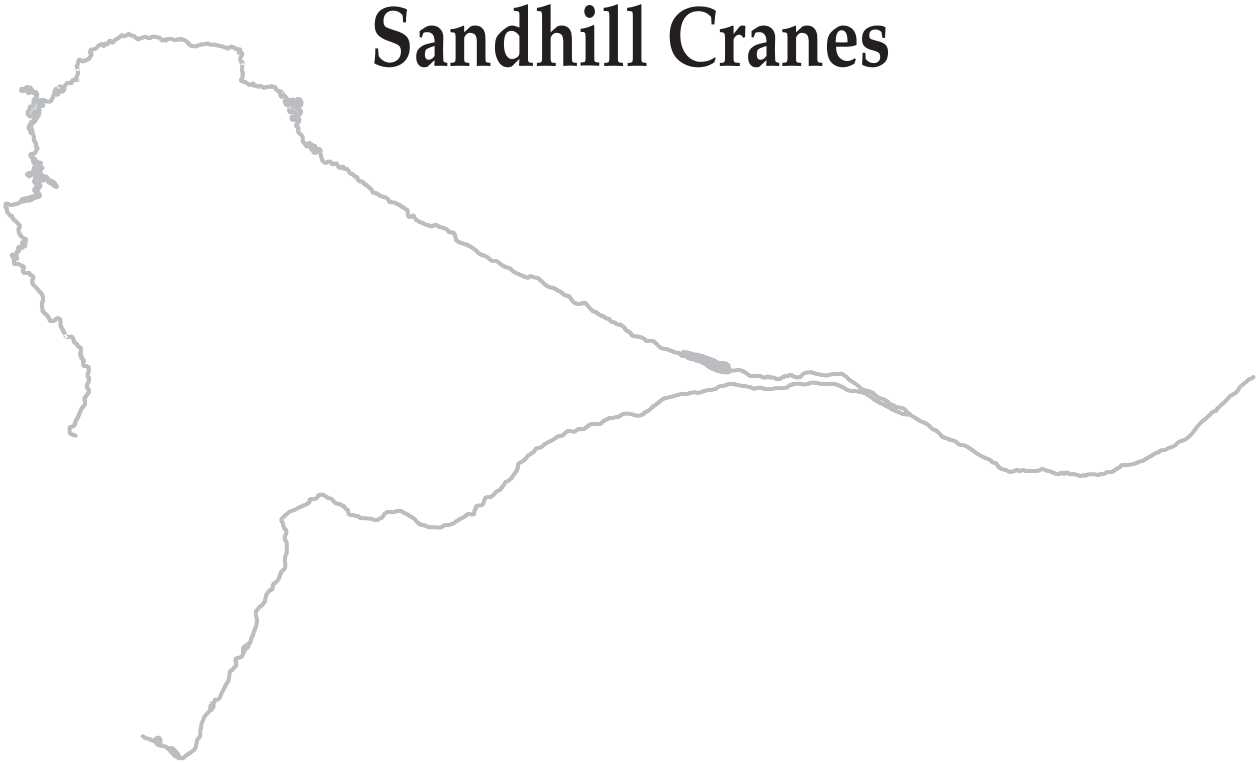
Platte River Recovery Implementation Program

Sandhill Cranes



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Platte River
Recovery Implementation Program
Technical Appendix

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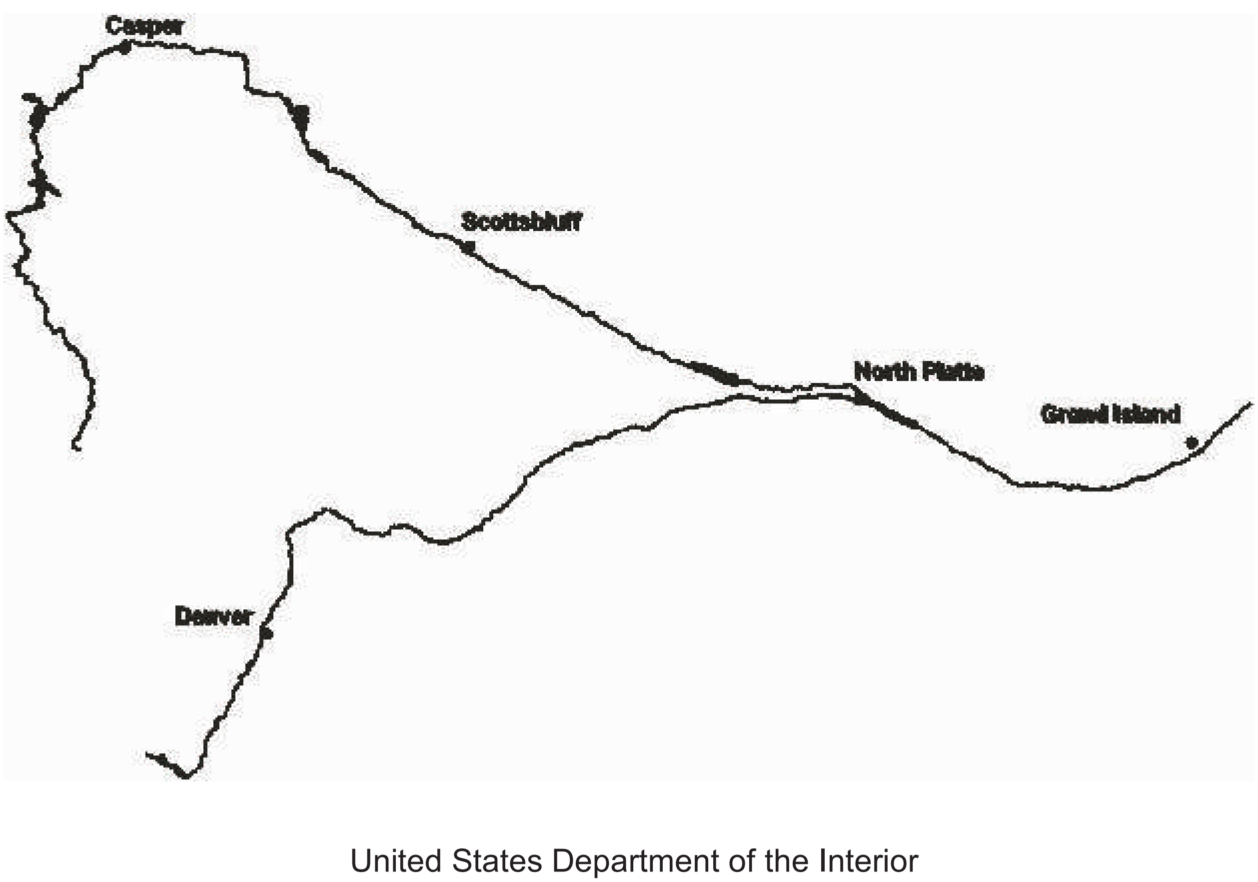

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Table of Contents

List of Tables

List of Tables - Continued

List of Tables - Continued

List of Figures

List of Figures - Continued

Sandhill Cranes Appendix

SPRING HABITAT USE IN NEBRASKA

Abstract

This assessment addresses sandhill cranes and their spring use of habitat along the North Platte and Platte Rivers in central Nebraska, and the potential effects of six alternatives currently being evaluated in the Platte River Programmatic EIS process. That process evaluates the effects of changing stream flows and managing additional lands along the Platte River for the benefit of whooping cranes, interior least terns, piping plovers, and pallid sturgeon. Sandhill crane use of the Platte River differs from that of the four target species, and thus the effects to sandhill cranes from implementation of any of these alternatives would also differ from predicted effects to the target species. In addition, use of the North Platte River by whooping cranes, interior least terns, and piping plovers is limited, but changes in flow to facilitate habitat benefits for these target species downstream may affect North Platte River reaches used by sandhill cranes.

Spring migration habitat traditionally used by sandhill cranes consists of three main components: (1) secure roost sites within the active river channel, (2) feeding sites where cranes obtain waste grain (primarily corn from harvested fields), and (3) feeding sites where cranes obtain invertebrate food (from wet meadows, alfalfa fields, grazed pastures, and hay fields). This evaluation is focused on the abundance of suitable roost sites, and the abundance of waste corn and invertebrate food. It is assumed that sandhill cranes prefer roosting sites that provide suitable water depth and an unobstructed view (measured as unobstructed channel width). Water depth and width are also characteristics of the channel, and thus the channel becomes the focus of this analysis. Food is evaluated indirectly as the relative abundance of lowland grasslands and alfalfa (invertebrate food), and corn fields.

Roosting Depth - Site Scale

Roost sites are the base of crane activity centers and thus the focus of our assessment of habitat suitability. It is assumed in this assessment that the suitability of roost sites can be characterize and quantified by an evaluation of the depth of water available for roosting and the unobstructed width of the channel. The relationship between roosting depth and discharge is discussed in the context of present conditions and then used at the site (transect) scale to estimate roosting depth abundance at future alternative flows. The relationship between roosting depth and discharge is then extrapolated to the system scale to estimate the direction of change in roosting depth abundance for the North Platte and Platte Rivers when only future discharge data are available.

A depth range of 3-9 inches was selected to represent suitable roosting depth. Two techniques and two sets of transect data were used to evaluate the relationship between discharge and roosting depth abundance in the 3-9 inch range. PHABSIM was used with data from eight sites located between just downstream of the Johnson Power Plant #2 return (Site 2) and Chapman (Site 12A), and the SEDVEG Model was used with 29 transects located between Lexington and Chapman, to document the relationship between discharge and roosting depth abundance.

The PHABSIM analysis indicated that roosting depth is maximized between 800 cfs and 1,600 cfs (mean of 1,175 cfs). Mean March flows were selected to represent discharge during the spring roosting period. Mean March flows under present conditions are greater than flows that would maximize roosting depth in the 3-9 inch depth range. Mean March flows for the action alternatives would provide similar or somewhat increased roosting depth abundance under existing channel morphology when compared to present conditions. The Water Emphasis Alternative is an exception to this generalization and would provide somewhat less roosting depth abundance at each site under predicted mean March flows.

SEDVEG Model output was converted to mean transect length within the 3-9 inch depth category for comparative purposes. Mean transect length within the 3-9 inch depth range was evaluated for all 29 transects and also for the Lexington to Kearney reach (11 transects) and the Kearney to Chapman reach (18 transects). Present condition analyses indicate that mean transect length in the 3-9 inch depth range would increase under fixed-bed conditions and remain similar under moveable-bed conditions when all 29 transects are compared for years 4-13. At the reach level, mean transect length in the 3-9 inch depth range would be reduced under both the fixed-bed and moveable-bed conditions in the Lexington to Kearney reach, while mean transect length within the 3-9 inch depth range would increase under both conditions in the Kearney to Chapman reach when compared to years 4-13 under present conditions.

The SEDVEG Model indicates that during 9 years (years 4-13 of the first study increment) of proposed channel management (e.g., island leveling), there would be an overall (mean value for 29 transects) reduction in roosting depth abundance under all action alternatives except the Governance Committee Alternative: Scenario 2. In the Lexington to Kearney reach, roosting depth abundance would increase under all action alternatives, except the Governance Committee Alternative: Scenario 1, over present conditions during years 4-13. During the same period, action alternatives would support reduced roosting habitat in the Kearney to Chapman reach. Under the fixed and moveable-bed conditions, mean transect lengths in the 3-9 inch depth range (all 29 transects) are greater than present conditions for all action alternatives except the Governance Committee Scenario 1 Alternative. A similar pattern exists for the Lexington to Kearney and Kearney to Chapman reaches which would support increased mean transect lengths over present conditions for all alternatives except the Governance Committee Scenario 1 Alternative. Under this alternative, only the moveable bed condition in the Kearney to Chapman reach would support an increase in mean transect length in the 3-9 inch depth range.

In summary, at the site scale (individual transect level), it appears that as habitat increases at managed sites, habitat is generally reduced at non-managed sites. Quite often in reaches exhibiting increases in mean transect length within the 3-9 inch depth range, individual transects experiencing reductions in roosting habitat outnumber those experiencing increases. There are currently no consensus management objectives for sandhill crane habitat, and sandhill crane habitat is not the focus of this study. However, the analysis indicates that while island leveling (simulated in this analysis) for target species benefits may increase roosting depth abundance for sandhill cranes in the vicinity of managed sites, non-managed sites may actually loose roosting habitat (reductions in transect length within the 3-9 inch depth range) under the proposed action alternatives. This may serve to further concentrate sandhill cranes in remaining suitable habitat.

Roosting Depth - System Scale

Roosting suitability at the system scale was evaluated via discharge data from various stream gauges located on the North Platte and Platte Rivers. Alternative data were compared to present conditions on an annual and seasonal basis (February-April and May-July). It is assumed that future changes in stream flow would be reflected as changes in sandhill crane roosting habitat through the same relationships between discharge and roosting depth abundance previously described for site-scale evaluations. Unfortunately, few cross-sectional transects are available outside the Lexington to Chapman reach of the Platte River. However, it is assumed that the relationships described for the central Platte River also exist in the North Platte River channel, and changes in future measures of discharge would represent future changes in roosting depth abundance when compared to present conditions.

Discharge at Lewellen would follow a pattern of somewhat lower flows during February and March and higher flows during April under all action alternatives. The one exception to this pattern would be slightly higher (+6 cfs) March flows under the Wet Meadow Alternative. Flows during the cottonwood seed production period—when compared to present conditions— would be mixed during May, lower in June, and higher in July). Future June and July flows lower than the historic June mean monthly flow may expose non-vegetated substrate during the cottonwood seed production period. The future response of woody vegetation to this type of discharge pattern is difficult to interpret. However, it is likely that under the action alternatives some additional woody vegetation would become established within the active channel between Lewellen and the upper end of Lake McConaughy (Clear Creek WMA).

The second site evaluated on the North Platte River is located between Sutherland and North Platte, Nebraska. A reduction in the frequency of spills from Kingsley Dam, reduced average annual discharge passing North Platte, and reduced flows in June and July, indicate the possibility of additional establishment of woody vegetation within the Sutherland to North Platte reach. Woody vegetation establishment would likely result in channel narrowing and perhaps deeper flows during the spring migration period, and an assumed reduction in roosting habitat. Both the Lewellen to Clear Creek WMA and this reach should be a candidates for research and monitoring studies under the Adaptive Resource Management Process.

Summer flows at Overton, Odessa, and Grand Island on the Platte River would follow a pattern similar to the flow pattern in the Lewellen to Clear Creek WMA reach of the North Platte River. June flows under the action alternatives would be lower than existing June flows and July flow would be lower than all June flows. Whether this pattern would result in increased woody vegetation depends on may factors including island leveling and how water in the Environmental Account is used for the central Platte River.

Unobstructed Channel Width

Data from a geographic information system (GIS) database were used to estimate unobstructed channel width for the Platte River at the bridge segment scale, with the focus on channel area > 501 feet. Area coverage defined as channel in 1982 (includes herbaceous islands) is similar to 1998 defined channel (does not include herbaceous islands), as is unobstructed channel width > 501 feet (calculated as area). Present conditions (1998 estimates) are compared to various future channel management scenarios that would level islands and thus increase the area of channel width > 501 feet.

Four of the five action alternatives propose some form of island leveling for the Platte River and would thus increase unobstructed channel width to some degree. No individual alternative proposes to manage lands in more than six bridge segments, or more than a total of about 8 miles of river channel. Example scenarios of land management activities would increase unobstructed channel width from 21.1 percent to 32.0 percent within the 13 bridge segments.

Food

A GIS analysis of food resources indicates that acres of corn and lowland grasses increased between 1982 and 1998 along the Platte River, while acres of upland grasses, alfalfa, and other crops were reduced. However, the increase in total acres of lowland grassland may reflect conversions of marginally productive farmland to the Conservation Reserve Program (CRP). CRP plantings generally consist of tall-grass prairie species that provide robust cover unsuitable for crane foraging. In addition, increases in acres of corn may not equate into an increase in food for cranes. For example, harvesting efficiency has increased, numbers of waterfowl using the Central Platte Valley have increased, cranes are foraging further from the Platte River, and fat storage in larger sandhill cranes and white-fronted geese has been reduced when compared to earlier studies. The abundance and adequacy of waste corn to provide food for sandhill cranes and other wildfowl should be the focus of continuing studies.

