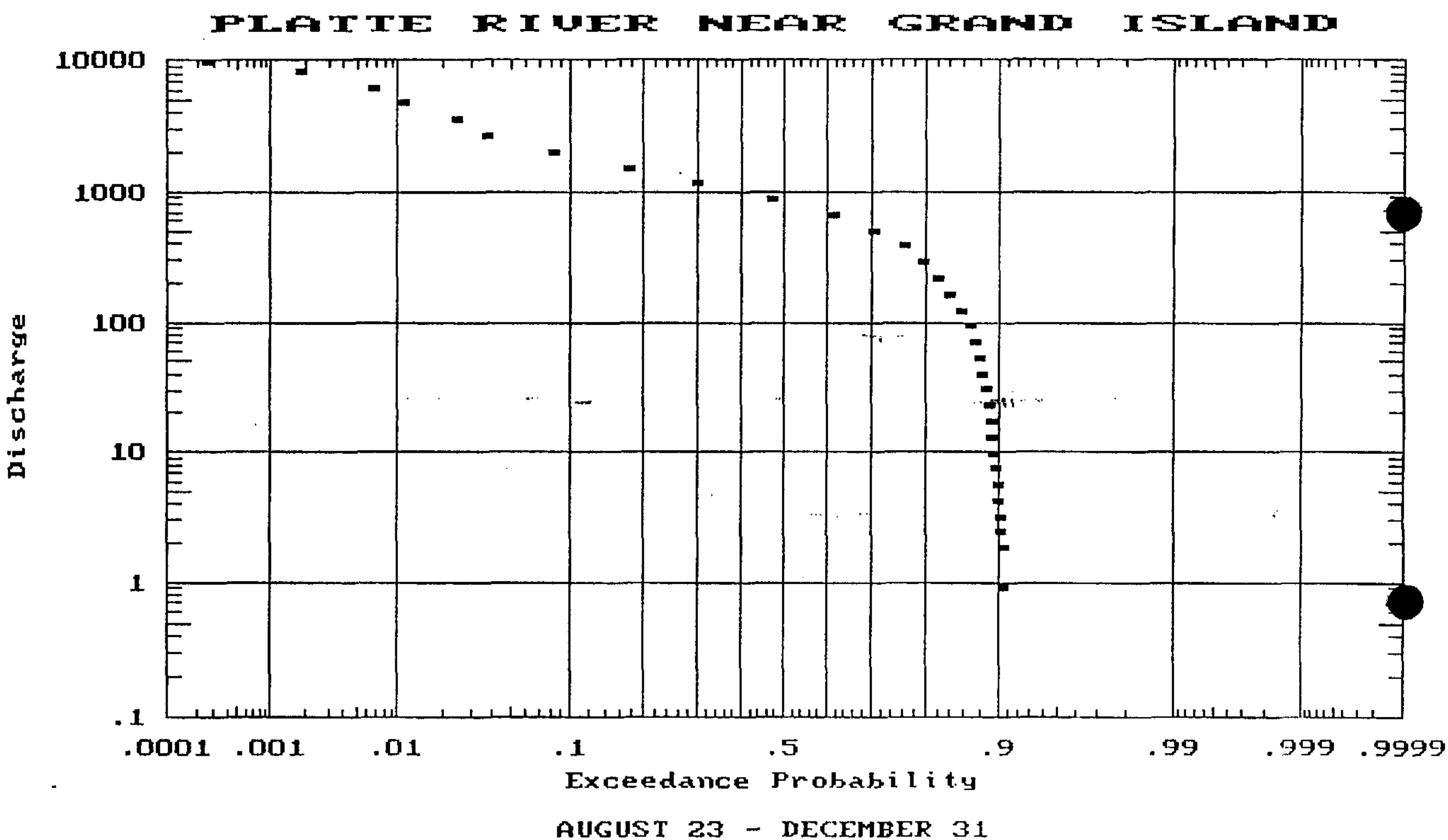
# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
371	0.0	0.9	9800.0	985.0

Interpolated Values for Specified Frequencies

.10	1892.2	.20	1426.1	.30	1153.2	.40	966.1	.50	821.7
.60	681.8	.70	508.9	.80	280.4	.90	6.6	.95	0.5

Interpolated Frequencies

400.00	75.29
800.00	51.33
1000.00	37.82
1100.00	32.40
1200.00	27.83
2000.00	8.64


PLATTE RIVER NEAR GRAND ISLAND
Discharge
10000
1000
100
10
1
.1
.0001
.001
.01
.1
.5
.9
.99
.999
.9999
Exceedance Probability
AUGUST 23 - DECEMBER 31

platte river near duncan
Flow Duration Table For 08/23-12/31

Class Number	Mid-point	Class Limit	Count	% Frequency
1	0.00	0.00	3930	100.000
2	0.04	0.08	3713	94.478
3	0.11	0.14	3710	94.402
4	0.16	0.20	3710	94.402
5	0.23	0.28	3700	94.148
6	0.33	0.40	3696	94.046
7	0.46	0.56	3680	93.639
8	0.66	0.80	3664	93.232
9	0.94	1.13	3648	92.824
10	1.33	1.61	3624	92.214
11	1.89	2.29	3597	91.527
12	2.69	3.26	3564	90.687
13	3.82	4.63	3541	90.102
14	5.43	6.57	3510	89.313
15	7.72	9.34	3440	87.532
16	10.97	13.28	3382	86.056
17	15.59	18.87	3348	85.191
18	22.16	26.82	3315	84.351
19	31.49	38.12	3290	83.715
20	44.75	54.17	3272	83.257
21	63.60	76.99	3241	82.468
22	90.38	109.41	3165	80.534
23	128.45	155.50	3094	78.728
24	182.55	220.99	2995	76.209
25	259.43	314.07	2857	72.697
26	368.70	446.34	2676	68.092
27	523.99	634.34	2334	59.389
28	744.68	901.51	1778	45.242
29	1058.33	1281.20	1025	26.081
30	1504.08	1820.82	524	13.333
31	2137.56	2587.71	178	4.529
32	3037.87	3677.61	105	2.672
33	4317.36	5226.55	48	1.221
34	6135.74	7427.87	11	0.280
35	8720.00	9150.00	1	0.025