Some action alternatives would convert cropland (e.g., corn ground) to grassland. If the abundance of waste corn is becoming an issue for sandhill cranes and other wildfowl, then this management activity should be evaluated through the Adaptive Resource Management Process.

Conclusions

Sandhill cranes are not the focus of proposed actions under evaluation within the Platte River Programmatic EIS process. The results of implementing any of the proposed five action alternatives on sandhill crane habitat would be mixed. Sandhill cranes using the Platte River would likely benefit from an increase in roosting depth abundance and unobstructed channel width at managed sites. However, when data from individual transects are inspected, it appears that while roosting depth at managed sites increases, many non-managed sites experience a reduction in roosting depth abundance. Reductions in habitat at non-managed sites may result in cranes becoming more concentrated at managed sites. Potential channel changes from island leveling within the Platte River channel and changes in flows on the North Platte River should be monitored for future effects to sandhill crane habitat.

Sandhill Cranes Appendix

SPRING HABITAT USE IN NEBRASKA

1. Introduction

The North Platte and Platte Rivers, and adjacent lands in central Nebraska, provide important habitat resources to sandhill cranes migrating from southern wintering sites (in Arizona, New Mexico, Texas, and Mexico) to breeding grounds in Alaska/Siberia, Northern Canada/Nunavut, west-central Canada/Alaska, and east-central Canada/Minnesota (G.L. Krapu unpublished data 2003). Approximately 550,000 cranes—or most of the midcontinental population and about 80 percent of all sandhill cranes in North America—spend from 4 to 6 weeks each spring (February-April) along portions of the North Platte and Platte Rivers. Although members of all three subspecies of sandhill cranes likely pass through central Nebraska, Canadian and lesser sandhill cranes are the more common subspecies, with greater sandhill cranes uncommon (Tacha et al. 1984). Sandhill cranes use this traditional stop-over to physiologically prepare themselves for continuing their migration and participating in the subsequent breeding season. Cranes build lipid reserves and obtain important proteins by feeding in harvested corn fields and lowland grasslands and alfalfa fields near river-channel roost sites (U.S. Fish and Wildlife Service 1981, Krapu et al. 1984, Krapu et al. 1985, Reinecke and Krapu 1986). Harvested cropland and lowland grasslands also provide secure sites for pair-bond formation and courtship. In contrast to spring use, cranes appear to use the rivers in fall as a nontraditional stopover site, i.e., opportunistically if inclement weather is encountered, or some other factor dictates an overnight or short stop.

Migration habitat and crane use can be placed into three categories based on distance traveled, length of stay, and function (Melvin and Temple 1981). *Staging areas* are sites where cranes gather during the first segment (within the first 20 percent of the route) of their fall migration to physiologically ready themselves for the next stage of migration. Use of these sites may be traditional, but can vary depending on habitat variables. *Traditional stopover areas* occur further along the migration route (25 to 75 percent of the distance) and are used for extended periods during spring and fall migrations every year. Melvin and Temple (1981) believed such sites are actively sought by individual cranes each year, and at least in the spring, may be used to accumulate lipid reserves (Krapu et al. 1984, 1985). *Nontraditional stopover sites* provide overnight (or a few days) habitat, and are used opportunistically. Although the Central Platte Valley (the lower North Platte River, the central Platte River, and adjacent lands) is commonly referred to as a "staging area," it is traditionally used each year for the purpose of physiologically preparing sandhill cranes for the breeding season. This preparation is accomplished by gaining weight—through acquiring lipid reserves, calcium, and critical amino acids necessary for egg production.

Sandhill crane use of the Central Platte Valley in the fall has not received the study generated by spring use. There appears to be no tradition associated with fall use, in contrast to spring use by sandhill cranes. Cranes appear to use the Central Platte Valley in fall as a nontraditional stopover site, i.e., opportunistically if inclement weather is encountered, or some other factor dictates an overnight or short stop.

This appendix provides background information, identifies assumptions and methods, and presents results from various analyses of sandhill crane spring habitat use of the Central Platte Valley. Numerous tables and figures are attached as supporting material for various analyses of sandhill crane habitat either conducted for, or associated with, the Platte River Programmatic Environmental Impact Statement (PEIS).

1.1 Historic Conditions and Use

In order to understand existing habitat resources and their use by migrating cranes, it is necessary to understand historic habitat distribution and abundance, and its use by sandhill cranes. The lower North Platte River, central Platte River, and adjacent lands have historically provided habitat resources for migrating sandhill cranes. Cranes used the Central Platte Valley from Sutherland to Grand Island, Nebraska (Krapu 1999). Although data are limited, there is documentation of extensive crane use in river reaches no longer used—for example, the area between the confluence of the North and South Platte Rivers (near North Platte, Nebraska), downstream to Overton, Nebraska (Walkinshaw 1956, Krapu 1999).

Historically, before major water development began in the late 1800's, high spring flows restructured the active channels of the North Platte and Platte Rivers and helped maintain a wide and sediment rich system (Simons & Associates, Inc. 2000). Estimated channel widths at selected sites on the Platte River in 1865 were: 3,746 feet at Cozad, 4,795 feet at Overton, 4,988 feet at Odessa, and 2,707 feet at Grand Island (Peak et al. 1985). Sediment was primarily provided to the Platte River by the North Platte River (estimated at 896,000 tons annually at North Platte) during the pre-development period (1895-1909) with a smaller contribution from the South Platte River (estimated at 212,000 tons annually at North Platte) (Randle and Samad 2003). Approximately 1,040,000 tons of sediment per year passed Grand Island, Nebraska. Sediment transport estimates (1895-1909) by Kircher (1983) and Simons & Associates, Inc. (2000) are somewhat higher than those presented above (reviewed by Randle and Samad 2003).

Riparian vegetation was a component of the pre-development river system (see review by Simons & Associates, Inc. 2000). The extent and abundance of riparian vegetation associated with the pre-development Platte River have been, and remain, the topics of much discussion (see Currier et al. 1985 and Johnson 1998 for differing views on the historic abundance of woody vegetation). Differing opinions may originate in the use of different data sets from different periods such as photographic comparisons (Williams 1978) and General Land Office surveys and notes (Johnson and Boettcher 1999). General Land Office data and historical accounts (reviewed by Eschner et al. 1983) indicate that the pre-development Platte River supported cottonwood, willow, and other trees and shrubs on islands of all sizes within the channel, and a band of riparian vegetation along both banks (Simons & Associates, Inc. 2000).

Based on our current understanding of rivers and the processes at work (see Standford et al. 1996, Poff et al. 1997, and Friedman et al. 1998 for process overview), we can assume that the pre-development North Platte and Platte Rivers were a dynamic system supporting diverse habitats. Cranes likely roosted in the broad active channels and fed on plants and animals in adjacent wetlands, wet meadows, and suitable prairie sites. Dynamic systems are often characterized by patchy resources. Local and/or regional weather cycles of abundant moisture followed by drought conditions would have favored diverse habitat conditions. Some sites may have supported abundant food and suitable roosting conditions during some years, while other sites supported more favorable conditions at other times. Crane use was likely opportunistic and dispersed in order to efficiently exploit resources separated in space and time.

1.2 Current Conditions and Use

Habitat resources—and crane use of these resources—in the Central Platte Valley of today have changed from historic conditions. The most obvious change commonly cited is channel narrowing resulting from occupation of much of the historic active channel by woody vegetation. Channel narrowing is a basin-wide characteristic occurring on the North, South, and Platte Rivers (reviewed by Simons & Associates, Inc. 2000). In general, sites from above Lake McConaughy on the North Platte River, to Chapman on the Platte River, have lost from 72 to 90 percent of their channel width when compared to estimates from the late 1800's (Simons and Simons 1994). Estimated channel widths at selected sites on the Platte River in 1983 (and the reduction in width when compared to 1865 data) were: 476 feet (-87 percent) at Cozad, 1,050 feet (-78 percent) at Overton, 893 feet (-82 percent) at Odessa, and 1,339 feet (-51 percent) at Grand Island (Peak et al. 1985).

Reductions in channel widths are linked to changes in annual discharge, sediment transport, bridge building, and other factors. Mean annual discharge measured at Overton declined from about 2.8 million acre feet (maf) before 1930, to 1.4 maf after 1970, and average peak discharge was reduced from 16,325 cubic feet /second (cfs) to 7,878 cfs (Simons & Associates, Inc. 2000). The sediment supply has also changed. Randle and Samad (2003) have estimated current (1970-1999) sediment transport at North Platte, Nebraska, of 71,900 tons/year from the North Platte River, and 245,000 tons/year from the South Platte River. Approximately 374,000 tons annually pass Grand Island, Nebraska. Finally, there are 20 bridge crossings, each affecting about 1 mile of channel, on the Platte River between North Platte and Chapman, Nebraska (Simons & Associates, Inc. 2000).

It is generally believed that changes in flow—primarily reduced mean annual discharge and lower mean peak flows—have substantially contributed to conditions that have permitted vegetation to become established within much of the historic active channel. Most channel narrowing occurred between 1930 and 1970 (reviewed by Simons & Associates, Inc. 2000), when major upstream reservoirs were constructed and filled, and two major regional droughts occurred (1930's and 1950's). Simons & Associates, Inc. (2000) argue that low flows exposed much of the active channel during this period and that the exposed substrate provided a seed bed for riparian vegetation. With reduced annual and peak flows, the river could not maintain historic channel widths.

Channel narrowing is believed to have stabilized since the late 1960's. However, the channel between Alda and Chapman, Nebraska, has experienced recent additional width reductions, possibly associated with vegetation management activities within this reach (Johnson 1996 in Simons & Associates, Inc. 2000). The River Hydraulics and Sediment Transport section of the PEIS provides a detailed discussion—based on new analyses—of the processes affecting the river channel and ultimately sandhill crane habitat. Basically, that analysis characterizes the Platte River from the confluence of the North Platte and South Platte Rivers to the Johnson Power Plant #2 (J-2) return (River Mile-RM 310-247) as aggrading, from J-2 to about 5-miles east of Overton (RM 247-234) as degrading, east of Overton to the Lillian Annette Rowe-Audubon Sanctuary (RM 234-206) as transitional, Audubon Sanctuary to Grand Island (RM 206-167) as aggrading, and Grand Island to west of Chapman (RM 167-160) as transitional.

Although the central Platte River between Lexington and Chapman supports the majority of spring habitat use by sandhill cranes, two other stream reaches also support cranes and are addressed in this assessment. The first of these areas is located along the North Platte River at the upper end of Lake McConaughy from the Clear Creek Wildlife Management Area (WMA) west approximately 2 miles. About 5,000 to 8,000 cranes use the river for roosting and adjacent grasslands and irrigated corn fields for feeding. The second area is also located on the North Platte River and occurs between Sutherland and North Platte, Nebraska, although most use now occurs between Hershey and North Platte. About 150,000 cranes use the river for roosting and feed in adjacent grasslands and grain fields.

Some limited crane use does occur outside these primary areas—an example would be portions of the Rain Water Basin south of the central Platte River. However, this appendix focuses on sandhill crane habitat and spring use along the North Platte and Platte Rivers. The Platte River between Overton and just east of Grand Island has received attention and study because of numerous whooping crane observations within the area. The Clear Creek WMA site and the Sutherland to North Platte reach of the North Platte River have received less attention and study.

Channel narrowing has occurred over a period from the first water diversions, and sandhill cranes have responded to these changes. For example, along the Platte River sandhill crane use has shifted eastward between Lexington and Chapman during the past 40 years. Approximately 60 percent of crane use occurred between Lexington and Kearney in 1957, with about 9 percent of the use between Kearney and Chapman (Fanes and Leally 1993). By 1989, 5 percent of cranes occupied the Lexington to Kearney reach and 81 percent of cranes used the Kearney to Chapman reach.

Researchers have identified three primary areas of sandhill crane habitat use: Sutherland to North Platte, Overton to Elm Creek, and Kearney to Grand Island (U.S. Fish and Wildlife Service 1981, Krapu et al. 1987). Further deterioration of roost sites has occurred in the two Platte River reaches, with cranes concentrating into remaining sites (Krapu 1996). The patterns of use for the Platte River for two periods:1980-1989 and 1990-1999, are compared in Figure SC-1.

Perhaps the second most important habitat change affecting sandhill cranes can be associated with the advent of the mechanical corn picker in the early 1940's (Krapu et al. 1985). Corn has likely been a common crop in the Central Platte Valley since the first irrigation attempts in the 1800's. However, hand-harvested corn was basically waste free and thus provided no waste grain food resources for spring migrating cranes. The first mechanical corn pickers were, however, somewhat inefficient and left a portion of the crop in the field as waste grain. The availability of an abundant and highly nutritious food (waste corn) permitted cranes to respond to narrowing channels by concentrating roosting activity into remaining vegetation-free areas. Thus it appears that abundant waste corn has facilitated the shift in use patterns to the eastern Central Platte Valley.

The availability and use of waste corn near the central Platte River was evaluated in the late 1970's. At that time, corn yields averaged 101 bushels/acre, with a 6 to 7 percent loss at harvest (U.S. Fish and Wildlife Service1981). Depending upon weather conditions, between 0 and 25 percent of the fields were fall tilled, leaving the remaining cornfields and their waste grain available. Foraging by livestock removed about half the available waste corn before cranes arrived in the spring. Cranes removed between 0.2 to 0.3 pounds of corn per bird/day, and an estimated crane population of 350,000 to 450,000 birds removed between 1,130 and 1,450 tons of waste corn during their spring stopover in the central Platte River (U.S. Fish and Wildlife Service1981).

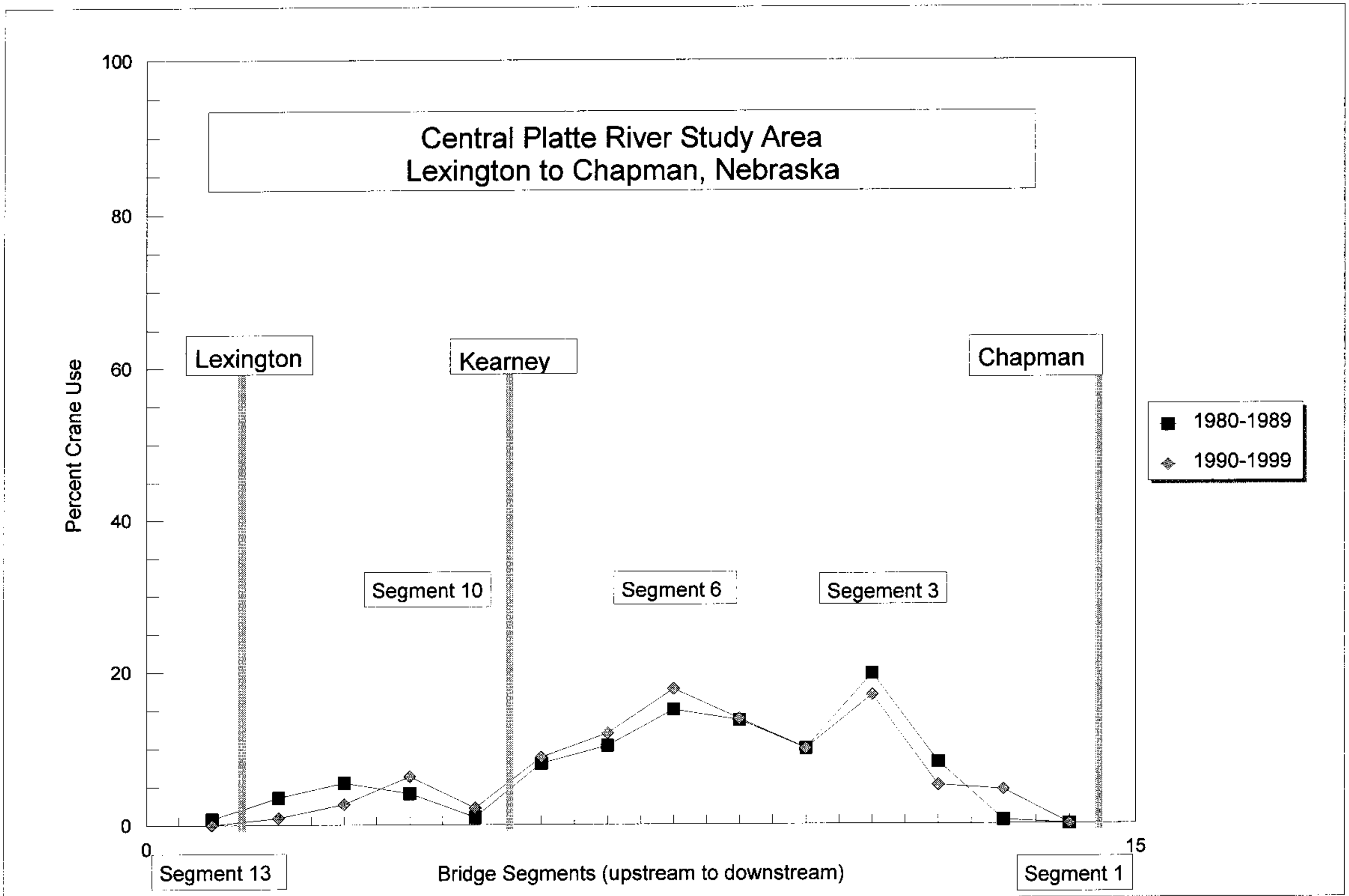


Figure SC-1 Percent sandhill crane observations from 13 bridge segments between Lexington and Chapman, NE, 1980-1999. Cranes are surveyed annually by the U.S. Geological Survey (__________ 2000).

1.2.1 Spring Habitat Components

Spring migration habitat traditionally used by sandhill cranes in the Central Platte Valley consists of three main components: (1) secure roost sites within the active river channel, (2) feeding sites where cranes obtain waste grain (primarily corn from harvested fields), and (3) feeding sites where cranes obtain invertebrate food (from wet meadows, alfalfa fields, grazed pastures, and hay fields) (Armbruster and Farmer 1981). Cranes generally roost in the channel, standing in shallow water, away from wooded banks and islands. They leave their roost sites at first light and move to nearby feeding sites. Mid-day activities include loafing, sleeping, and courtship. The afternoon feeding period ends at dusk when cranes move to roost sites for the night.

Roosting-Spatial Characteristics.—Sandhill crane roost requirements in the Platte River have been variously defined and debated. A concept common to most discussions involves "unobstructed view," which is generally translated into a measurable unit referred to as "unobstructed channel width" (Armbruster and Farmer 1981, Currier and Ziewitz 1987). *Unobstructed channel width* is an active channel measure—the bank-to-bank distance perpendicular to stream flow— that is devoid of obstructions that would interfere with roosting cranes' line of sight [generally estimated at 1 meter (39.4 inches) above the substrate]. It is assumed that cranes select roost sites that provide some measure (via an unobstructed channel width) of security from terrestrial predators. Security is generally believed associated with some minimum distance (i.e., width) from woody (concealing) cover (e.g., vegetated banks and islands), and wider channel reaches. The distance from defined roosts to woody vegetation varies, but sandhill cranes appear to use channel sites more frequently on the Platte River that exhibit greater unobstructed channel widths than sites with smaller width values. Krapu et al. (1984) found that 70 percent of roosting cranes were located at sites where the channel was greater than 150 meters (about 492 feet).

Roosting-Physical Characteristics.—The Platte River between Lexington and Chapman has a generally flat bed and vertical banks. The river at low flows is a mosaic of individual braided channels carrying water, the exposed bed and low elevation sediment deposits of different size and height, and higher elevation sediment deposits (islands) supporting herbaceous vegetation (cleared islands) and shrubs and trees (non-managed islands). As flows increase, individual channels carrying water increase in depth and width, and merge with others as low elevation sediment deposits become submerged. Submerged sediment deposits—at suitable depths—are used for roosting by sandhill cranes. Optimum water depth for roosting ranges from 4 to 8 inches, with depths greater than 14 inches unsuitable for sandhill cranes (Armbruster and Farmer 1981). Depth of submerged sediment deposits varies with discharge, and different stream flows provide different amounts (area) of channel roosting habitat.

Feeding-Spatial Characteristics.—The diet of sandhill cranes using the Central Platte Valley consists primarily of corn—96 percent of the daily composite diet was obtained from cornfields—and the remaining 4 percent from grasslands and alfalfa fields (U.S. Fish and Wildlife Service 1981). Researchers believe that the invertebrate component of the diet (3 percent reported by Reinecke and Krapu 1986), increases the protein intake of cranes by 10-20 percent and calcium intake by more than 500 percent. Cranes obtain invertebrates from wet meadows, alfalfa fields, and grasslands (pastures and hayfields).

1.2.2. Habitat Complex

Habitat components discussed above cannot be evaluated in isolation. Habitat should be viewed in terms of a complex of landscape features providing the needs of sandhill cranes. The complex is best envisioned as a home range—or the total area used by a crane during a spring stopover along the Platte River. Researchers radio marked 20 cranes near Kearney and collected various data during 1978 and 1979 (U.S. Fish and Wildlife Service 1981). Individual home ranges averaged 14 square miles (mi^2) (range 4.5 to 26 mi^2) in size, and included 44 percent cropland, 20 percent native grassland, 18 percent riverine, and 10 percent hayland. Eighteen percent of the home range was either former or currently active channel. Cranes traveled a mean daily distance of 6 miles, and moved on average 1.7 miles from the roost site to the area where they spent the day. The average distance moved decreased as the spring stopover progressed. Suitable roost sites should be the focal point of habitat component evaluations (see Sparling and Krapu 1994). Researchers believe cranes exhibit a high degree of roost site fidelity (U.S. Fish and Wildlife Service 1981). The average river reach used by marked cranes was 7.3 miles long. Only 2 of 20 cranes moved out of the Kearney to Shelton reach—1 bird moved 11 miles and the other 14 miles.

The Platte River Whooping Crane Maintenance Trust, Inc. (The Trust), a non-profit conservation organization based out of Wood River, Nebraska, incorporates the concept of habitat complex into their management plan (Platte River Whooping Crane Maintenance Trust, Inc. 1998). One of The Trust’s goals involves creation of habitat complexes in each of the river segments (separated by bridge crossings) between Overton and Chapman. Each complex would consist of approximately two miles of cleared channel at least 1,000 feet wide (about 240 acres) and about 2,400 acres of adjacent grassland and wet meadow. Although not explicitly stated, it is assumed that cropland would be abundant nearby to provide the energetic needs of sandhill cranes.

The effects of human disturbance should also be considered when addressing the habitat complex. Cranes avoid areas of high human use such as roads, bridges, and sand and gravel mining (sand/gravel pits) operations. For example, residential development—particularly those on former sand/gravel pits near the river—potentially increase human disturbances near roosting areas. Crane avoidance behavior basically reduces the amount of potential habitat that would otherwise be available for use.

Human disturbance and the avoidance response it presumably elicits from sandhill cranes are not treated in this analysis. Avoidance and the disturbance buffers or zones of influence around various features used to portray the response have been debated for some time (Table SC-1). At present, there is no consensus on the influence of human disturbances to potential crane habitat, or even how the concept of disturbance should be evaluated. While developing material for this appendix, various disturbance buffers, similar to those described by Armbruster and Farmer

(1981), were applied to potential roost sites via a geographic information system (GIS)-based analysis. In several cases, sites well within described zones of influence from disturbance features—and therefore supposedly avoided by cranes—are known to be used by sandhill cranes. The issue of human disturbance and its role in habitat assessments for cranes clearly requires additional research. Until the issue of human disturbance can be adequately addressed, information presented in this appendix should be viewed as an over-simplification of how sandhill cranes respond to habitat resources.

Table SC-1. Disturbance buffers/zones of influences for various man-made features affecting sandhill crane habitat.

Man-Made Features	Armbruster and Farmer 1981			Norling et al. 1990		
	Roost Buffer (m)	Grassland Buffer (m)	Cropland Buffer (m)	Roost Buffer (m)		Zone of Influence (m)
				Screen	No Screen	
Paved Road	400	200	100	301-400	>900	500
Gravel Road	200	100	50	301-400	301-400	400
Private Road	40	20	10	100	100	100
Urban Dwelling	800	400	200	limited data	limited data	800
Single Dwelling	200	100	50	101-200	>400	100
Railroad	400	200	100	limited data	limited data	600
Commercial	800	400	200	limited data	limited data	700
Recreation Area	200	100	50	no data	no data	no data
Highlines	40	20	10	limited data	limited data	200
Bridges	400	200	100	400	400	400
Sand/Gravel Operations				100	100	

1.2.3 Competition for Resources

The U.S. Fish and Wildlife Service conducted the “Platte River Ecology Study” in the late 1970's to document the relationships between cranes, waterfowl, and other species, and the habitat resources provided by the central Platte River (U.S. Fish and Wildlife Service1981). The study evaluated both riverine habitat and food resources in grasslands and cropland. The quantity of waste corn remaining for cranes after fall tillage, winter foraging by livestock, and use by waterfowl was a particular interest of the study. For example, field-feeding waterfowl—primarily mallard and pintail ducks, and Canada, white-fronted, and snow geese—also utilize waste corn while over-wintering or during spring migration through the Central Platte Valley. In the late 1970's, several thousand mallards and Canada geese wintered along the Platte River and in adjacent ice-free canals (U.S. Fish and Wildlife Service 1981). Highest concentrations of wintering waterfowl occurred between Lexington and Grand Island. Corn accounted for 94 to 97 percent of the diet of wintering mallards. Use by migrants was weather dependent. Upon arrival, migrant waterfowl roosted on the Platte River and fed in adjacent fields until wetlands in the Rainwater Basin became ice-free. The study concluded that waste corn was abundant and could meet the needs of foraging livestock, wintering and migrant waterfowl, and cranes. For example, cranes used only 10-20 percent of the waste corn present upon arrival, and left behind an amount equal to 3-5 times the population's requirements (U.S. Fish and Wildlife Service1981).

Spring use of the Central Platte Valley by migrating waterfowl has increased substantially since the above referenced ecology study's findings were published. For example, the Rainwater Basin, located to the south and east of the central Platte River, has become the first principal stop for lesser snow geese migrating north each spring from the Gulf Coast (Farrar 1998). Numbers of geese can be impressive. For example, snow geese using Funk Lagoon—one basin complex about 15 miles south of Odessa— can exceed one million birds. Geese generally arrive in mid-to-late-winter before sandhill cranes, but timing varies and periods of use may overlap with sandhill cranes. For example in 1998, snow geese, Canada geese, and sandhill crane numbers all peaked in late March, while in 1999, geese were declining in numbers as cranes began arriving [The Trust unpublished data 1999, 2000 (http://www.whoopingcrane.org)]. The Trust speculates that high snow geese numbers in 1999 may indicate a response to increased spring hunting pressure in the eastern Rainwater Basin. Regardless of the reasons for an increase in waterfowl numbers, geese now commonly exceed cranes in abundance in the Central Platte Valley during the spring migration period.

In addition to the substantial increase in waterfowl numbers during the last 25 years, and the resulting increase in demand for waste corn, a second factor also raises concerns for the current adequacy of food resources for wintering and migrating waterfowl and sandhill cranes. Krapu et al. (in press) recently found less waste corn now available for cranes and other wildfowl because of increased harvesting efficiency. These researchers found that harvest efficiency has increased by nearly 50 percent over the last 25 years.

Sandhill cranes are responding to a reduction in waste corn by moving further from the river to feed. VerCauteren (1998) observed cranes using corn fields 5 miles north and 8 miles south of the river, while Krapu (unpublished data 1999) found that some cranes using roost sites between Wood River, Nebraska, to State Highway 281, traveled up to 12 miles south to feed. Such movements are in sharp contrast to use in the late 1970's when cranes generally forged within 3 miles of the river (U.S. Fish and Wildlife Service 1981). These increased movements may come with a physiological cost. While abundant waste corn in the late 1970's permitted cranes to store fat reserves for migration and subsequent nesting on the breeding grounds, larger cranes (greater and Canadian subspecies) are now storing less fat (Krapu et al. in press). Fat storage is also declining in spring staging geese with white-fronted geese now unable to store fat, whereas " white-fronts" stored an average 14 grams of fat/day in the late 1970's (Krapu et al. 1995, Krapu et al. in press).

2.0 Methods

Sandhill cranes use the Central Platte Valley for specific purposes. The primary purpose is likely the accumulation of lipids and other physiological requisites to reproduction. The fact that cranes interrupt their northern migration to spend 4-6 weeks each spring along the North Platte and Platte Rivers indicates the importance of this period in their annual cycle. This traditional use of the Central Platte Valley also indicates the ability of the area—and therefore its value and importance—in providing the various habitat resources needed during this period of the annual cycle. Other habitat purposes and uses include providing secure sites for roosting, resting, feeding, and courtship.

Sandhill cranes migrate as family groups, sub-adults, and other non-breeders that congregate to form flocks. It is assumed that this gregarious behavior facilitates the efficient exploitation of habitat resources. However, large numbers of birds—flocks can range in size from a few individuals to thousands of cranes—require abundant habitat resources in close juxtaposition in order to efficiently acquire food and deposit lipid reserves. The concept of a habitat complex—suitable roost sites near abundant food sources—fits our perceptions of how large flocks of cranes would efficiently exploit their environment. Unfortunately, no credible, comprehensive, and ready-to-use assessment model for sandhill crane habitat complexes exists for the Central Platte Valley.

2.1 Assumptions

The analysis presented in this appendix relies on some basic concepts, relationships, and assumptions. The concept of habitat complex has been discussed and a discussion of the relationships between discharge and roosting habitat will be present following a discussion of basic assumptions.

One of the primary assumptions deals with data interpretation. In order to interpret data from our analysis, we have assumed that an increase in habitat resources is a better situation than a reduction in resources. The assumption may seem obvious, but is necessary because we do not currently know the resource quantities required by the midcontinental population of sandhill cranes during their spring stay in the Central Platte Valley. For example, estimates have been made of the quantities of waste corn available and consumed by cranes in the late 1970's (U.S. Fish and Wildlife Service 1981). Since those studies were completed, harvesting efficiency has increased, acres of corn have increased, and the use of waste grain by other species of wildfowl has increased. Studies are currently underway that address the question of how much corn is enough, but the data are not yet available. A similar situation exists for lowland grasslands. As presented below, data appear to indicate an increase in acres of lowland grasslands (1981 vs.

1998 GIS coverage). However, this comparison may reflect an increase in lands enrolled in the Conservation Reserve Program(CRP). These CRP lands are generally planted to and managed for robust grass species that are not generally used by sandhill cranes.

A potential problem with the assumption of "more is better" in an analysis that compares proposed alternatives to present conditions is that it implies that present conditions are adequate and acceptable. Without knowledge of what resource quantities are needed we do not know if present conditions provide adequate supplies of waste corn, invertebrate food, and/or roosting habitat. Present resource conditions may be inadequate or provide surpluses, and adding more to a surplus or removing some quantity from an already inadequate supply would have very different consequences. Because of this uncertainty, we have elected to take a conservative approach, and until additional data become available, will view an increase in resource abundance and/or condition as a positive situation, and a reduction as a negative effect.

The analysis of roosting habitat attempts to go beyond acceptance of present conditions and identify the amount of roosting habitat that would be present at various flows. Sandhill cranes roost in flocks on submerged sediment deposits in the active channel. Flows that maximize the area of submerged sediment deposits within a suitable depth range are of interest in defining sandhill crane roosting habitat because these are the flows that would accommodate the largest numbers of cranes (i.e., more is better). This appendix first treats the relationships between discharge and roosting depth at a limited number of sites between Lexington and Chapman. It is assumed that relationships between discharge and habitat defined at the site scale can then be extrapolated to the system scale where only hydrology data are available.

This evaluation of sandhill crane spring habitat and its use in the Central Platte Valley is focused on the abundance of suitable roost sites, and the abundance of waste corn and invertebrate food. It is assumed that cranes prefer roosting sites that provide suitable water depth and an unobstructed view (measured as unobstructed channel width). Water depth and width are also characteristics of the channel, and thus the channel becomes the focus of this analysis. Food is evaluated indirectly as the relative abundance of lowland grasslands and alfalfa (invertebrate food), and corn fields. As previously stated, the analysis does not address the influences of human disturbances or potential competition for food and roost sites by field-feeding ducks and geese. The analysis is therefore a simplistic approach that is further complicated by treating habitat complex components individually. However, until additional information and more creative approaches become available, the analysis can serve to represent our current understanding of sandhill crane use of the Central Platte Valley, and can readily be updated through the Adaptive Resource Management Process.