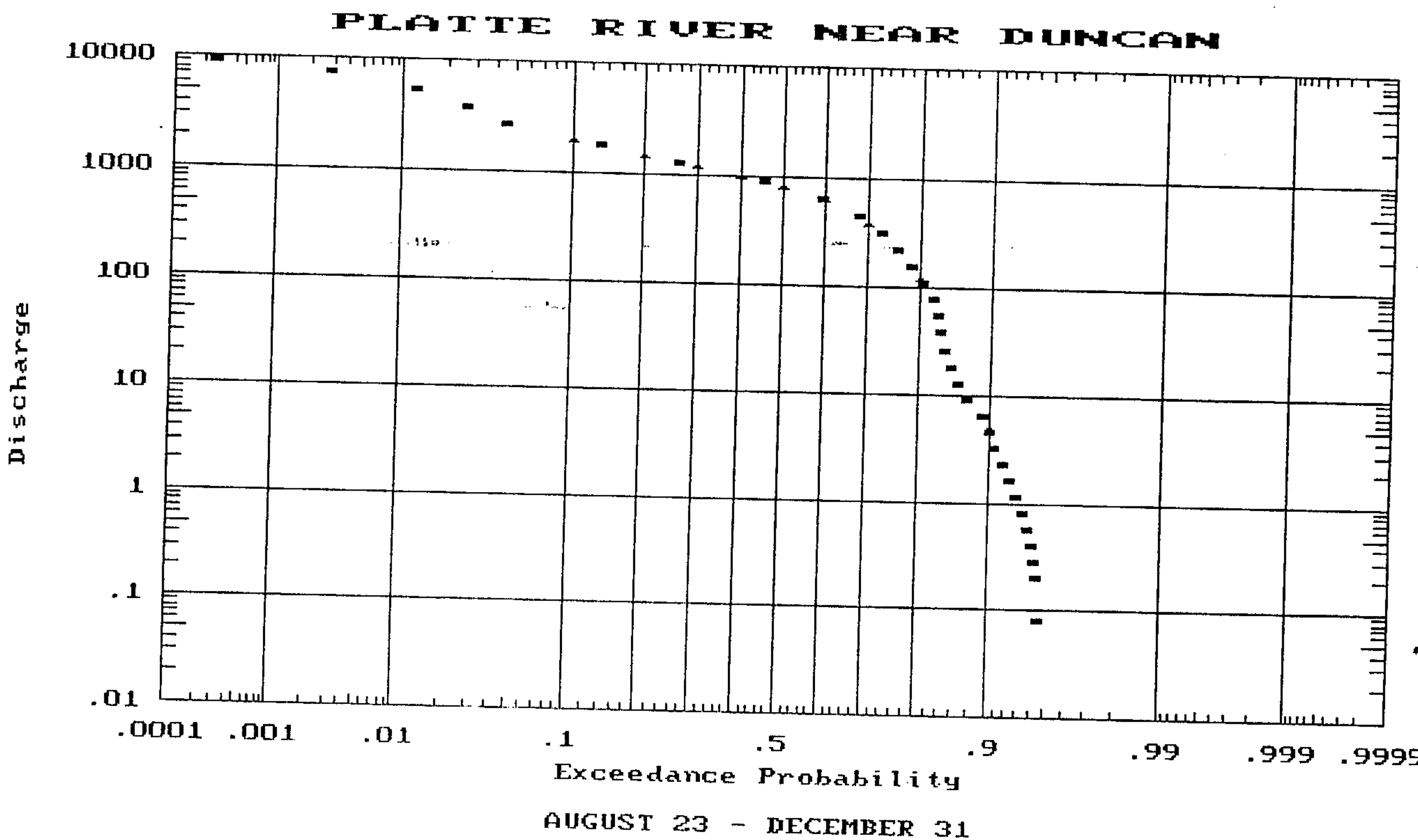
# of Zeros	Minimum	Lowest non-zero	Maximum	Mean
217	0.0	0.1	9150.0	982.4

Interpolated Values for Specified Frequencies

.10	1999.6	.20	1472.4	.30	1171.7	.40	975.2	.50	792.3
.60	617.9	.70	384.8	.80	121.3	.90	4.8	.95	0.1

Interpolated Frequencies

400.00	69.50
800.00	49.62
1000.00	38.46
1100.00	33.12
1200.00	28.90
2000.00	9.99


PLATTE RIVER NEAR DUNCAN
Discharge
10000
1000
100
10
1
.1
.01
.0001
.001
.01
.1
.5
.9
.99
.999
.9999
Exceedance Probability
AUGUST 23 - DECEMBER 31

SENIOR APPROPRIATIONS

The proposed appropriation for instream flow would, by Nebraska law, be junior in priority to all other existing appropriations and applications.

Under Nebraska's water rights system of "first in time is first in right" there would be no effect that this junior application for instream flow would have on existing appropriations and applications as a result of administering water rights.

There is however the potential effect of this, or some other "instream flow", being granted a senior status to existing applications that have not been perfected (Prairie Bend, Twin Valley, and Landmark) as a condition of federal cost-share or permitting.

State Water Goals

STATE GOALS FOR WATER RESOURCES USE

1. The principal public and private beneficiaries shall participate financially in projects costs:

The principal beneficiary of this instream flow right is the general public. The administrative costs of applying for the instream flow water right and costs associated with some of the studies needed for the application have been paid for by the Natural Resources District, a political subdivision of the State of Nebraska.

In some cases assistance with studies and data collection has been provided to the District without costs by cooperative governmental agencies and in still other cases the District has utilized applicable studies that were conducted by other agencies as part of ongoing studies there were carrying out on the Platte River and its ecosystem.

In all three cases the costs were paid for by public funds, either local, State, or Federal. Future costs would involve administering the water right and would be funded by the State of Nebraska.

2. The impact on instream use of water for fish, wildlife and recreation:

This application is for instream use and therefore the impacts on these purposes are all positive. Economic and hydrology studies, computer generated models, and maps of the area are attached as part of the application.

3. When state financial assistance is being sought . . . :

No state funds are being sought for the instream flow water rights.

4. The impact on downstream uses of water that are not protected:

Downstream uses of water that are not protected under the existing system of water rights administration such as groundwater use, sub-irrigation, waste assimilation, and stock watering are protected and will be enhanced.

The fish, wildlife, and recreation flows requested in the application would be protected from diversion and are in excess of the needs for groundwater recharge, sub-irrigation, waste assimilation, and stock watering.

5. Projects entailed consumptive use of water:

There will be no consumptive use of water as a result of the application for an instream flow water right.

6. Projects to provide supplemental water to replenish groundwater supplies:

There will be no diversion of water from the Platte River. Groundwater recharge that is occurring naturally will continue to occur and will be protected from future project diversions. The area of the Platte River is within the Central Platte Natural Resources District's Groundwater Management Area.

7. Any interrelationship between groundwater and surface water shall be identified:

There is an existing relationship between groundwater and surface water of the Platte River in the area described in the application. The Platte

River, especially downstream from Kearney, currently recharges the groundwater aquifer in Buffalo and Hall Counties, an estimated 50,000 to 75,000 acre feet per year. Additionally the municipal well fields located on the Platte River for the cities of Kearney and Grand Island induce recharge from the Platte.

This interrelationship should continue in the future and, with implementation of the application, the mutual sharing of water will be protected from future project diversions.

8. Projects for the provision of irrigation water:

No water for irrigation would be diverted from the river as a result of approval of the application. Irrigation that depends on recharge will be enhanced by the assurance that others will not be able to divert the water protected by the right requested in the application.

9. Flood control projects designed to protect residential, commercial, or industrial areas:

There are no flood control features involved in the application for instream flow rights.

10. Water development should take place with the recognition that differences in needs and priorities may exist within the state between river basins.

This application is not considered a "water development".

Public Interest Factors by Raymond Supalla

ANALYSIS OF PUBLIC INTEREST FACTORS FOR PROPOSED PLATTE RIVER INSTREAM FLOWS

Prepared by

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for

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July 19, 1990

ANALYSIS OF PUBLIC INTEREST FACTORS FOR PROPOSED PLATTE RIVER INSTREAM FLOWS

The Platte River instream flow right requested by the Central Platte NRD is for water to meet the needs of fish and wildlife. Various flows have been requested for different reaches of the river between the J-2 return and Columbus and for different times of the year (Table 1). The requested flows have been identified as necessary for meeting the needs of the Bald Eagle, the Whooping Crane, Sandhill Cranes, Least Terns and Piping Plovers.

Under Nebraska law the Director of Water Resources shall grant an instream appropriation if he or she finds that: (1) there is unappropriated water available, (2) the appropriation is the minimum necessary to maintain the instream uses, (3) the appropriation will not interfere with a senior water right, and (4) the request is in the public interest. In determining whether the appropriation is in the public interest the Director must consider state water resources goals and assess the economic, social and environmental value for instream use versus any reasonably foreseeable out-of-stream uses of the water. This analysis addresses only the public interest aspects. The water availability and instream flow dimensions of the application are addressed elsewhere.

Methodology

The Director of Water Resources is required to determine whether the instream flow application is in the public interest by considering the economic, environmental and social impacts. However, Nebraska law is silent on how this public interest

Table 1. Proposed Instream Flows

Time Period	Purpose	Segment	Minimum Flow - C.F.S.
January 1 - June 23	Forage Fish Maintenance Flow	J-2 Return to Columbus	500
January 1 - February 25	Feeding/Bald Eagle	J-2 Wasteway Gate to Wasteway Mouth	750
January 1 - February 25	Feeding/Bald Eagle	J-2 Return to Elm Creek	1100
February 15 - February 28	Wet Meadow/Initiate Biological Activity	J-2 Return to Chapman	1100
March 1 - March 31	Staging/Sandhill Crane	J-2 Return to Chapman	1100
April 1 - April 14	Staging Sandhill/Stopover Whooping Crane	J-2 Return to Grand Island	1300
April 1 - April 14	Staging Sandhill Crane	Grand Island to Chapman	1100
April 15 - May 3	Stopover/Whooping Crane	J-2 Return to Grand Island	1500
June 24 - August 22	Forage Fish Maintenance Flow	J-2 Return to Columbus	600
August 23 - December 31	Forage Fish Maintenance Flow	J-2 Return to Columbus	500
October 1 - October 11	Stopover/Sandhill Crane & Whooping Crane	J-2 Return to Chapman	1100
October 12 - November 10	Stopover/Whooping Crane	J-2 Return to Grand Island	1500
December 10 - December 31	Feeding/Bald Eagle	J-2 Wasteway Gate to Wasteway Mouth	750
December 10 - December 31	Feeding/Bald Eagle	J-2 Return to Elm Creek	1100

analysis should be performed. In this analysis the general approach was to: (1) identify the relevant public interest variables; (2) estimate the potential effect of the appropriation on out-of-stream diversions; (3) assess the effect of the proposed appropriation on each public interest variable as specifically and quantitatively as possible; and (4) interpret the analytical results in the context of statutory requirements and Nebraska water resources goals.

The public interest variables considered in this analysis were compiled based on the water resources goals promulgated by the Nebraska Natural Resources Commission and on discussions with staff in the Department of Water Resources and in the Game and Parks Commission (Table 2). Two general categories of impacts were identified, socio-economic and environmental, with "socio-economic" including both the economic and social impacts. The factors identified under socio-economic included all impacts from the instream appropriation which could potentially affect the welfare of people, including income, employment, recreation values, aesthetics and public service costs. The impacts identified as environmental included impacts on fish and wildlife populations, especially threatened or endangered species, and water quality.