2.2 Site Scale

Flows and channel morphology have been the focus of numerous studies in the Central Platte Valley since the early 1980's (Simons & Associates, Inc. 2000). Numerous permanent channel transects have been established for various purposes, and used to collect data over the years. We use two subsets of those transects to evaluate the abundance of roosting habitat in the 3-9 inch depth range. Permanent transects permit repeated measurements of the channel's profile at the same sites through time and at different flows. Brief descriptions of the two assessment techniques used in this analysis are presented below.

2.2.1 PHABSIM Analysis

Components of the Physical Habitat Simulation System (PHABSIM) (Bovee and Milhous 1978, Bovee 1982, Milhous et al. 1984) were used as one of two approaches to estimating the amount of channel available for roosting. Channel profile information such as wetted width, depth, velocity, etc., and mean monthly flow data are input into PHABSIM to predict user-defined habitat abundance.

Habitat transect data collected from sites established by the U.S. Fish and Wildlife Service (Service) and the Bureau of Reclamation (Reclamation) in the mid-1980's (U.S. Bureau of Reclamation 1989) were manipulated and analyzed to identify the abundance of depths suitable for roosting sandhill cranes. About 16 sites, each supporting from 3 to 9 transects, and believed to represent from 3 to over 16 miles of channel per site, constitute the original source of data. Each site was sampled several times at various flows. A subset of these data—a single sampling event at eight sites (representing about 41.5 channel miles)—was selected for this analysis (Table SC-2).

Table SC-2. Habitat transect site locations used to evaluate roosting depths for sandhill cranes. Background data includes number of transects and river miles represented, number of surveys, and minimum and maximum measured flows 1983-1986 (U.S. Bureau of Reclamation 1989).

Habitat Transect Site #	Approx. Location (RM)	Bridge Segment	Number of Transects	Miles Represented	Number of Surveys	Minimum Measured Flow	Maximum Measured Flow
2	243.5	12	8	3.9	3	642	2290
4A	227.5	10	6	3.0	3	227	1861
6	206.5	7	9	7.6	4	291	1976
8C	196.5	6	4	3.0	3	537	4276
8B	191.5	5	5	2.3	4	415	3336
9BW	178.5	3	5	16.3	8	110	1299
9BE	177.5	3	7	---	6	96	1305
12A	158.5	1	3	5.4	4	221	2225

Optimum water depth for roosting ranges from 4 to 8 inches, with depths greater than 14 inches unsuitable for sandhill cranes (Armbruster and Farmer 1981). A depth range of 3-9 inches was selected to represent suitable roosting depth. This depth range can be easily acquired from the habitat transect data sets, and is similar to optimum roosting depth for sandhill cranes. It is assumed in this analysis that roosting depth is maximized at flows that maximize the area (represented by wetted channel width) within the 3-9 inch depth range. Therefore, the impact indicator for roosting suitability at the site scale is **roosting depth abundance (roosting habitat indicator 1)** as measured by the **transect length (feet) within the 3-9 inch depth range.**

Note that this indicator seeks to identify roosting depth abundance in the 3 to 9 inch depth range. Because this analysis does not address disturbance, no buffering of bank or island vegetation, or bridges, or other human disturbance features (Table SC-1) has been performed. Abundance is a useful measure or index to roosting habitat. The area available for crane use would be abundance minus the area affected by cranes' disturbance avoidance response. In addition, because this analysis does not address spatial issues (e.g., distance to food) of habitat complex components, or the issues of potential competition with other wildfowl, the actual area used by sandhill cranes may be less then that which is available (which is likely less than the predicted abundance). Therefore, the indicator should be viewed as an index useful in relative comparisons among alternatives and not as a predictor of crane use. More research is needed to adequately address crane use of roost sites.

The site-scale analysis focuses on the interaction of discharge with channel morphology to produce various amounts of roosting habitat. For example, the channel bottom consists of numerous sub-channels of various depths separated by sediment deposits of various heights. Low flows are confined to deeper sub-channels within the bottom of the main channel. As discharge increases, water overflows these deeper sub-channels to merge into progressively shallower sub-channels until it spreads out over the bottom of the channel and covers low elevation sediment deposits. During this initial increase in flow, wetted channel width increases rapidly until the channel bottom is filled. Once the channel bottom is filled, wetted width increases by water moving up the channel banks. The rate of wetted width increase is reduced after the banks are encountered, but water depth continues to increase (Figure SC-2, A and B). Roosting depth abundance is maximized at the flow that maximizes the area of submerged sediment deposits under 3-9 inches of water, and at most sites, occurs after the channel bottom has filled (Figure SC-2, C). This relationship between discharge and channel morphology forms the basis for roosting suitability at the site scale.

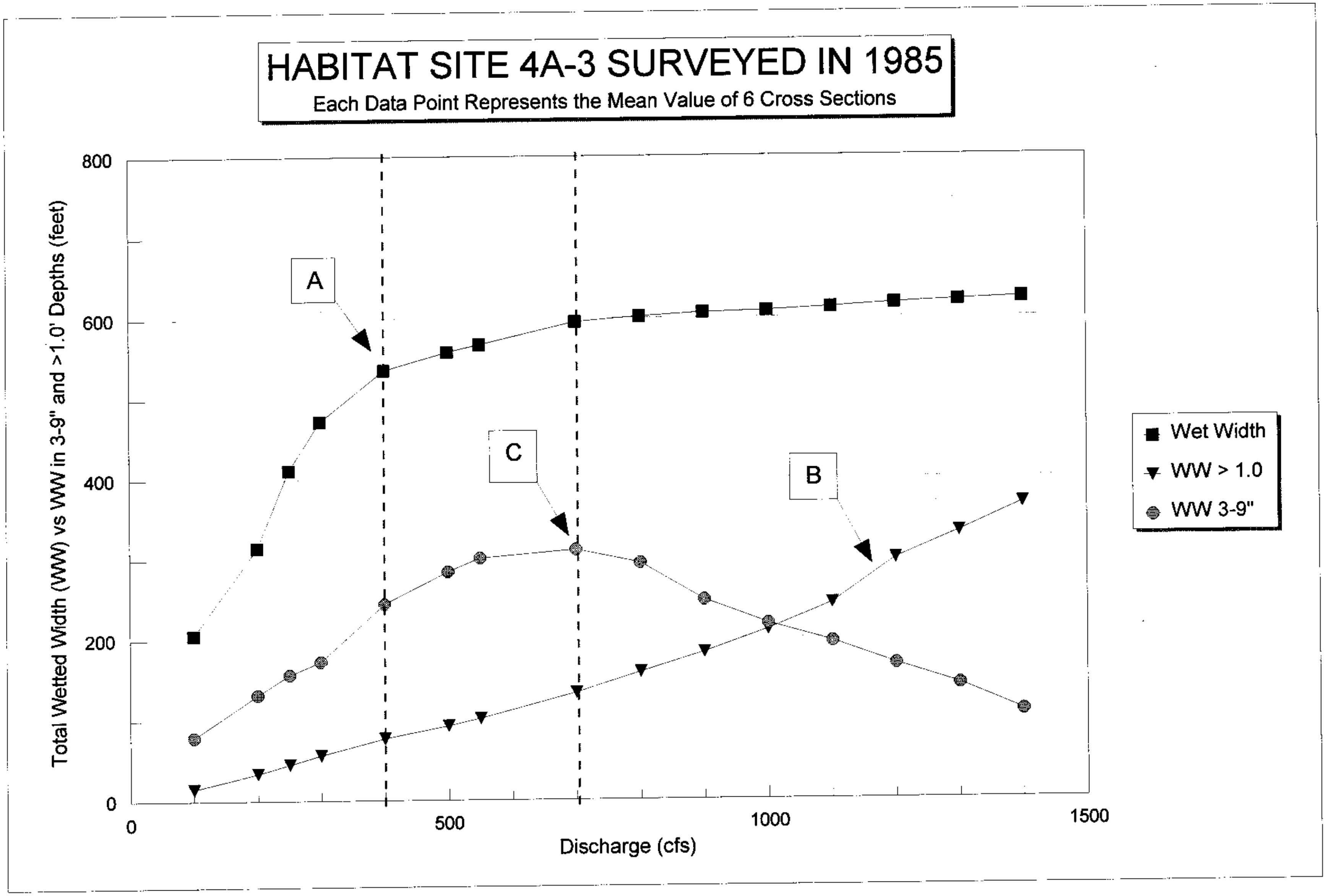


Figure SC-2. Relationships between total channel wetted width (A), wetted width with depths greater than 12 inches (B), wetted width within a depth range of 3-9 inches (C), and discharge at habitat site 4A-3.

2.2.2 SEDVEG Analysis

Some action alternatives contain provisions for island leveling for the purpose of increasing roosting area and unobstructed view. Island leveling would radically alter channel morphology at some sites in some bridge segments. The PHABSIM approach identified above assumes a reasonably stable channel—a channel in dynamic equilibrium—throughout the period of analysis. Island leveling, as proposed in some alternatives, would likely nullify the assumption of channel stability and limit the usefulness of the PHABSIM approach for future impact assessment. To address this uncertainty, a second technique, employing the SEDVEG model (Murphy and Randle (2003), was also used at the site scale to evaluate future abundance of roosting depth in the 3-9 inch depth range. This model uses island leveling scenarios and future hydrology to simulate channel morphology and stage/discharge relationships under the various action alternatives. The SEDVEG model provides the capability to evaluate the process linkages between hydrology, river hydraulics, sediment transport, and vegetation on channel morphology. The model simulates the evolution of channel geometry, sediment grain-size distribution, and vegetation growth and removal.

Twenty-nine SEDVEG transects (#5 through #33) (Murphy et al. 2001) located between Lexington and Chapman, NE were evaluated to assess roosting depth availability during the spring migration period. Only channels greater that 170 feet (52 m) wide were evaluated. Estimated daily flows between February 15 and April 10 (54 days) for each year of the 48-year period of hydrology record were collapsed into mean width (3-9 inch depth range) estimated for each transect for each alternative.

Output from three analyses were evaluated to determine the pattern of response at each transect to changes in channel morphology from leveling, hydrology, and a combination of alternative hydrology and vegetation responses. Although the exact timing of island leveling during the first program increment (years 1-13) are unknown, it was assumed for the purposes of analysis that the work would occur in years 4-13. The first increment analysis uses 13 years of hydrology assumed to represent the entire period of record (!961-1973). Although no proposed channel management activities would occur under present conditions, years 4-13 were evaluated for present conditions to provide the standard of comparison for the other action alternatives in estimates of **roosting depth abundance**.

In order to evaluate the potential variability of flows on island leveling occurring during the first increment, output from a “fixed-bed” analysis was also evaluated. Channel morphology parameters were fixed at year 13 values and the effects of 48 years of hydrology were examined. In this approach, each year of hydrology data can be considered independent of other years because channel morphology and vegetation are not allowed to change after year 13. It is assumed that output from this fixed-bed analysis provides an indication of future transect behavior to hydrology only.

The third analysis involved the same 48 years of hydrology data with a moveable rather than fixed bed channel morphology. In this analysis, channel morphology and vegetation modified during years 4-13 are allowed to evolve in response to an additional 48 years of hydrology data without additional island leveling. It is assumed that this “moveable-bed” analysis provides an indication of how flow management under each alternative would sustain island leveling actions conducted during the first increment (years 4-13).

The above analyses approaches will provide insight into the relationships between discharge and depth (PHABSIM), and to how island leveling (changes in channel morphology) may affect abundance of roosting habitat (SEDVEG). However, their output should not be viewed as absolute values, but rather the outputs are of value in providing relative comparisons among alternatives.

2.3 Bridge Segment Scale

The second level of analysis detail—the bridge segment scale—focuses on roost conditions in the Platte River between Lexington and Chapman. A digital database—supported within a geographic information system (GIS)—was used in an analysis of channel width. Two coverages (1982 and 1998) depicting an area from near Lexington to Chapman, and including the river channel and a band of adjacent lands approximately 3.5 miles in width on each side of the channel (see GIS Appendix for details) were compared. Resource managers and researchers working on the central Platte River have adopted a naming convention for describing locations of sample sites and resources. The naming convention is based on individual river reaches generally defined by bridge crossings, with the bridges named for the nearest town or highway number. The GIS coverage developed for the Platte River PEIS project in 1998 follows this convention. For example, Bridge Segment1 begins near Chapman, Nebraska, and numbering progresses westward to near Lexington, Nebraska (Bridge Segment 13). Note that the 1998 coverage is larger (1 through 13 bridge segments) than the 1982 coverage (1 through12 bridge segments). Segment 12 in the 1998 coverage is larger than Segment 12 in the 1982 coverage. However, comparisons between the two years utilize an adjusted (“clipped”) 1998 Segment 12 to represent areas equivalent to the 1982 Segment 12, and are valid.

In this analysis, unobstructed channel width was evaluated as area (acres) in various channel-width categories for each bridge segment. The impact indicator for roosting suitability at the bridge segment scale is **unobstructed channel width (roosting indicator 2) as measured in feet (distance) or acres (area).**

The food component of spring sandhill crane habitat is also evaluated at the bridge segment scale via use of the GIS database previously described. The approach compares existing acres in various cropland types, to projected acreage under future alternative management scenarios. The focus of the food analysis is waste **corn (crane food indicator 1)** as measured in **acres of corn**, and **invertebrate food (crane food indicator 2)** as measured by **acres of lowland grassland, alfalfa, and upland grassland**.

Note that as in the analysis of roosting depth abundance, these indicators are indices of the relative abundance of food. The actual availability of food and its use by cranes would depend on disturbance features and other factors such as harvesting efficiency, cattle grazing, fall tillage, and field feeding by waterfowl.

2.4 System Scale

The analysis approach at the system scale evaluates simulated flow data (see Hydrology Appendix for details) at selected sites within the basin (North, South, and Platte Rivers) and their assumed effects on water depth and channel width. Present conditions (hydrology period of record 1947 - 1994) are used as the standard of comparison. It is assumed that present conditions reflect the system's responses to the magnitude and frequency of flows and sediment transport from the North and South Platte. Existing relationships between discharge and channel depth, and channel width are the product of these responses.

Because system components are linked, changes in flows and/or sediment supply/transport would likely elicit changes in channel characteristics such as depth and width (Randle and Samad 2003). Changes in channel depth and/or width may affect roosting suitability.

The impact indicator **(roosting indicator 3)** for this analysis is **discharge [measured in thousand acre feet (kaf) and/or cubic feet per second (cfs)]** at selected stream gauges upstream and within the Central Platte Valley.

3.0 Results (Alternative Analysis)

The following sections evaluate the effects of alternatives (including present conditions) on sandhill crane habitat—specifically, roosting suitability at the site, bridge segment, and system scale, and food suitability at the bridge segment scale.

3.1 Roosting Suitability—Site Scale

Transect data were manipulated within PHABSIM and the SEDVEG model, and in supplementary spreadsheet analyses, to yield estimates of wetted width supporting a 3-9 inch depth range at differing flows. At each site involved in the PHABSIM analysis, a mean wetted width was obtained from the summation of transect lengths for all individual braided channel segments carrying water at a specific discharge. No adjustments were made for minimum channel width or location (e.g., near banks and/or islands). The value obtained should be viewed as an index to the abundance of roosting habitat at specific sites rather than an absolute quantity. The index value can be used to make relative comparisons of roosting habitat abundance among sites at the same flow, and changes in abundance among different flows at the same site.

Channel morphology was also evaluated within the SEDVEG model to determine how proposed island leveling and alternative hydrology would affect the abundance of the 3-9 inch depth range. The locations of future island leveling and other channel clearing activities are currently unknown. For purposes of analysis, seven transects in seven different bridge segments representing approximately eight miles of river were selected to simulate leveling activities. As in the PHABSIM analysis, the values obtained should be viewed as indices and not absolute quantities. The index value can be used in relative comparisons of roosting abundance among sites under different alternative flow regimes.

3.1.1 Present Conditions

3.1.1.1 PHABSIM Analysis

Data from eight habitat transect sites (three to nine transects per site) were evaluated to determine: (1) if the relationships between discharge and roosting depth abundance had changed between the first surveys in the early to mid 1980's and recent surveys, and (2) at what flows were 3-9 inch depths maximized.