The effect of the proposed instream appropriation on each of these variables was analyzed as specifically and as quantitatively as possible, given the limited availability of secondary data. For those instances where secondary data which addressed a given factor were not available, proxy variables and/or reasoned professional judgment was used to determine the

Table 2. Public Interest Variables

I. Socio-economic

   A. Economic output
   B. Household income
   C. Employment security
   D. Public services
   E. Recreation values
      1. Fishing
      2. Water fowl hunting
      3. Wildlife observation
      4. Boating or canoeing
      5. Swimming
      6. Picnicking
      7. Camping
   F. Aesthetic values

II. Environmental

   A. Impact on threatened or endangered species of fish or wildlife
      1. Whooping Crane
      2. Bald Eagle
      3. Least Tern
      4. Piping Plover
   B. Maintenance and/or enhancement of other fish and wildlife
      1. Forage fish
      2. Sandhill Cranes
   C. Water quality

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most likely public interest impacts. The use of expensive surveys or other means of primary data collection was outside the scope of this analysis.

Potential Effect on Out-of-Stream Diversions

All of the public interest impacts from the proposed instream appropriation result from competition for water. If there were no reasonably foreseeable alternative uses for the water, then the same amount of water would be available in the river and the same impacts would occur irrespective of whether or not the appropriation was granted. Thus, the single most important factor in determining the public interest impacts is the type and magnitude of the opportunities potentially foregone from granting the appropriation.

Many alternative uses for Platte River water have been proposed in recent years, including diversion proposals generally referred to as Enders, Catherland, Prairie Bend, Twin Valley and Landmark. The Department of Water Resources has denied a water right request for the Enders diversion and dismissed the Catherland application, but the three remaining proposals have active sponsors with planning activities and water right applications in process. Although variants of all of these proposals might be considered reasonably foreseeable over the long term, "reasonably foreseeable" is defined in this analysis as including only those project proposals which are presently active. The requested diversions for the three active proposals for out-of-stream use total 260,400 acre feet, consisting of 74,900, 47,000 and 138,500 acre feet for Prairie Bend, Twin Valley and Landmark, respectively (Supalla, 1990, Boyle Engineering, 1988).

The requested instream flow appropriation, if given seniority or required as a funding condition, would reduce the amount of water available for diversion by up to 639,674, 546,846 and 373,885 acre feet for Twin Valley, Prairie Bend and Landmark, respectively (Table 3). The potential impact on Prairie Bend is less than the total reserved flow of 639,674 acre feet, because the Prairie Bend diversion is below the cut off point (Elm Creek) for some of the Bald Eagle requirements. Likewise, the potential impact on Landmark is considerably less than the total reserved flow, because the Landmark Diversion is downstream from the areas where the instream needs are the highest. Reductions in the amount of water available for diversion does not necessarily mean that insufficient water would be available for meeting foreseeable out-of-stream needs. One must also consider the total amount of water available, diversion capacity and related factors. The results from such analyses vary widely. Using the Op Study model developed by the Bureau of Reclamation, Simons and Associates found that with Landmark in a first priority position and instream flows only slightly greater than those requested herein, Prairie Bend and Twin Valley would get less than half of the water needed and would be infeasible (Simons and Associates, March, 1990). In a similar study for the Landmark project, Boyle Engineering found that there was sufficient water to meet instream needs, the Prairie Bend diversion and 97 percent of the Landmark requirements, assuming no Twin Valley project (Boyle Engineering, January, 1988). In contrast, Bleed found that with instream flow requirements similar to those requested there would still be over 400,000 acre feet of water

Table 3. Quantity of Water Required to Meet Requested Instream Flows

	J-2 to Columbus			Chapman to Columbus		
	Minimum Flow		Total Used	Minimum Flow		Total Used
Dates	CFS	AF/Day	Acre Feet	CFS	AF/Day	Acre Feet
1/1 - 3/31	1,100	2,182	196,364	500	992	89,256
4/1 - 4/14	1,300	2,579	36,099	500	992	13,884
4/15 - 5/3	1,500	2,975	56,529	500	992	18,843
5/4 - 6/23	500	992	50,579	500	992	50,579
6/24 -8/22	600	1,190	71,405	600	1,190	71,405
8/23 - 9/30	500	992	38,678	500	992	38,678
10/1 - 10/11	1,100	2,182	24,000	500	992	10,909
10/12 - 11/10	1,500	992	89,258	500	992	29,752
11/1 - 12/9	500	992	28,761	500	992	28,761
12/10 - 12/31	1,100	2,182	48,001	500	992	21,818
Annual			639,674			373,885

available for diversion (Bleed et al, 1986). This is more than the combined requests of the three presently active diversion alternatives. The Bleed study also found, however, that the reasonably foreseeable out-of-stream diversions were much larger than current proposals and concluded that some foreseeable diversions would be precluded if all instream flow needs were met.

From the total available evidence it is clear that an instream appropriation of 639,700 acre feet, if given seniority, would probably preclude meeting some out-of-stream needs, but there is obviously much disagreement regarding the actual size of the shortage. The evidence that there is likely to be some shortage makes it necessary to compare instream and out-of-stream values when assessing the public interest, even though the size of the probable shortage remains unknown.

For purposes of this analysis, it was assumed that five percent of the water requested for instream use (32,000 AF) would otherwise be diverted for irrigation to either Prairie Bend, Twin Valley, Landmark, or to some project in the Big Bend reach.

Socio-economic Impacts

The most significant socio-economic impacts from the requested in-stream appropriation include changes in state economic output, household income, recreation activity, employment security, aesthetic values, and public services.

State Economic Output

Potential change in state economic output is the driving force for many socio-economic effects. Without changes in economic output there are unlikely to be changes in household income, employment, tax revenues and so forth. Changes in state economic output occur when there are changes in productivity and/or changes in income from outside the state. An instream flow appropriation is not likely to change resource productivity, but it could substantially change the inflow of income from other states.

An instream flow appropriation for the Platte River is most likely to affect state economic output in two major ways: (1) through changes in the sale of agricultural products from irrigation; and (2) through increased sale of recreation services to out-of-state residents. Instream flows will reduce the sale of agricultural products in direct proportion to the impact on irrigation diversions. The impact on recreation sales is less clear. Instream flows will increase (prevent reductions) instream based recreational activity, but may preclude the construction of reservoirs and thus reduce the amount of reservoir recreation.

Previous research has shown that each acre foot of water diverted for irrigation in the Platte Valley increases grain production by approximately $156 (Supalla, 1990). Any increase in grain production would be exported to other states, with the new revenue being multiplied 2.1 times as it is spent and respent by Nebraskan's (Lamphear and Erikson, 1990). Thus, each one acre foot reduction in irrigation water decreases state economic output by approximately $328 (156 X 2.1 = 328).

An instream appropriation could also negatively affect reservoir recreation. Most irrigation diversions are associated with storage reservoirs and, thus, reduced irrigation diversions may cause some change in reservoir recreation. For example, if reduced irrigation diversions occurred in the Central Platte

Valley and the impact on recreation use was proportionate and similar to the Prairie Bend project, there would be 3.24 fewer visitor days of recreation produced for every one acre foot change in diversion. The corresponding impact on state economic output would be nine dollars per acre foot diverted, assuming that 20 percent of reservoir recreation in the Big Bend reach of the Platte Valley produces an average of five dollars per visitor day in additional revenue for Nebraska[1] and further assuming a multiplier of 2.8 for recreation spending.[2]

The potential negative effects of an instream appropriation on economic output would be offset, at least in part, by changes in instream based recreation spending by out of state recreationists in Nebraska. It was estimated that river based recreation in the Platte River valley presently generates 4.2 million occasions of recreational activity by out of state recreationists each year (SCORP, 1979). Assuming an average expenditure in Nebraska of five dollars per recreation use, the

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1 There are no definitive ways of determining the amount of out of state recreation to expect at a prospective reservoir, or how much they will spend in Nebraska per use occasion. The 20 percent value for out of state use was assumed based on current use patterns for Platte valley facilities and the proximity of the proposed reservoirs to Interstate 80. The $5.00 per use value is also an assumption based on the type of recreation use expected and on the proportion of spending by out of state recreationists that is likely to occur in Nebraska. In other words, a resident from Kansas might spend $100 for five recreational use occasions in Nebraska, but $75 of the total might be spent for gas, food and equipment within Kansas, spending only $25, or $5 per use occasion, in Nebraska.

2 The recreation multiplier was computed from input-output requirements reported in Lamphear and Erikson, 1990. The "with households" input-output table was used and it was assumed that recreation spending occurred equally in three sectors: hotels and lodging, eating and drinking establishments, and other amusements.

river is generating over 21 million dollars per year in spending by out of state recreationists in Nebraska. Using a recreation multiplier of 2.8, this means an increase in state economic output of 58.8 million dollars per year.

Another impact which would offset some of the negative effects of an instream appropriation is the recreation spending by Nebraska residents which might otherwise be lost to other states. A recent survey found that Nebraska residents spend 51.3 million per year on Platte Valley recreation (NASIS, 1988). An unknown part of this 51.3 million dollars would be lost to other states if Nebraska recreational opportunities deteriorated. It seems reasonable to assume, however, that this loss could reach ten percent of residential recreation spending, or $5.1 million. If this amount of current recreation spending was lost to other states, state economic output would fall by $14.2 million, assuming a multiplier of 2.8.

The foregoing analysis of recreational spending means that economic output in Nebraska may fall significantly if Platte River recreational resources are not adequately maintained. There is 58.8 million dollars in out-of-state spending that is at risk (21 X 2.8 = 58.8), plus some $14.2 million of in state recreation spending that could be lost to other states (5.1 X 2.8 = 14.2), for a total at risk amount of $73.0 million. On a per acre foot basis, the total value of state economic output that is at risk from reduced recreation spending is $114 per acre foot of flow reserved for instream use (73,000,000/639,700 = 114). It is important to note, however, that this estimate of what is at risk is a maximum potential impact. The impact on recreation spending would be much less if it turned out, for example, that the link between instream flows and out-of-state recreational activity was less than proportional.

One of the most meaningful ways of summarizing the tradeoff between instream use and an out-of-stream diversion is in terms of potential net impacts per acre foot of reserved water. Given the simplifying assumptions incorporated in the above analysis, one can conclude that each acre foot of water that is reserved for instream use will reduce state economic output by $223 per year (114 - 337 = -223). This calculation is based on the finding that each acre foot of reserved instream flow adds $114 to state economic output through increased river based recreation, but simultaneously precludes diversion to a multi-purpose irrigation project (irrigation and reservoir recreation) which decreases state economic output by $337 per acre foot, for a net loss of $223.

Household Income

The requested instream appropriation will substantially affect personal incomes in Nebraska. Individuals engaged in supplying river based recreational services, or related services such as motels and restaurants, will gain from an instream appropriation, while prospective irrigators and associated businesses will lose. The net effect on personal incomes will be closely correlated to the changes in state economic output discussed above.

Estimated input-output relationships for the Nebraska economy indicate that the total change in state economic output resulting from irrigation and recreation adds an average of 23.6

and 24.6 cents, respectively, to household income. This means that each acre foot of reserved flow for instream use adds $28 to household income (114 in output X .246 = 28), while a corresponding one acre foot reduction in diversion to a multi purpose irrigation project would decrease household income by $80 (328 X .236 + 9 X .246 = 80). The net effect is therefore a loss of $52 per year in household income for every one acre foot of instream use that comes at the expense of an acre foot of diversion.

Employment Security

Another important socio-economic impact is employment security. People need steady employment to meet their day to day living requirements. The effect of an instream appropriation on the number of jobs is directly related to state economic output and household income, but the potential impact on variability in employment is more difficult to assess.