In order to address the first objective, total wetted width and wetted width within the 3-9 inch depth range values from sites surveyed in the mid-1980's were compared to survey data collected under similar flows from the same sites in 1998-2001. Results varied (Attachment A). Four sites provided very similar patterns (as exemplified in Figure SC-3), three sites differed somewhat (for example Figure SC-4), and habitat transect Site 2 exhibited large differences in survey data (Figure SC-5). Although the pattern described above (Figure SC-2) occurs commonly, higher measured discharge at the same site tends to result in a shift in the 3-9 inch curve's peak to the right and down (Figure SC-6). Once the area (represented by mean transect length) in the 3-9 inch depth range is maximized, higher flows reduce roosting depth (3-9 inch range).

A second objective was to determine at what flows the 3-9 inch depth range was maximized at each site (for example Figure SC-7). Surveys from the same eight habitat sites were selected (measured flow range between 1,068 cfs and 2,062 cfs), and the discharge providing the maximum transect length containing depths between 3 and 9 inches were compared (Table SC-3). For these eight sites, at measured flows between 1,068 cfs and 2,062 cfs, roosting depth is maximized between 800 cfs and 1,600 cfs (mean of 1,175 cfs). Length of transect occupied by depths between 3 and 9 inches —when maximized—ranged from 148 feet to 885 feet. Individual data for the eight sites are provided in Attachment B.

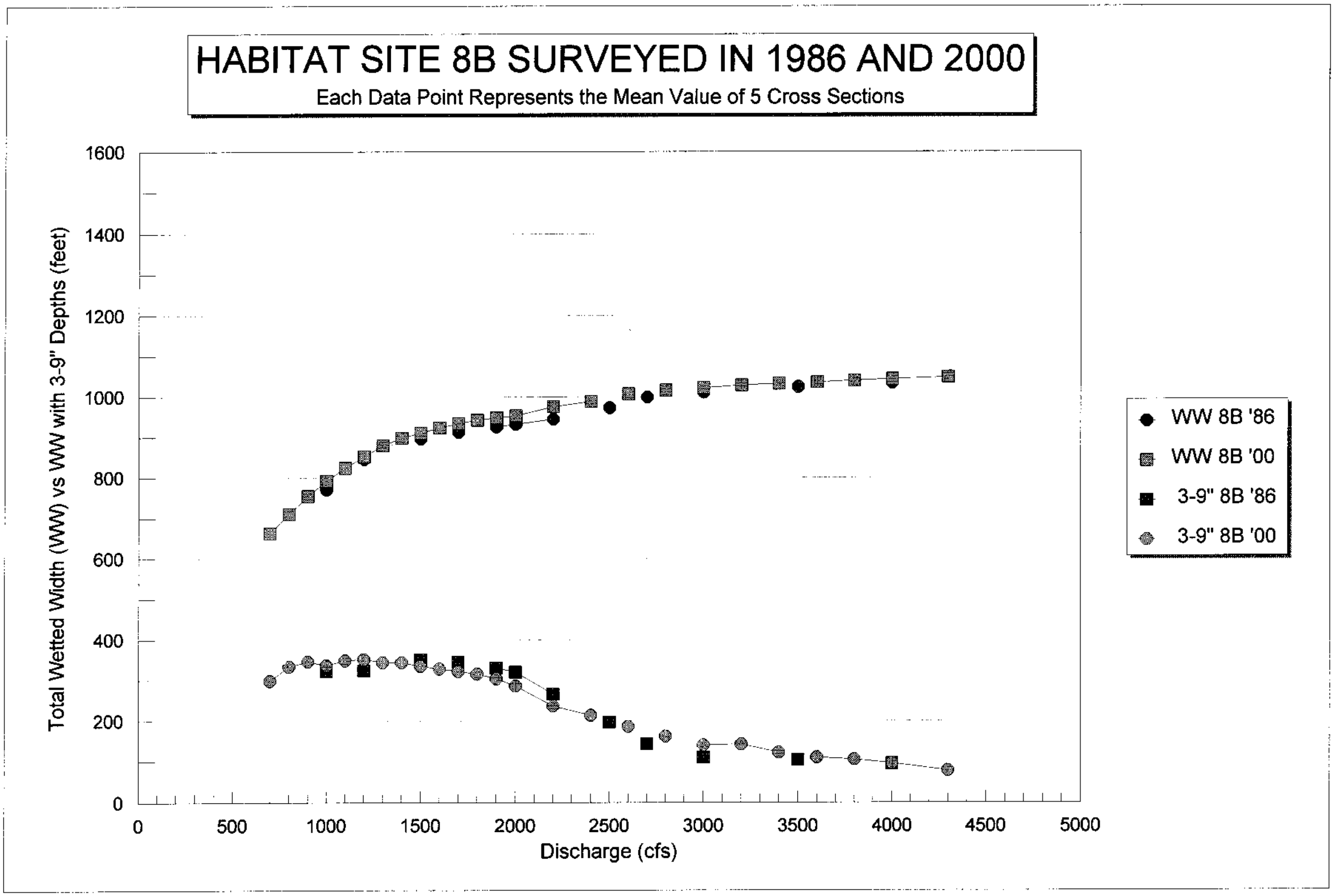


Figure SC-3. Habitat site 8B data depicting discharge, total wetted width, and wetted width in the 3-9 inch depth range from surveys conducted in 1986 and 2000.

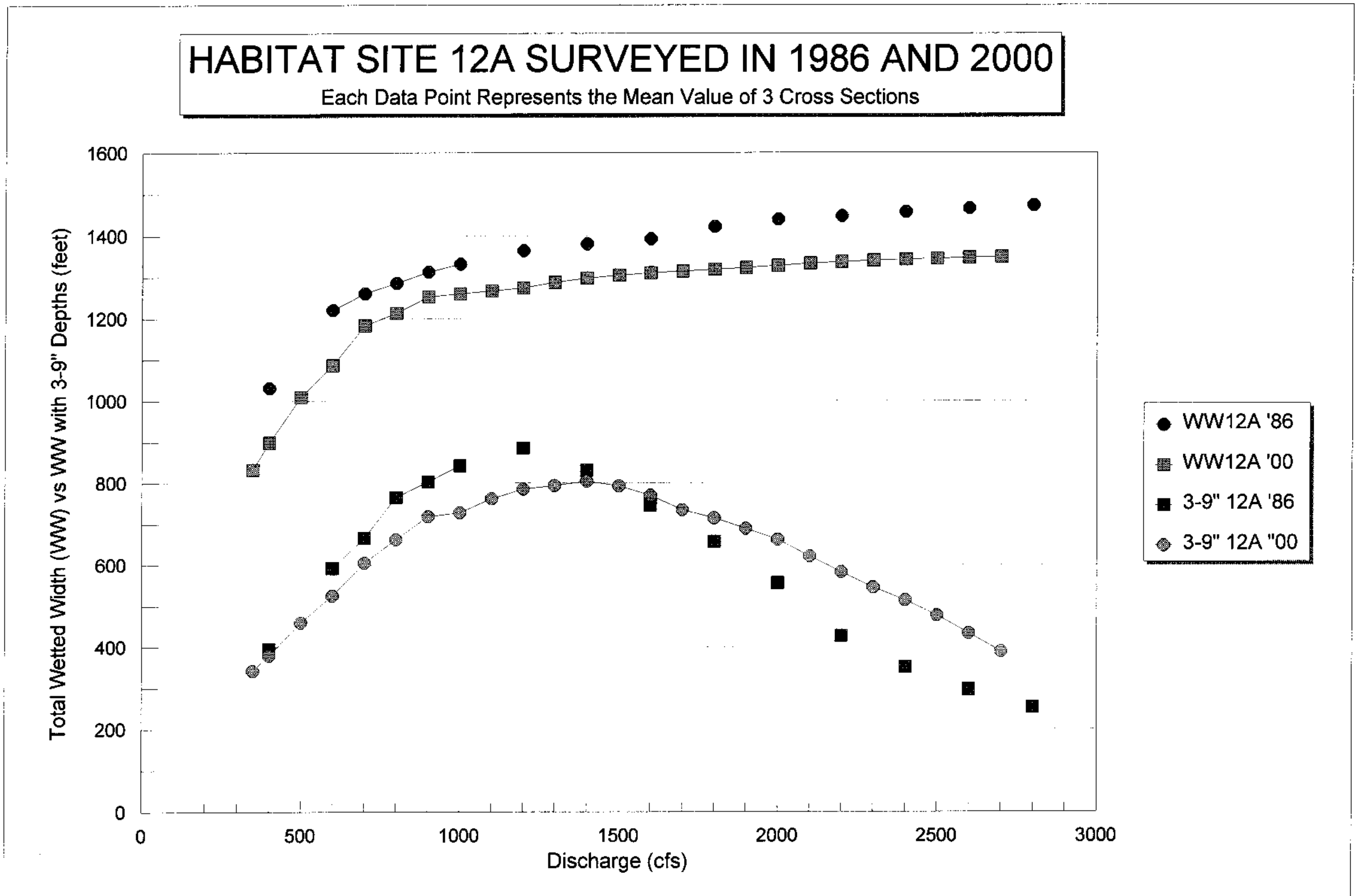


Figure SC-4. Habitat site 12A data depicting discharge, total wetted width, and wetted width in the 3-9 inch depth range from surveys conducted in 1986 and 2000.

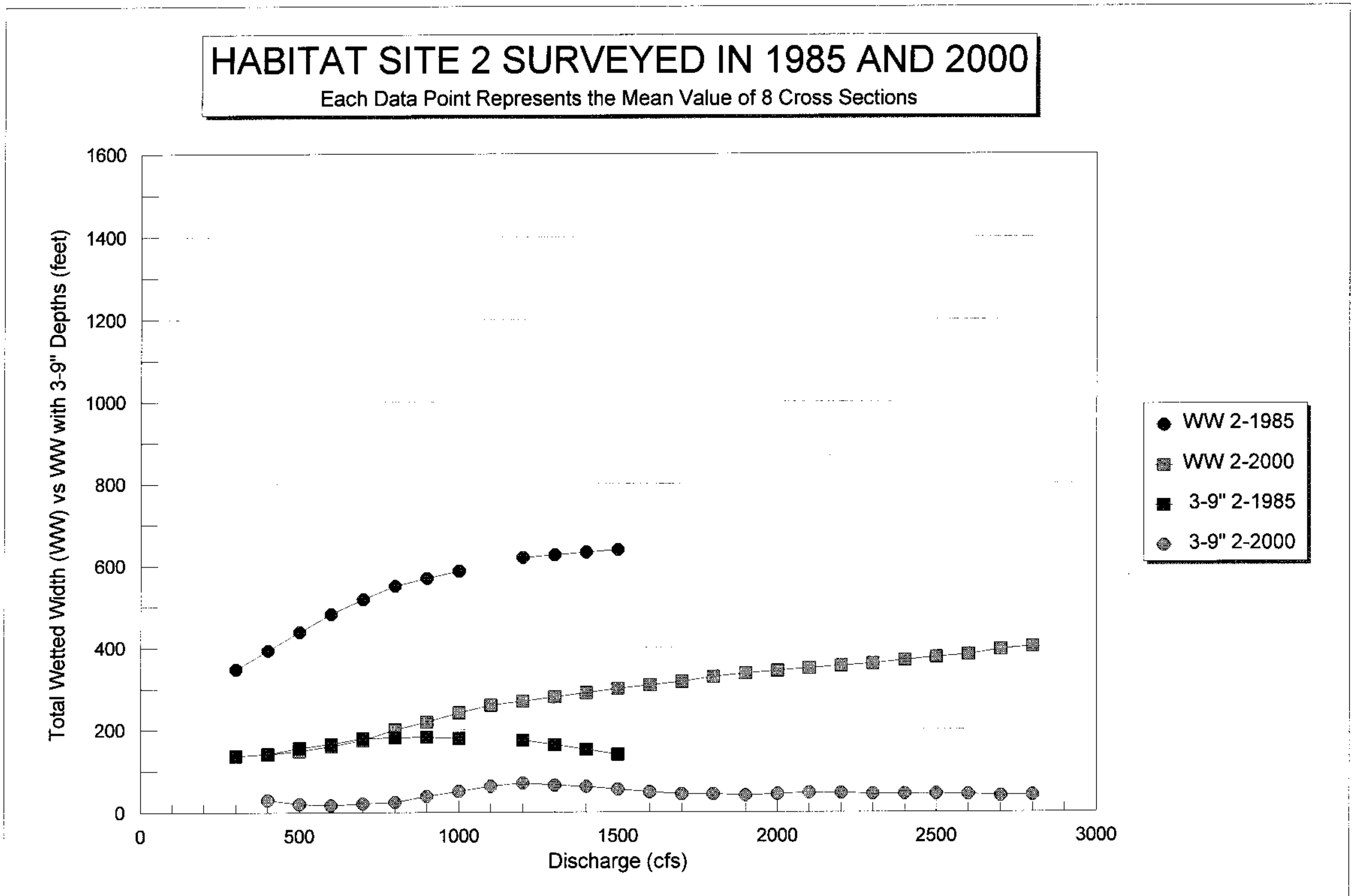


Figure SC-5. Habitat site 2 data depicting discharge, total wetted width, and wetted width in the 3-9 inch depth range from surveys conducted in 1985 and 2000.

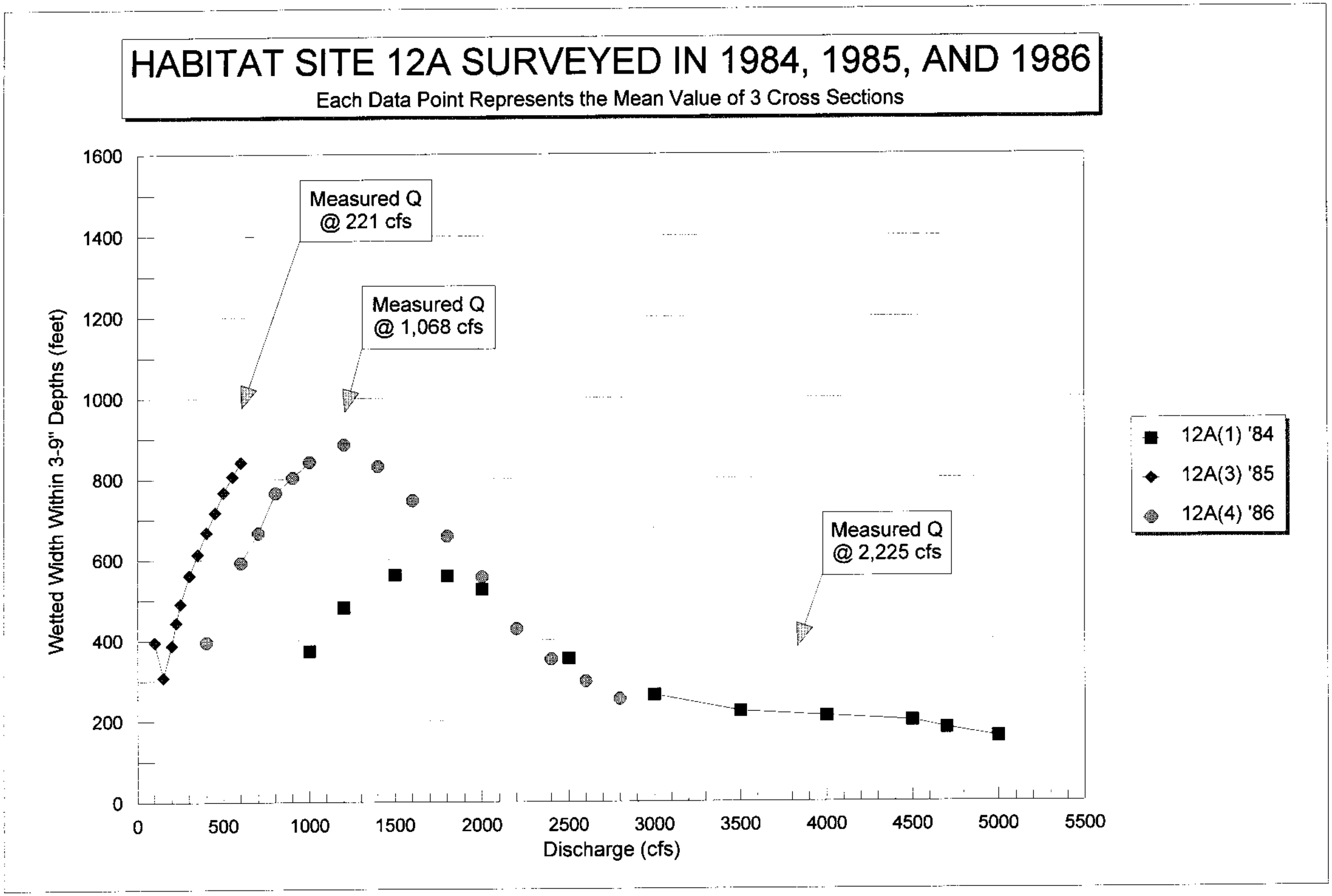


Figure SC-6. Habitat site 12A data depicting discharge and wetted channel width supporting the 3-9 inch depth range from surveys taken during different measured flows, 1984-1986.