The probable net effect of an instream appropriation on the number of jobs can be most easily calculated by relating changes in state economic output to changes in employment. Assuming that average economic output per worker for the sectors influenced by an instream flow appropriation is similar to the average for all of Nebraska, one can calculate an employment effect by dividing change in state economic output by average state output per worker. In 1986 Nebraska total economic output was $26.5 billion and total employment was 763,000 jobs, for an average gross output per worker of $34,758. This means, for example, that if the requested appropriation reduced irrigation diversions by 32,000 acre feet, the net effect on economic output would be $7,136,000 (32,000 X 223), which translates to 205 fewer jobs

(7,136,000/34,758 = 205), or 0.006 jobs per acre foot. The actual employment impact could be quite different, however, if the economic output per job associated with irrigation or recreation was found to be different from the state average.

The effect of an instream flow appropriation on employment stability or variability is likely to be negligible, because there is no reason to believe that agriculturally related employment is any more or less stable than recreation related employment. Fewer total jobs would probably mean higher unemployment rates in the short run, but in the long run people move to where the jobs are. The net long term effect may be fewer people in some locations, but probably no change in unemployment rates or other measures of employment stability.

Public Services

Public service impacts consist of changes in the availability, cost or quality of public services such as schools, medical care, cultural events, sanitary facilities etc. Such impacts can be caused by changes in the population and/or the tax base of affected communities. Changes in the tax base directly affect the ability of a community to deliver quality public services, while changes in population indirectly affect the per capita costs and, thus, the feasibility of offering certain services.

Assuming that the requested instream flow right would reduce irrigation diversions by only 32,000 acre feet, it is unlikely that there would be a significant percentage change in available tax revenues for supporting public services. Most critical public services are provided locally and supported by property tax revenues. A reduced diversion of 32,000 acre feet would mean that approximately 25,400 acres of land in the Central Platte Valley may eventually revert to dryland production, thus reducing land values. Irrigated land presently sells for approximately $600 per acre more than dryland without irrigation potential (Johnson, 1989). This means that assessed property values in the region would fall by $13.7 million (25,400 X 600 X .9 = 13,716,000), assuming assessments at 90 percent of market value. Further assuming a typical mill levee of $20 per $1000 of assessed valuation, the aggregate effect on agricultural land based tax revenues would be $274,320 per year. At the margin this is equivalent to $8.57 per acre foot.

An unknown part of the agricultural land value impact would be offset by additional property taxes from stream based recreation facilities and by sales tax collections from additional out of state recreationists. Even without considering this offsetting effect, however, it is unlikely that the availability or quality of public services will be affected very much by a $274,300 change in tax collections disbursed over several political jurisdictions.

It is even less likely that community population will change by enough to affect the feasibility of providing services. A total employment effect of 205 jobs converts to a population effect of less than 450 people. This change amounts to a small percentage of the total population in the Big Bend area of the Platte River. Unless the population change is very concentrated in one or two small communities, the impact on public services is likely to be negligible.

Recreation Activity

One of the most important public interest implications of an instream appropriation concerns recreational values. Recreation is an important contributor to human well being and human satisfaction. This importance can be measured in several ways. One indicator is simply the amount of recreational activity (visitor days) associated with the use of particular resources. Another indicator is the willingness of people to pay for a recreational experience or to pay taxes for improved recreational programs. By all of these measures the Platte River is an important recreational resource.

A survey of Nebraska residents conducted by the Bureau of Sociological Research, University of Nebraska-Lincoln found that the Platte River Valley provided 7.7 million occasions or visitor days of recreational use during a recent one year period (Table 4). This estimate includes a great deal of recreational activity that would not be impacted by instream flows, such as Lake McConaughy activity and recreation downstream from Columbus, but it is nevertheless indicative of the recreational importance of the river.

Another indication of the amount of recreational activity in the Platte Valley is the number of people who annually visit the state parks and state recreation area in the Platte valley (Table 5). Average values for 1987 to 1989 indicate 2.9 million uses of all the State Recreation Areas in the Platte valley, with 0.9 million occurring at Lake Mcconaughy or above and 1.5 million occurring below Columbus. This leaves about 0.5 million recreational uses of State Recreation Areas in the part of the

Table 4. Recreational Use of the Platte Valley by Nebraska Residents, Fall, 1986 to Fall, 1987.

Activity	Percent Participating	Average Days of Use	Total Visitor Days
Picnicking	17.0	5.3	1,048,223
Swimming	9.6	15.2	1,697,633
Canoeing/Boating	6.8	2.7	213,600
Hiking	12.4	9.0	1,298,354
Camping	3.3	7.6	291,781
Wildlife Observation	11.8	9.2	1,262,987
Fishing	12.7	10.8	1,595,719
Hunting	3.5	8.6	350,183
Total			7,758,480

Source: Nebraska Annual Social Indicators Survey, 1988. Bureau of Sociological Research, University of Nebraska-Lincoln, Lincoln, Nebraska, 68588-0325.

Table 5. Visitor Counts for State Recreation Areas in the Platte Valley, 1987 to 1989.

Area	Visitor Counts 1987	1988	1989	Average
Platte Valley Above North Platte				
Minatare SRA	186,534	212,020	195,229	197,928
Bridgeport SRA	45,650	43,000	40,085	42,912
Lake McConaughy	696,858	733,887	637,788	689,511
Total	929,042	988,907	873,102	930,351
Platte Valley from North Platte to Columbus				
Fort Kearney	117,090	116,465	116,050	116,535
Morman Island	266,500	298,000	337,000	300,500
Windmill	103,654	107,405	134,085	115,048
Total	487,244	521,870	587,135	532,083
Platte Valley from Columbus to Missouri				
Fremont	766,600	784,075	813,300	787,992
Two Rivers	292,291	282,745	349,514	308,183
Schramm Park	95,900	97,600	126,450	106,650
Louisville	271,232	274,318	275,200	273,583
Total	1,426,023	1,438,738	1,564,464	1,476,408
Total all SRA's in Platte Valley	2,842,309	2,949,515	3,024,701	2,938,842

Source: Nebraska Game and Parks Commission: State Parks Division, Annual Report, 1989.