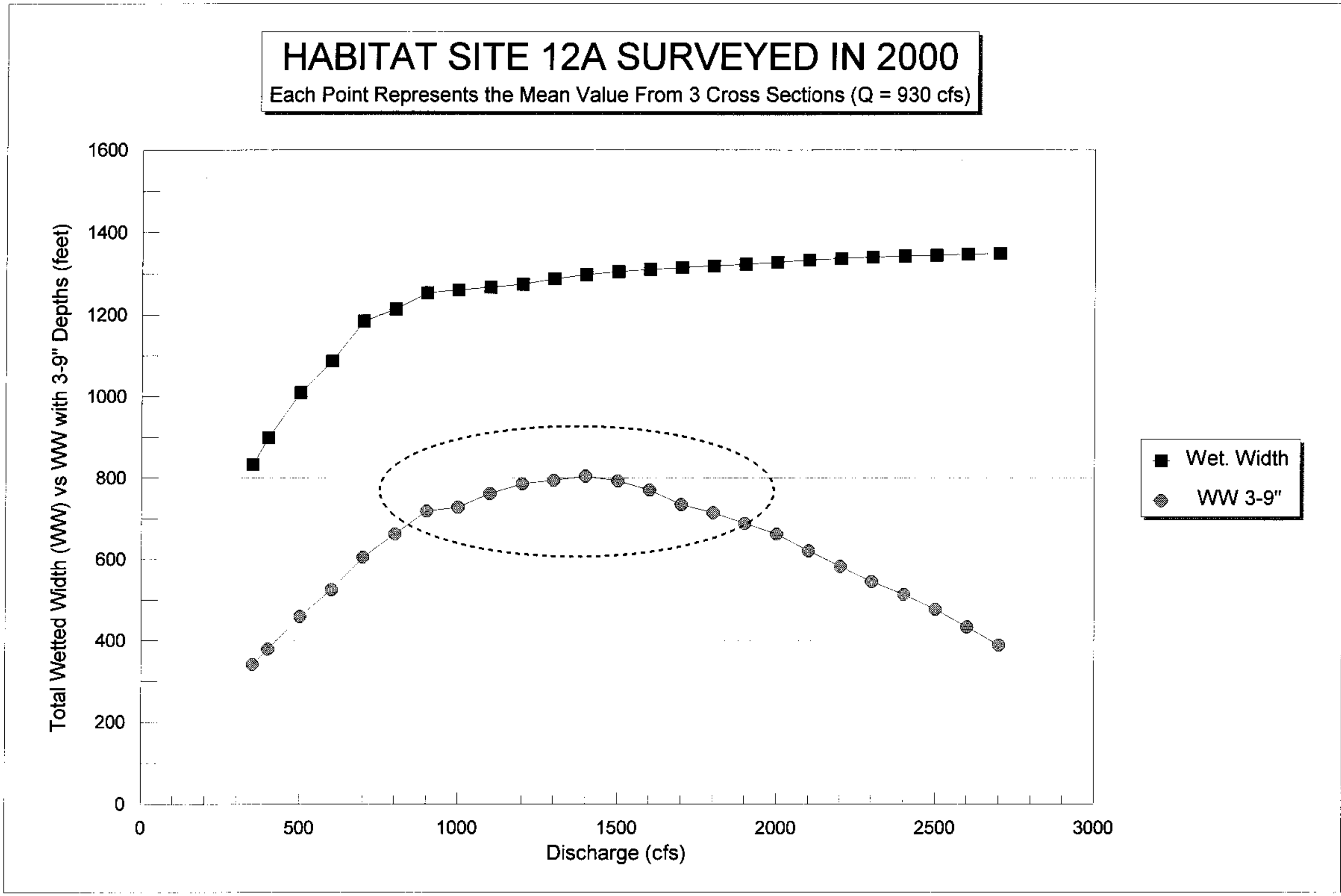


Figure SC-7. Relationships between total channel wetted width, wetted width within a depth range of 3-9 inches, and discharge at habitat site 12A. At this site and measured Q, roosting depth availability would be maximized at 1400 cfs and occupy 800 feet of a total wetted channel width of 1300 feet.

Table SC-3. Mean wetted width (3-9 inch depth range) at eight habitat transect sites (2 through 12A) at various flows (cfs). Multiple transect (3-9 transects per site) measurements were obtained at most sites and the number after the dash identifies a particular site data set. The measured flow for each respective data set is in parentheses. Data are not available at all flows for all sites. Maximum mean wetted widths (3-9") for each site are bolded and occur within the range of shaded flows.

Flow	Mean Wetted Width (feet) in the 3-9 Inch Depth Range at Eight Habitat Transect Sites							
	2-1 (2,062)	4A-2 (1,861)	6-1 (1,422)	8C-2 (1,373)	8B-4 (1,802)	9BW -2 (1,568)	9BE-1 (1,098)	12A-4 (1,068)
400							89	395
550				248				
600			238			115	103	592
700								666
800	142		288	**279**		145	126	765
900	**148**	190						803
1000		**192**	299		322	182	153	842
1100			313	228				
1200	135	191	**320**		324	196	**192**	**885**
1300			304	200				
1400	122	183				236	188	831
1430			291					
1500			285	172	**351**			
1600	121	147	275			**256**	169	746
1700					346			
1800	120	130	236	150		241	164	657
1900					331			
2000	112	103	213		320	208	140	556
2100				137				
2200	109		189		266		126	427
2300				139				
2400	99		182			145		351
2500		77		132	197			
2600	88		178			104		297
2700		71			144			
2800	79		182	140		90		254
3000	72	43	190	133	110	74		
3200	62			130		69		
3400	60	27				65		
3430				121				
3500					104			
3600	59	24				53		
3800						49		
4000					95			

Wetted width with depths between 3 and 9 inches can also be expressed as percentages of total wetted channel width (Table SC-4). While the relationships are similar to those presented in Table SC-3, the maximization of the 3-9 inch depth range, when considered as a percentage of total wetted channel width, occurs at lower flows for five of the eight sites. Flows that maximize the percentage of wetted width within the 3-9 inch depth range fall between 550 cfs and 1,600 cfs, with a mean of about 1,006 cfs at the eight habitat transect sites.

In order to translate the above relationships into estimates of **roosting depth abundance** under present conditions, mean March flows (1947-1994) were selected to represent discharge during the spring roosting period. Mean March flows for all eight transect sites were greater than flows that would maximize roosting depth in the 3-9 inch depth range. Mean March flows ranged from 2,157 cfs (Overton gauge) to 2,435 cfs (Grand Island gauge). These flows would extrapolate—under more recent (1998-2001) survey conditions to from 47 feet (Site 2) to 500 feet (Site 12A) within the 3-9 inch depth range.

Median March flows were also compared to flows that would maximize roosting depth abundance at the eight transect sites. Median March flows ranged from 1,972 cfs (Overton gauge) to 2,194 cfs (Grand Island gauge). These flows would extrapolate—under more recent (1998-2001) survey conditions to from 42 feet (Site 2) to 582 feet (Site 12A) within the 3-9 inch depth range. Median March flows under present conditions were less than March means at all eight sites and would therefore provide somewhat more roosting habitat (except at Site 2—see below) in the 3-9 inch depth range than would March mean flows.

Table SC-4. Mean wetted width (3-9 inch depth range) presented as a percentage of total wetted width at eight habitat transect sites at various flows (cfs). Multiple transect measurements were obtained at most sites and the number after the dash identifies a particular site data set. Data are not available at all flows for all sites. Maximum mean percent wetted width (3-9") values for each data set are bolded and occur within the range of shaded flows.

Flow	Percent Mean Wetted Width in the 3-9 Inch Depth Range at Eight Habitat Transect Sites							
	2-1	4A-2	6-1	8C-2	8B-4	9BW-2	9BE-1	12A-4
400							31.7	38.3
550				**45.7**				
600			39.0			30.9	29.4	48.5
700								52.8
800	**31.9**		**40.9**	43.1		31.8	28.3	59.5
900	31.4	**38.6**						61.2
1000		37.4	39.2	32.2	**41.8**	32.6	30.5	63.2
1100			40.1		38.3	30.7	**37.0**	**64.9**
1200	25.4	35.2	40.2	27.1				
1300			37.5			35.5	33.3	60.2
1400	21.9	32.9						
1430			35.0	22.5	39.3			
1500			33.7			**37.8**	28.6	53.5
1600	20.9	24.6	31.8					
1700					37.9			
1800	19.9	21.3	26.1	18.6		34.1	27.0	46.2
1900					35.7			
2000	18.1	16.6	22.9		34.3	28.8	22.5	38.6
2100				16.1				
2200	17.3		19.6		28.2		19.6	29.5
2300				16.0				
2400	15.2		18.3			19.8		24.1
2500		12.1		15.0	20.3			
2600	13.3		17.3			14.2		20.2
2700		11.2			14.4			
2800	11.7		17.2	15.5		12.3		17.2
3000	10.5	6.7	17.6	14.5	10.9	10.0		
3200	9.0			14.0		9.3		
3400	8.6	4.2				8.8		
3430				12.9				
3500					10.2			
3600	8.4	3.7				7.2		
3800						6.5		
4000					9.2			

3.1.1.2 SEDVEG Analysis

SEDVEG analysis for years 4-13 under present conditions indicate a mean transect length in the 3-9 inch depth range of about 94 feet for all transects (Table SC-5). The mean transect length for the fixed-bed analysis (105.5 feet) is predicted to be somewhat greater. The mean transect length supporting the 3-9 inch depth range obtained from the moveable bed analysis is very similar to the value obtained for years 4-13.

Because sandhill crane use of the river is different upstream of Kearney than downstream (Figure SC-1), we also looked at SEDVEG output for transects 5-15 (Lexington to near Kearney) and transects 16-33 (just downstream of Kearney to Chapman). Model output indicates that the majority of transects upstream of Kearney (6 of 11 under fixed bed and 11 of 11 under moveable bed) may experience some future reductions in mean length within the 3-9 inch depth range under present condition hydrology (Table SC-5). Downstream from Kearney, both the fixed-bed analysis (14 of 18 transects) and moveable-bed analysis (12 of 18 transects) indicate the future mean length within the 3-9 inch depth range may increase.

Table SC-5. Mean transect length within the 3-9 inch depth range for 29 SEDVEG transects within 13 bridge segments between Lexington and Chapman, NE. Mean values are derived from daily flows between February 15 and April 10, 1947-1994.

Bridge Segment	Transect Number	Present Conditions (mean transect length in feet)		
		Years 4-13	48 Years Fixed Bed	48 Years Moveable Bed
13	5	126.7	72.8	68.6
12	6	25.4	12.8	11.0
11	7	57.5	82.8	17.4
11	8	57.9	63.7	41.4
11	9	81.3	85.6	74.6
10	10	32.1	30.6	30.0
10	11	43.2	37.3	32.9
10	12	40.5	38.2	36.5
9	13	151.5	172.8	113.9
9	14	39.8	25.3	15.4
9	15	112.7	116.3	77.7
8	16	13.2	6.2	5.6
8	17	21.8	27.8	29.2
8	18	14.3	5.1	16.3
7	19	289.9	325.4	337.8
6	20	100.6	114.5	105.4
6	21	100.3	102.8	103.0
6	22	95.0	103.4	90.0
5	23	89.2	78.6	79.4
5	24	87.6	85.8	146.2
5	25	86.2	121.7	121.3
4	26	121.5	170.3	258.5
3	27	171.1	230.4	183.8
2	28	92.8	179.8	117.3
2	29	176.2	204.1	131.0
2	30	197.3	213.8	147.2
1	31	108.0	123.9	101.2
1	32	96.3	119.1	106.5
1	33	89.4	94.6	100.5
Mean Transect Length		93.8	105.5	93.1

3.1.2 Comparison of Alternatives

3.1.2.1 PHABSIM Analysis

Survey data (1998-2001) from the eight habitat transect sites were reviewed for insight into flows currently providing roosting depths for sandhill cranes, and how roosting suitability may change with future flows. Projected mean March flows for each alternative, and the estimated transect length within the 3-9 inch depth range at that discharge, were compared to present conditions on a site to site basis (Table SC-6). The maximum transect length within the 3-9 inch depth range, and the flow at which this maximum value occurred at each site, are also referenced in Table SC-6.

In general, the action alternatives would provide similar or somewhat increased ($\leq$ 7.0 percent difference) **roosting depth abundance** under existing channel morphology when compared to present conditions. The Water Emphasis Alternative is an exception to this generalization and would provide somewhat less roosting depth abundance (up to -15.6 percent at Site 12A) at each site when mean March flows are used as the measure of central tendency.

Table SC-7 presents a similar comparison for March median flows. Median March discharge currently exceeds flows that would maximize roosting depth abundance in the 3-9 inch depth range.

The action alternatives would provide similar or somewhat reduced roosting depth abundance under existing channel morphology when median March flows are compared. As with March mean comparisons, the Water Emphasis Alternative would provide the largest (-22.7 percent) deviation from present conditions.

Table SC-6. Estimated mean transect length in 3-9" depth range for March mean flows at eight habitat sites on the Platte River. Flow estimates from “CentralPlatteSchematic.xls” (M-Drive) for Overton (Site 2), Odessa (Sites 4A and 6), and Grand Island (all other sites). Maximum transect length in 3-9 inch depth range from site survey data collected in 1998-2001 (Attachment A).

Habitat Site	Maximum Length (ft) WW 3-9"	Alternatives and Time Periods					
		Present Conditions	Governance Committee (hydrology only)		Water Emphasis	Water Leasing	Wet Meadow
			Scenario 1 (1980 cfs)	Scenario 2 (3000 cfs)			
		1947-1994	2017	2017	2017	2017	2017
Site 2	71 ft @ 1200 cfs	47 ft @ 2157 cfs	46 ft @ 2049 cfs	46 ft @ 2051 cfs	44 ft @ 2344 cfs	46 ft @ 2077 cfs	47 ft @ 2132 cfs
Site 4A[1]	278 ft @ 700 cfs	<146 ft @ 2189 cfs	<146 ft @ 2082 cfs	<146 ft @ 2083 cfs	<146 ft @ 2376 cfs	<146 ft @ 2109 cfs	<146 ft @ 2165 cfs
Site 6	339 ft @ 1000 cfs	175 ft @ 2189 cfs	180 ft @ 2082 cfs	180 ft @ 2083 cfs	170 ft @ 2376 cfs	180 ft @ 2109 cfs	177 ft @ 2165 cfs
Site 8C[1]	360 ft @ 900 cfs	<249 ft @ 2435 cfs	<249 ft @ 2327 cfs	<249 ft @ 2329 cfs	<249 ft @ 2622 cfs	<249 ft @ 2355 cfs	<249 ft @ 2410 cfs
Site 8B	352 ft @ 1200 cfs	210 ft @ 2435 cfs	222 ft @ 2327 cfs	222 ft @ 2329 cfs	183 ft @ 2622 cfs	220 ft @ 2355 cfs	214 ft @ 2410 cfs
Site 9BW[1]	463 ft @ 700 cfs	<82 ft @ 2435 cfs	<82 ft @ 2327 cfs	<82 ft @ 2329 cfs	<82 ft @ 2622 cfs	<82 ft @ 2355 cfs	<82 ft @ 2410 cfs
Site 9BE[1]	377 ft @ 700 cfs	<95 ft @ 2435 cfs	<95 ft @ 2327 cfs	<95 ft @ 2329 cfs	<95 ft @ 2622 cfs	<95 ft @ 2355 cfs	<95 ft @ 2410 cfs
Site 12A	804 ft @ 1400 cfs	500 ft @ 2435 cfs	537 ft @ 2327 cfs	537 ft @ 2329 cfs	422 ft @ 2622 cfs	529 ft @ 2355 cfs	509 ft @ 2410 cfs

[1]Mean March flows for all alternatives exceed the sampled/simulated range of survey flows. The wetted width value for the highest flow sampled/simulated is presented for reference. The actual wetted width in the 3-9" depth range would be less than the value given because at flow levels represented by March mean values the area in the 3-9 inch depth range is decreasing with increasing flows.