Platte Valley most likely to be affected by an instream appropriation.

Still another indicator of the recreational importance of the Platte River is the expressed willingness of Nebraska residents to pay for improvements in recreational resources. A 1988 survey of Nebraska residents found that 62 percent were willing to pay at least $5 per year in taxes or fees to improve nature associated recreation in the Platte Valley (Table 6). Seventy seven percent were willing to pay at least one dollar per year and only 23 percent were willing to pay nothing. This is a clear indication that Nebraska residents would like to see recreational resources in the Platte Valley maintained or improved and would be willing to pay to support such programs.

A final indicator of the recreational importance of the Platte Valley is the economic value recreationists place on recreational activity. We have already noted their willingness to pay for <u>improving</u> the resource. A related question is their willingness to pay for <u>using</u> the Platte River based recreational resources. There are no good data on the willingness of Nebraskan's to pay for Platte River based recreational activity. The Nebraska Natural Resources Commission presently uses $3.35 per visitor day in evaluating Resources Development Fund proposals. The U.S. Bureau of Reclamation used $4.00 per visitor day in their recent analysis for Prairie Bend and Twin Valley. Assuming $4.00 per visitor day and further assuming that 18 percent of all Platte Valley recreation occurs in the parts of the Platte potentially affected by instream flows, the value to recreationists of river based recreation in the critical reaches

Table 6. Nebraskan's Willingness to Support Further Development of the Platte River Valley for Nature Associated Recreation.

Annual Tax or Fee	Percent of Nebraska Residents Willing to Pay
Large Amount ($15)	17.2
Moderate Amount ($5)	44.8
Small Amount ($1)	14.8
Nothing	23.2
Total	100.0

Source: Nebraska Annual Social Indicators Survey, 1988. Bureau of Sociological Research, University of Nebraska-Lincoln, Lincoln, Nebraska, 68588-0325.

of the Platte is 5.6 million dollars per year. This is equivalent to $9.57 per year, per acre foot of reserved flow.

Aesthetic Values

Aesthetic considerations are also an important dimension of the public interest, especially for decisions involving natural resources. Aesthetic experiences are important to the well being of people for reasons similar to those for recreation. Aesthetics provide enjoyment that has value, but unfortunately we have no direct measure of the aesthetic importance of the Platte River or of how the aesthetic value of the Platte might be impacted by instream flows.

The only available indication regarding the importance of aesthetics is that some types of "recreation" are essentially aesthetic experiences. Wildlife observation is the best example, but hiking and picnicking are also largely aesthetic experiences. Nebraska residents reported 1,262,987 wildlife observation occasions in the Platte Valley in 1986-87, plus 1,048,223 picnicking and 1,298,354 hiking occasions. Even if only about 18 percent of this activity occurred in the critical reaches of the Platte, as previously estimated, it is still an important public interest consideration. Instream flows facilitate the presence of wildlife and probably enhance the general aesthetic environment of the river. An empirical estimate of the potential effect of instream flows on aesthetics is not available, however. It may be that one could change flows significantly without materially changing aesthetic values, but surely at some point aesthetic quality would be lost.

Environmental Impacts

The major environmental impacts which would result from the proposed instream appropriation are those associated with fish, wildlife and water quality. The importance attached to these environmental dimensions is an essential component of the required public interest analysis.

Fish and Wildlife

Whether or not the requested flows are necessary for maintaining or enhancing the fish and wildlife populations is a biological question that is outside the scope of this assessment. This assessment addresses the relative importance of fish and wildlife from a public interest perspective, assuming the requested flows are biologically necessary.

The strongest indicator of the importance of fish and wildlife to the public interest is perhaps our threatened and endangered species laws. Threatened and endangered species of fish and wildlife are protected by state and federal law. One cannot take any action which is determined by the appropriate state or federal agencies to be detrimental to threatened or endangered species. This is equivalent to attaching an infinite value to fish or wildlife that are threatened or endangered. By law, nothing is more important! Such strong and definitive legal protection can be interpreted to mean that instream flows which are needed for threatened and endangered species are in the public interest, irrespective of any offsetting costs associated with meeting the flow requirements.

The public importance attached to fish and wildlife is also strongly supported or implied by fish and wildlife dependent recreation. Fishing, hunting and wildlife observation account for over 41 percent of the 7.8 million Platte River recreation uses reported in Table 4. Also, much of the remaining recreational activity, especially picnicking or hiking, would not occur without abundant fish and wildlife populations.

Survey results are another indicator of the high level of public interest in maintaining fish and wildlife populations. A 1987 telephone survey of Nebraska residents found very high levels of public support for maintaining fish and wildlife populations, especially endangered species (Table 7). Over 85 percent of Nebraska residents agreed that endangered species should be protected even if it meant limiting irrigation; over 90 percent agreed that agricultural development of wetlands should be limited to protect endangered species; and, somewhat surprisingly, over 80 percent of Nebraskan's considered wildlife more important than using pesticides to maintain food production. These results must be used with interpretive caution, but certainly the evidence is strong that Nebraska residents view fish and wildlife as a resource that should be protected, even if the costs are very high.

Water Quality

The final environmental dimension which is of particular importance is water quality, both surface and groundwater. Studies of surface water quality have found some attrazine and excessive concentrations of sulfates, mercury and cadmium in the critical reaches of the Platte River, but in general the quality of the surface water is quite good (CPNRD, 1988). Water quality analysts have concluded that the compounds detected in Platte

Table 7. Attitude of Nebraskan's Toward Protection of Fish and Wildlife

Question	Strongly Agree	Agree	Disagree	Strongly Disagree
	--- Percent of Nebraska Respondents ---			
Would you agree to protect endangered species even if it meant limiting irrigation?	20.9	65.9	11.4	1.8
Would you agree to limit agricultural development of wetlands to protect endangered species?	22.3	67.9	9.3	0.5
If pesticides are needed to maintain food production at present levels, we must use them even if they are harmful to wildlife.	1.0	15.8	56.9	26.4

Source: Nebraska Annual Social Indicators Survey, 1987. Bureau of Sociological Research, University of Nebraska-Lincoln, Lincoln, Nebraska, 68588-0325.