Table SC-7. Estimated mean transect length in 3-9" depth range for March median flows at eight habitat sites on the Platte River. Flow estimates from “CentralPlatteSchematic.xls” (M-Drive) for Overton (Site 2), Odessa (Sites 4A and 6), and Grand Island (all other sites). Maximum transect length in 3-9 inch depth range from site survey data collected in 1998-2001 (Attachment A).

Habitat Site	Maximum Length (ft) WW 3-9"	Alternatives and Time Periods					
		Present Conditions	Governance Committee (hydrology only)		Water Emphasis	Water Leasing	Wet Meadow
			Scenario 1 (1980 cfs)	Scenario 2 (3000 cfs)			
		1947-1994	2017	2017	2017	2017	2017
Site 2	71 ft @ 1200 cfs	42 ft @ 1972 cfs	41 ft @ 1943 cfs	41 ft @ 1942 cfs	47 ft @ 2127 cfs	40 ft @ 1908 cfs	42 ft @ 1979 cfs
Site 4A[1]	278 ft @ 700 cfs	<146 ft @ 1930 cfs	<146 ft @ 1933 cfs	<146 ft @ 1931 cfs	<146 ft @ 2267 cfs	<146 ft @ 1955 cfs	<146 ft @ 1950 cfs
Site 6	339 ft @ 1000 cfs	195 ft @ 1930 cfs	195 ft @ 1933 cfs	195 ft @ 1931 cfs	173 ft @ 2267 cfs	195 ft @ 1955 cfs	195 ft @ 1950 cfs
Site 8C[1]	360 ft @ 900 cfs	<249 ft @ 2194 cfs	<249 ft @ 2519 cfs	<249 ft @ 2538 cfs	<249 ft @ 2565 cfs	<249 ft @ 2500 cfs	<249 ft @ 2537 cfs
Site 8B	352 ft @ 1200 cfs	237 ft @ 2194 cfs	197 ft @ 2519 cfs	195 ft @ 2538 cfs	190 ft @ 2565 cfs	200 ft @ 2500 cfs	195 ft @ 2537 cfs
Site 9BW[1]	463 ft @ 700 cfs	<82 ft @ 2194 cfs	<82 ft @ 2519 cfs	<82 ft @ 2538 cfs	<82 ft @ 2565 cfs	<82 ft @ 2500 cfs	<82 ft @ 2537 cfs
Site 9BE[1]	377 ft @ 700 cfs	<95 ft @ 2194 cfs	<95 ft @ 2519 cfs	<95 ft @ 2538 cfs	<95 ft @ 2565 cfs	<95 ft @ 2500 cfs	<95 ft @ 2537 cfs
Site 12A	804 ft @ 1400 cfs	582 ft @ 2194 cfs	466 ft @ 2519 cfs	460 ft @ 2538 cfs	450 ft @ 2565 cfs	477 ft @ 2500 cfs	460 ft @ 2537 cfs

[1]Median March flows for all alternatives exceed the sampled/simulated range of survey flows. The wetted width value for the highest flow sampled/simulated is presented for reference. The actual wetted width in the 3-9" depth range will be less than the value given because at flow levels represented by March median values the area in the 3-9 inch depth range is decreasing with increasing flows.

3.1.2.2 SEDVEG Analysis

Channel leveling during the first increment of the study (years 4-13) would vary, with proposed alternatives either supporting no leveling, leveling in two bridge segments, or supporting a maximum of leveling in six bridge segments and initially directly affecting about 8 miles of channel. As with present conditions, roosting depth abundance was first evaluated in terms of all 29 transects and then as the transects 5-15 reach, and transects 16-33 reach. For purposes of analysis, the total quantity of island leveling simulated in this example was added to the model in equal increments during years 4-13 (Murphy and Randle 2003).

Governance Committee Alternative.—Two scenarios were evaluated under the Governance Committee Alternative: Scenario 1 which would support a flow passage of 1, 980 cfs at North Platte and no channel management, and Scenario 2 which would support a flow passage of 3,000 cfs at North Platte and six managed transects (Table SC-8). While individual transect lengths within the 3-9 inch depth range would vary during years 4-13, the mean value for all 29 transects under Scenario 1 would be less than present conditions.

The Governance Committee Alternative Scenario 2 contains provisions for increased flow passage at North Platte and simulated island leveling at transects 8, 11, 14, 17, 21, and 29. Again, individual transect lengths within the 3-9 inch depth range would vary, but the mean value for all 29 transects during the years 4-13 period would be greater than present conditions (Table SC-8).

Model output indicates additional differences in Scenarios 1 and 2 of the Governance Committee Alternative when transects 5-15 and transects 16-33 are evaluated. For example, the majority of transects upstream from Kearney (10 of 11 during years 4-13, 8 of 11 under a fixed bed, and 9 of 11 under a moveable bed analysis) may experience some future reductions in mean transect length in the 3-9 inch depth range under Scenario 1 (Table SC-8). This reach under Scenario 2 may also experience some reductions (7 of 11 transects during years 4-13, 5 of 11 under a fixed bed analysis, and 6 of 11 under a moveable bed analysis), but reach means would be greater than present conditions for all time periods.

Table SC-8. Mean transect length within the 3-9 inch depth range for 29 transects within 13 bridge segments between Lexington and Chapman, NE. Mean values are derived from estimated daily flows between February 15 and April 10, 1947-1994.

Bridge Segment	Transect Number	Present Conditions			Governance Committee: Scenario 1			Governance Committee: Scenario 2		
		Years 4-13	Fixed Bed	Moveable Bed	Years 4-13	Fixed Bed	Moveable Bed	Years 4-13	Fixed Bed	Moveable Bed
13	5	126.7	72.8	68.6	98.7	61.8	57.8	105.0	66.3	63.5
12	6	25.4	12.8	11.0	16.8	7.2	7.2	17.8	7.6	5.3
11	7	57.5	82.8	17.4	49.9	96.9	12.9	43.2	95.9	20.2
11	8	57.9	63.7	41.4	38.7	59.4	13.3	176.7	378.9	285.3
11	9	81.3	85.6	74.6	49.7	88.3	58.4	287.7	434.6	546.6
10	10	32.1	30.6	30.0	16.2	9.9	11.8	19.2	8.4	6.9
10	11	43.2	37.3	32.9	22.7	15.3	12.1	47.9	78.1	85.0
10	12	40.5	38.2	36.5	21.4	21.8	17.9	24.9	11.1	11.6
9	13	151.5	172.8	113.9	159.4	154.9	121.0	135.2	134.7	81.8
9	14	39.8	25.3	15.4	35.9	22.6	12.7	70.0	122.3	83.4
9	15	112.7	116.3	77.7	102.2	144.1	91.9	94.2	170.5	49.1
8	16	13.2	6.2	5.6	10.0	19.6	5.5	10.2	21.8	7.6
8	17	21.8	27.8	29.2	19.8	37.5	17.5	74.4	116.8	115.0
8	18	14.3	5.1	16.3	11.1	26.5	9.1	11.6	45.2	8.5
7	19	289.9	325.4	337.8	307.4	296.7	321.5	320.3	306.6	314.4
6	20	100.6	114.5	105.4	58.0	84.3	78.0	63.0	88.6	91.5
6	21	100.3	102.8	103.0	100.6	87.4	66.7	84.3	182.3	188.9
6	22	95.0	103.4	90.0	62.5	67.4	69.7	72.0	144.8	64.8
5	23	89.2	78.6	79.4	71.3	89.4	71.8	85.0	67.9	84.5
5	24	87.6	85.8	146.2	103.1	92.4	206.3	87.5	89.2	276.8
5	25	86.2	121.7	121.3	87.5	101.0	213.7	81.0	112.5	309.4
4	26	121.5	170.3	258.5	99.0	207.7	274.1	91.1	178.4	175.8
3	27	171.1	230.4	183.8	132.8	196.8	140.3	122.6	192.6	122.4
2	28	92.8	179.8	117.3	106.6	162.2	124.5	92.0	189.7	151.1
2	29	176.2	204.1	131.0	144.4	174.0	131.2	135.5	206.8	357.4
2	30	197.3	213.8	147.2	181.3	228.9	164.8	192.9	343.8	176.0
1	31	108.0	123.9	101.2	98.6	103.1	111.4	102.6	108.6	102.3
1	32	96.3	119.1	106.5	115.7	106.4	99.3	91.3	105.9	97.1
1	33	89.4	94.6	100.5	104.0	93.6	92.6	103.4	99.2	98.7
Mean Length		93.8	105.0	93.1	83.6	98.5	90.2	98.0	141.7	137.3

In the Kearney to Chapman reach (transects 16-33), different relationships would develop. Scenario 1 flows would result in a reduction of **roosting depth abundance** (11 of 18 transects reduced) during years 4-13 and the fixed-bed condition (11 of 18 transects reduced), but a small increase in the moveable-bed condition even though 11 of 18 transects would experience a reduction in transect length within the 3-9 inch depth range. Scenario 2 flows would result in a reduction of roosting depth abundance (15 of 18 transects reduced) during years 4-13, and an increase in the fixed-bed (7 of 18 transects reduced) and moveable-bed conditions (8 of 18 transects reduced).

The remaining three alternatives—with channel management actions—were also compared to present conditions. During the first increment (years 4-13) of the proposed program, all three alternatives (Water Emphasis, Water Leasing, and Wet Meadow Restoration Alternatives) would experience reduced mean length of transects within the 3-9 inch depth range, for all 29 transects, when compared to present conditions (Table SC-9). In contrast, all three alternatives would experience increases in roosting depth abundance (all 29 transects) under both the fixed and moveable-bed conditions, when compared to present conditions. A discussion of predicted changes in the upper river transects(Lexington to Kearney) and lower river transects (Kearney to Chapman) is present below by individual alternative.

Water Emphasis Alternative.—The Water Emphasis Alternative was evaluated with only two of the 29 SEDVEG transects (transects 8 and 24) manipulated to simulate island leveling (Table SC-9). Inspection of transects 5-15 and transects 16-33 indicate that the majority of transects upstream from Kearney (9 of 11 during years 4-13, 8 of 11 under fixed-bed conditions, and 9 of 11 under a moveable-bed analysis) may experience future reductions in **roosting depth abundance**, but all three time periods exhibit reach means greater than present conditions. In the Kearney to Chapman reach (transects 16-33), increased water (Tables SC-6 and SC-7) and simulated island leveling would result in the majority of transects experiencing a reduction in roosting depth abundance for years 4-13 (14 of 18 transects), as would the reach mean. The majority of transects under the fixed-bed (12 of 18 transects) and moveable-bed (12 of 18 transects) conditions would experience reductions in roosting depth abundance, but the reach means would all be greater than present conditions.

Water Leasing Alternative.—This alternative contains provisions for simulated island leveling at the same six transects as identified in the Governance Committee Alternative Scenario 2. Inspection of transects indicate that the majority of sample sites upstream from Kearney (7 of 11 during years 4-13, 5 of 11 under fixed-bed, and 6 of 11 under a moveable bed analysis) may experience future reductions in **roosting depth abundance**, but all time -period means would be greater than present conditions (Table SC-9). In the Kearney to Chapman reach, roosting depth abundance would be reduced for years 4-13 (14 of 18 transects). Although reach means would be greater than present conditions, the majority of transects in the fixed-bed (10 of 18 transects) and moveable-bed (11 of 18 transects) analyses would experience reductions in roosting depth abundance.

Wet Meadow Restoration Alternative.——This alternative also contains provisions for simulated island leveling at the same six transects as identified in the Governance Committee Alternative Scenario 2. The majority of transects upstream from Kearney may experience future reductions in **roosting depth abundance** under this alternative (8 of 11 during years 4-13, 6 of 11 under fixed-bed, and 7 of 11 transects under moveable-bed conditions), but means for all three time periods would be greater than present conditions (Table SC-9). Roosting depth abundance in the Kearney to Chapman reach would be reduced in years 4-13 (13 of 18 transects). Under both fixed-bed (6 of 18 transects reduced) and moveable-bed (9 of 18 transects reduced) conditions, reach means would exceed present conditions.

Table SC-9. Mean transect length within the 3-9 inch depth range for 29 transects within 13 bridge segments between Lexington and Chapman, NE. Mean values are derived from estimated daily flows between February 15 and April 10, 1947-1994, for Present Conditions and three action alternatives.

Transect Number	Present Conditions			Water Emphasis			Water Leasing			Wet Meadow Restoration		
	Years 4-13	Fixed Bed	Moveable Bed	Years 4-13	Fixed Bed	Moveable Bed	Years 4-13	Fixed Bed	Moveable Bed	Years 4-13	Fixed Bed	Moveable Bed
5	126.7	72.8	68.6	76.0	53.4	45.0	101.8	70.0	63.3	98.2	67.8	56.7
6	25.4	12.8	11.0	17.2	9.5	4.8	12.8	5.6	6.6	21.4	12.7	5.2
7	57.5	82.8	17.4	24.3	55.8	8.2	44.8	91.3	25.7	17.1	71.8	13.3
8	57.9	63.7	41.4	153.5	366.7	142.9	123.9	377.1	238.6	171.4	389.4	299.7
9	81.3	85.6	74.6	322.7	514.8	623.5	258.4	408.3	667.6	255.1	454.5	639.0
10	32.1	30.6	30.0	12.1	6.3	7.7	0.4	4.9	4.8	14.4	10.7	8.9
11	43.2	37.3	32.9	15.5	13.7	10.1	15.2	91.4	79.3	40.6	81.7	91.0
12	40.5	38.2	36.5	13.5	14.3	8.5	49.1	75.3	15.5	23.2	13.5	11.6
13	151.5	172.8	113.9	113.3	127.2	40.4	134.0	154.0	83.8	135.8	120.2	58.7
14	39.8	25.3	15.4	13.6	13.6	8.9	67.9	123.0	55.9	62.6	133.4	78.5
15	112.7	116.3	77.7	42.9	127.3	62.0	81.8	65.7	60.6	45.5	206.2	50.8
16	13.2	6.2	5.6	15.9	11.0	3.2	11.7	24.5	8.8	9.1	19.1	5.0
17	21.8	27.8	29.2	18.7	30.6	5.0	63.0	103.0	90.3	51.0	110.4	113.0
18	14.3	5.1	16.3	20.5	35.3	9.6	25.0	46.2	7.6	8.3	39.9	8.2
19	289.9	325.4	337.8	225.7	245.7	264.2	281.1	287.9	290.1	303.2	309.3	319.1
20	100.6	114.5	105.4	48.7	55.0	96.1	36.5	55.2	73.9	51.1	76.2	83.0
21	100.3	102.8	103.0	60.7	71.6	74.4	58.9	173.6	155.6	70.0	182.7	170.8
22	95.0	103.4	90.0	42.1	69.4	68.3	46.4	84.9	56.2	61.9	134.6	63.6
23	89.2	78.6	79.4	54.8	53.2	114.4	95.7	89.2	61.2	67.5	81.1	75.8
24	87.6	85.8	146.2	67.1	100.4	308.5	70.1	91.4	205.8	85.5	88.9	291.7
25	86.2	121.7	121.3	224.4	856.7	706.9	70.5	148.8	123.5	89.2	120.1	206.9
26	121.5	170.3	258.5	81.5	176.6	93.2	46.8	164.8	232.5	87.1	183.9	209.9
27	171.1	230.4	183.8	111.6	178.5	121.9	96.8	181.0	126.6	111.7	192.0	123.1
28	92.8	179.8	117.3	99.2	169.4	138.6	118.5	169.8	130.0	132.2	185.1	144.7
29	176.2	204.1	131.0	107.5	143.9	135.7	107.3	195.2	374.8	131.3	239.2	391.8
30	197.3	213.8	147.2	149.9	177.3	159.6	132.5	391.9	238.2	162.2	349.4	198.1
31	108.0	123.9	101.2	78.4	80.3	87.7	56.6	97.5	85.9	99.4	113.3	106.5
32	96.3	119.1	106.5	75.4	87.0	84.5	66.2	93.9	83.1	87.5	111.3	108.7
33	89.4	94.6	100.5	72.2	78.9	85.8	61.9	85.5	92.8	101.7	109.8	100.1
Mean	93.8	105.0	93.1	81.3	135.3	121.4	80.5	136.2	128.9	89.5	145.1	139.1

3.2 Roosting Suitability—Bridge-Segment Scale

The active channel is also the focus of understanding roosting suitability at the bridge-segment scale. One of the issues encountered in this analysis is the definition of active channel as represented by remotely sensed data converted into GIS coverages. The interpretation of active channel—and more importantly unobstructed channel width— from remotely sensed data (e.g., photographs and/or GIS data developed from photographs) became more challenging with the advent of island clearing in the mid-1980's as a management action designed to increase channel width. While clearing removes trees and shrubs, islands generally retain their pre-clearing elevation and are believed to function as obstructions even without woody vegetation. In contrast, herbaceous islands (captured on photographs and transformed into a GIS database) in 1982 were likely low elevation deposits exposed and vegetated during a low-flow period and thus would not have functioned as obstructions. Depending on how herbaceous islands are treated, different results in trend analyses of unobstructed channel width can be obtained.