River water at the various levels would not affect aquatic life, upland birds, water fowl, or pose a public health hazard (CPNRD, 1988). This water quality situation is unlikely to be materially changed by an instream flow appropriation, because the water which might otherwise be diverted from the Platte is likely to be of the same quality as the river in general and, thus, the concentrations of pollutants are likely to remain the same.

The groundwater quality in the areas most likely to be impacted by an instream appropriation generally meets drinking water standards, with the exception of high nitrates. Under present conditions, some municipalities have had to provide bottled water or invest in new well fields and others may need to do so in the future. One way of improving the nitrate problem in in the Central Platte Valley is to recharge the existing groundwater with higher quality surface water (CPNRD, 1988). The Central Platte NRD estimated that the proposed Prairie Bend - Twin Valley project would improve groundwater quality by enough to save $600,000 per year in domestic and municipal water supply costs. If an instream appropriation was to reduce the diversions available for the Prairie Bend - Twin Valley project, ground water quality would be adversely affected and domestic water supply costs would rise. Assuming a proportional relationship between diversions and groundwater quality, our illustrative 32,000 acre foot impact on out-of-stream diversions would mean an increase in domestic water supply costs of $157,500 per year (32,000/121,900 X 600,000 = 157,500)

Summary and Conclusions

The potential public interest impacts from the proposed instream flow appropriation for the Platte River were analyzed using secondary data and the available literature. It was found that the instream appropriation would probably preclude a significant amount of out-of-stream diversions to multi-purpose irrigation projects. The potential impacts from maintaining instream flows were then compared to the impacts from precluded out-of-stream diversions as a basis for determining whether the instream appropriation was in the public interest. Economic, social and environmental public interest variables were considered, including impacts on state economic output, household income, employment, public services, recreation activity, aesthetics, fish and wildlife, and water quality.

The analysis indicates that there are major tradeoffs involved with the requested instream appropriation (Table 8). It was estimated that at the margin the instream appropriation would decrease state economic output by $223 per acre foot of reserved flow; decrease household income by $52 per acre foot; and decrease total employment by 0.006 jobs per acre foot, but with no significant change in employment stability. The general impact of an instream appropriation on the quantity, quality and cost of public services was found to be negligible, despite decreases in local property tax revenues of about $8.57 per acre foot of reserved flow. In the specific case of domestic water supply services, however, it was found that the adverse impact on diversions would reduce groundwater quality and thus increase domestic water supply costs. These negative impacts from the

Table 8. Summary of Public Interest Impacts

Public Interest Variable	Probable Impact of Proposed Instream Appropriation
Socio-Economic	
State Economic Output	Decrease $223/AF of reserved flow
Household Income	Decrease $52/AF of reserved flow
Employment	Decrease 0.006 jobs/AF of reserved flow. No significant impact on employment stability.
Public Services	Property tax effects ($-8.57/AF) and population impacts (-0.012 people/AF) are too small to cause significant change in the quantity or quality of public services.
Recreation Activity	Over 1.4 million recreational uses of critical reach each year, worth over 5.6 million dollars to recreationists, or $9.57/AF of reserved flow.
Aesthetic Enjoyment	Impact on aesthetic enjoyment proportional to impact on stream based recreation.
Environmental	
Fish and Wildlife	Proposed flows would protect threatened and endangered species, including Whooping Crane, Bald Eagle, Least Tern and Piping Plover. Over 3.2 million occasions of recreation use each year in the Platte Valley are dependent on protected fish and wild-life populations. Over 80 percent of Nebraskan's have expressed strong support for protecting fish and wild-life.
Water Quality	Surface water quality not significantly impacted by instream flow. Groundwater quality would decrease from decreases in irrigation diversions, increasing cost of providing quality domestic water by $157,500 per year.

instream flow request would be offset by the protections afforded fish and wildlife populations, by increased aesthetic enjoyment, and by increased river based recreational activity that is valued by over 1.4 million recreationists at over $9.50 per year, per acre foot of reserved flow.

In interpreting these findings it is important to note the extremely high level of public concern for fish and wildlife, especially threatened or endangered species. Both state and federal law assign an infinite value to the protection of threatened or endangered species; over 3.2 million occasions of Platte Valley recreation use per year is dependent on protected fish and wildlife populations; and survey results indicate that a large percentage of Nebraskan's strongly support programs to protect fish and wildlife through increased taxes or fees, reduced irrigation diversions and/or reduced use of agricultural pesticides.

A final consideration in determining whether the proposed instream flow appropriation is in the public interest is consistency with state goals for water resources use. State water resources goals for use by all state agencies were adopted by the Nebraska Natural Resources Commission on August 29, 1985. The goals and principles which are relevant to an instream appropriation essentially state that (1) all water use decisions must consider both instream and out-of-stream needs; and (2) "... when unavoidable choices between economic and environmental values must be made, the well being of all the people should be the overriding determinant in considering the best use of the water available."

Using the criteria specified in the Nebraska instream flow statute and the interpretive guidance provided by the water resources goals and principles, one can quite clearly conclude that flows needed for threatened or endangered species are in the public interest. Society has definitively stated via state and federal law that there is no use of water that is more important than protection of threatened or endangered species. Thus, all corresponding public interest tradeoffs are or lesser importance.

The appropriate conclusion is much less clear when flow requirements for non-threatened or non-endangered species are considered. Approximately 15 percent (98,000 acre feet) of reserved flow is designated for Sandhill Cranes, which is the only non-threatened or non-endangered species for which flows were requested (Table 1). In this case, the public interest conclusion depends on how the political process weighs the adverse impacts on economic output, household income, employment and groundwater quality, in comparison with the positive impacts on aesthetics, Sandhill Cranes, and recreation values.

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