To illustrate the effect of herbaceous islands, overall channel area within bridge segments, as represented in 1982 GIS data, was compared to channel area in 1998 GIS data in an effort to identify areas that have changed during the 14-year period between coverages. Reclamation staff used the GIS database (1982 and 1998 coverages) to evaluate active channel area—defined as open water, sandbar, and herbaceous islands in 1982—and as open water and sandbar in 1998. The difference in data treatment is linked to island clearing that began in the mid 1980's. In general, the active channel had a similar total area in 1982 and 1998 (0.7 percent increase), while the area of woodland increased by about 11.3 (Table SC-10). Reclamation staff also evaluated 1982 channel area as open water and sandbar, and compared these data with open water and sandbars delineated in 1998. This approach indicates an increasing channel area (Table SC-11).

We also looked at channel width (presented below) to document changes that may have occurred between 1982 and 1998. It is believed that wide channels provide security to roosting cranes and researchers use the measure of unobstructed channel width to express this relationship. The study and interpretation of change in unobstructed channel width has become important, and any activity that may adversely affect unobstructed channel width becomes an issue of concern.

Table SC-10. Acres (1998 compared to1982) of channel and riparian woodland within a band 3.5 miles north and south of the Platte River. The study area extends from about 3.5 miles west of Overton to near Chapman, NE. Channel consists of open water, sandbars, and herbaceous islands in 1982, and open water and sandbars in 1998.

Bridge Segment[1]	'82 Channel	'98 Channel	Change	Percent Change	'82 Riparian Woodland	'98 Riparian Woodland	Change	Percent Change
12a	316	420	104	32.9	1106	988	-118	-10.7
11	1029	838	-191	-18.6	3581	3230	-351	-9.8
10	620	644	24	3.9	2766	2147	-619	-22.4
9	862	889	27	3.1	2960	3002	42	1.4
8	684	780	96	14.0	1853	2061	208	11.2
7	727	723	-4	-0.6	1726	1529	-197	-11.4
6	739	703	-36	-4.9	1313	1489	176	13.4
5	932	946	14	1.5	1930	2331	401	20.8
4	666	718	52	7.8	966	1272	306	31.7
3	966	969	3	0.3	1092	1455	363	33.2
2	851	847	-4	-0.5	1188	1771	583	49.1
1	1875	1865	-9	-0.5	2909	4760	1851	63.6
Totals	10,267	10,342	75	0.7	23,390	26,035	2,645	11.3

[1]Segment 12a -3.5 miles west of Overton to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

Table SC-11. Acres (1998 compared to1982) of channel and riparian woodland within a band 3.5 miles north and south of the Platte River. The study area extends from 3.5 miles west of Overton to near Chapman, NE. Channel consists of open water and sandbars in both 1982 and 1998.

Bridge Segment[1]	'82 Channel	'98 Channel	Change	Percent Change	'82 Riparian Woodland	'98 Riparian Woodland	Change	Percent Change
12a	406	420	14	3.4	1106	988	-118	-10.7
11	1,003	838	-165	-16.5	3581	3230	-351	-9.8
10	607	644	37	6.1	2766	2147	-619	-22.4
9	803	889	86	10.7	2960	3002	42	1.4
8	633	780	147	23.2	1853	2061	208	11.2
7	670	723	53	7.9	1726	1529	-197	-11.4
6	686	703	17	2.5	1313	1489	176	13.4
5	878	946	68	7.7	1930	2331	401	20.8
4	608	718	110	18.1	966	1272	306	31.7
3	934	969	35	3.7	1092	1455	363	33.2
2	775	847	72	9.3	1188	1771	583	49.1
1	1,714	1,865	151	8.8	2909	4760	1851	63.6
Totals	9,717	10,342	625	6.4	23,390	26,035	2,645	11.3

[1]Segment 12a -3.5 miles west of Overton to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

3.2.1 Present Conditions

Service staff used the GIS database to evaluate **unobstructed channel width**, and compared the results with similar earlier analyses (U.S. Fish and Wildlife Service unpublished data 1985). Corps of Engineers river mile markers were used to position straight lines perpendicular to the channel, and additional lines were placed midway between each mile marker. From each line (approximately one-half mile apart), an unobstructed width value was obtained for the widest channel. This approach indicates that the unobstructed channel width has increased in seven bridge segments and decreased in five segments between 1985 and 1998. However, the mean channel width (estimate derived from 178 lines in 12 bridge segments) decreased from 556 feet to 544 feet during the 14-year period.

Reclamation staff also evaluated **unobstructed channel width**, but from the aspect of unobstructed area (width x length). Six width categories from the 1998 GIS data—ranging from less than 170 feet to greater than 1,000 feet—were evaluated (Table SC-12). The most abundant width category—expressed as a percentage of total channel area—was the 251- to 500-foot category (27.7 percent). Areas in which more than 1,000 feet of unobstructed channel width occur in all directions are uncommon (3.2 percent).

Data from 1982 and 1998 were collapsed into three width categories and compared employing the assumption that herbaceous islands were part of the 1982 channel (Table SC-13). The categories—501 to 750 feet, 751 to 1,000 feet, and greater than 1,000—were arbitrarily selected to focus on widths greater than 500 feet, because sandhill cranes most commonly roost in channels greater than 500 feet wide on the Platte River (Krapu et al. 1984). Area in unobstructed channel width decreased (-6.5 percent) in the 501- to 750-foot category, increased in the 751- to 1,000-foot category (11.5 percent), and decreased in the greater than 1,000-foot category(-1.1 percent) between 1982 and 1998. Overall, this analysis indicates that area within these width categories decreased by 21 acres or -0.7 percent (U.S. Bureau of Reclamation unpublished data 2000).

Treating herbaceous islands as obstructions in both 1982 and 1998, produces a different trend (Table SC-14). Under this approach, each width category increased when all bridge segments are combined: 60.4 percent (636 acres) for the 501- to 750-foot category, 149.0 percent (587 acres) for the 751- to 1,000-foot category, and 341.8 percent (270 acres) for the greater than 1,000-foot category (U.S. Bureau of Reclamation unpublished data 2000).

The above examples indicate the importance of analysis technique, assumptions, and the treatment of managed islands when dealing with channel width and/or area. Channel width analyses (U.S. Fish and Wildlife Service unpublished data 1985, 2000) indicate similar or slight narrowing of the channel between 1985 and 1998 when herbaceous islands are treated as obstructions. Channel area analyses (U.S. Bureau of Reclamation unpublished data 2000) indicate either a very small reduction in area (herbaceous islands as channel in 1982), or an increase in roosting area (herbaceous islands as obstructions in 1982) depending upon treatment of herbaceous islands.

Table SC-12. Acres (1998) of total channel and various channel width (feet) categories within the Platte River between just west of Lexington to Chapman, NE.

Bridge Segment[1]	Channel Area	Width <170	Percent <170	Width 171-250	Percent 171-250	Width 251-500	Percent 251-500	Width 501-750	Percent 501-750	Width 751-1000	Percent 751-1000	Width >1000	Percent >1000
13	345	112	32.5	96	27.8	137	39.6	0	0.0	0	0.0	0	0.0
12	644	275	42.7	161	25.0	162	25.2	47	7.3	0	0.0	0	0.0
11	838	321	38.3	174	20.8	274	32.7	24	2.9	45	5.4	0	0.0
10	644	107	16.6	43	6.7	143	22.2	240	37.3	110	17.1	0	0.0
9	889	314	35.3	171	19.2	312	35.1	81	9.1	11	1.2	0	0.0
8	780	260	33.3	179	22.9	249	31.9	92	11.8	0	0.0	0	0.0
7	723	146	20.2	123	17.0	165	22.8	203	28.1	85	11.8	0	0.0
6	703	182	25.9	108	15.4	242	34.4	119	16.9	53	7.5	0	0.0
5	946	204	21.6	178	18.8	327	34.6	135	14.3	103	10.9	0	0.0
4	718	138	19.2	104	14.5	169	23.5	199	27.7	109	15.2	0	0.0
3	969	230	23.7	164	16.9	221	22.8	224	23.1	81	8.4	50	5.2
2	847	311	36.7	158	18.7	235	27.7	86	10.2	57	6.7	0	0.0
1	1,865	407	21.8	210	11.3	384	20.6	239	12.8	327	17.5	299	16.0
Totals	10,911	3,007	27.6	1,869	17.1	3,020	27.7	1,689	15.5	981	9.0	349	3.2

[1]Segment 13 - Lexington to ________
Segment 12 - ________ to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

Table SC-13. Three categories (in acres) of unobstructed width compared (1982 and 1998) by bridge segment. GIS analysis evaluates unobstructed width in all directions for each category. Wooded islands were considered obstructions in 1982, and herbaceous and wooded islands were considered obstructions for analysis of 1998 data.

Bridge Segment[1]	Unobstructed Width 501-750'				Unobstructed Width 751-1,000'				Unobstructed Width > 1,000'			
	1982	1998	Change	Percent	1982	1998	Change	Percent	1982	1998	Change	Percent
12a	83	47	-36	-43.4	0	0	0	-------	0	0	0	-------
11	70	24	-46	-65.7	0	45	45	-------	0	0	0	-------
10	150	240	90	60.0	45	110	65	144.4	0	0	0	-------
9	89	81	-8	-9.0	0	11	11	-------	0	0	0	-------
8	66	92	26	39.4	30	0	-30	-------	0	0	0	-------
7	84	203	119	141.7	34	85	51	150.0	51	0	-51	-------
6	145	119	-26	-17.9	18	53	35	194.4	0	0	0	-------
5	166	135	-31	-18.7	42	103	61	145.2	0	0	0	-------
4	135	199	64	47.4	90	109	19	21.1	20	0	-20	-------
3	281	224	-57	-20.3	194	81	-113	-58.2	0	50	50	-------
2	212	86	-126	-59.4	135	57	-78	-57.8	0	0	0	-------
1	326	239	-87	-26.7	292	327	35	12.0	282	299	17	6.0
Totals	1,807	1,689	-118	-6.5	880	981	101	11.5	353	349	-4	-1.1

[1] Segment 12 - ________ to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

Table SC-14. Three categories (in acres) of unobstructed width compared (1982 and 1998) by bridge segment. GIS analysis evaluates unobstructed width in all directions for each category. Islands supporting herbaceous or woody vegetation are treated as obstructions for both years.

Bridge Segment[1]	Unobstructed Width 501-750'				Unobstructed Width 751-1,000'				Unobstructed Width > 1,000'			
	1982	1998	Change	Percent	1982	1998	Change	Percent	1982	1998	Change	Percent
12a	64	47	-17	-26.6	0	0	0	-------	0	0	0	-------
11	37	24	-13	-35.1	0	45	45	-------	0	0	0	-------
10	124	240	116	93.5	45	110	65	144.4	0	0	0	-------
9	16	81	65	406.3	0	11	11	-------	0	0	0	-------
8	21	92	71	338.1	0	0	0	-------	0	0	0	-------
7	25	203	178	712.0	17	85	68	400.0	51	0	-51	-------
6	69	119	50	72.5	0	53	53	-------	0	0	0	-------
5	55	135	80	145.5	22	103	81	368.2	0	0	0	-------
4	67	199	132	197.0	23	109	86	373.9	0	0	0	-------
3	225	224	-1	-0.0	137	81	-56	-40.9	0	50	50	-------
2	99	86	-13	-13.1	0	57	57	-------	0	0	0	-------
1	251	239	-12	-4.8	150	327	177	118.0	28	299	271	967.9
Totals	1,053	1,689	636	60.4	394	981	587	149.0	79	349	270	341.8

[1] Segment 12 - ________ to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

3.2.2 Comparison of Alternatives

The Platte River Programmatic EIS evaluates the effects of channel management activities such as island clearing and leveling. Island leveling activities would increase unobstructed channel width. Example land-management scenarios were developed to facilitate analysis of channel management. Because unobstructed channel width (Fish and Wildlife Service unpublished data 2000) and unobstructed channel area greater than 501 feet (Table SC-13) have changed little since the early to mid-1980's, present conditions (1998) were used as the comparison standard. When the action alternatives are compared to present conditions, example scenarios of land management activities would increase **unobstructed channel width** from 21.1 percent to 32.0 percent (Table SC-15).

Implementation of any habitat management plan would have site-specific effects, i.e., no two sites are identical and any island leveling would result in different acreage values for unobstructed channel width—depending upon features at the managed site. In addition, the actual locations at which management would occur will not be selected until after the preferred alternative is defined in the Record of Decision. Given these constraints in this example, the Governance Committee Alternative Scenario 2, Water Leasing and Wet Meadow Alternatives all focuses management activities in the western end of the study area (bridge segments 11, 10, 9, and 8) and provide 965 acres of additional unobstructed channel area greater than 501 feet wide (Table SC-15).

Table SC-15. Acres of unobstructed channel (in all directions) greater than 501 feet that would result from various alternatives. Shaded cells indicate the bridge segments in which unobstructed width would increase over existing conditions (1998).

Bridge Segment [1]	Alternatives and Time Periods					
	Present Conditions	Governance Committee		Water Emphasis	Water Leasing	Wet Meadow
		Scenario 1	Scenario 2			
	1998 Coverage	2017	2017	2017	2017	2017
13	0	0	0	0	0	0
12	47	47	47	47	47	47
11	69	69	378	230	378	378
10	350	350	501	350	501	501
9	91	91	211	91	211	211
8	92	92	244	92	244	244
7	289	289	289	289	289	289
6	172	172	263	172	263	263
5	238	238	238	712	238	238
4	307	307	307	307	307	307
3	354	354	354	354	354	354
2	143	143	285	143	285	285
1	864	864	864	864	864	864
Totals	3,016	3,016	3,981	3,651	3,981	3,981

[1] Segment 13 - Lexington to _______
Segment 12 - ________ to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

3.3 Roosting Suitability—System Scale

Systems are assemblages of linked components. If conditions supporting the system change, or if change occurs in one or more of the components, then other components (via their respective linkages) are likely to change. It is assumed that present conditions (that support roosting habitat) on the North Platte and Platte Rivers reflect the responses of linked components to the external and internal forces and processes that define this system (Figure SC-8). Discharge (stream flow) and sediment transport are the two most important processes at work in this system, and we encourage the reader to review the hydrology and sediment sections of the Platte River PEIS.

Based on the above concept of system operation and component response to change, it is assumed that future changes in stream flow would be reflected as changes in sandhill crane roosting habitat through the same relationships between discharge and roosting depth abundance previously described for site-scale evaluations. Unfortunately, few cross-sectional transects are available outside the Lexington to Chapman reach of the Platte River. We are however, assuming that the relationships described between discharge and roosting depth abundance for the central Platte River also exists in the North Platte River channel, and changes in future measures of **discharge** would represent future changes in roosting depth abundance when compared to present conditions. For the purposes of this evaluation, increases in flow are assumed to represent a reduction in roosting depth abundance while reduced flow would represent an increase in roosting habitat.

Data from the hydrology analyses (Hydrology Appendix period of record equals 1947-1994) were used to evaluate the effects of flow on roosting habitat at the system scale. The two previous analyses at the site and bridge segment scales provided a detailed discussion of present conditions to establish trends and that discussion will not be repeated here.

Central Platte Schematic Displaying Average Annual Flow

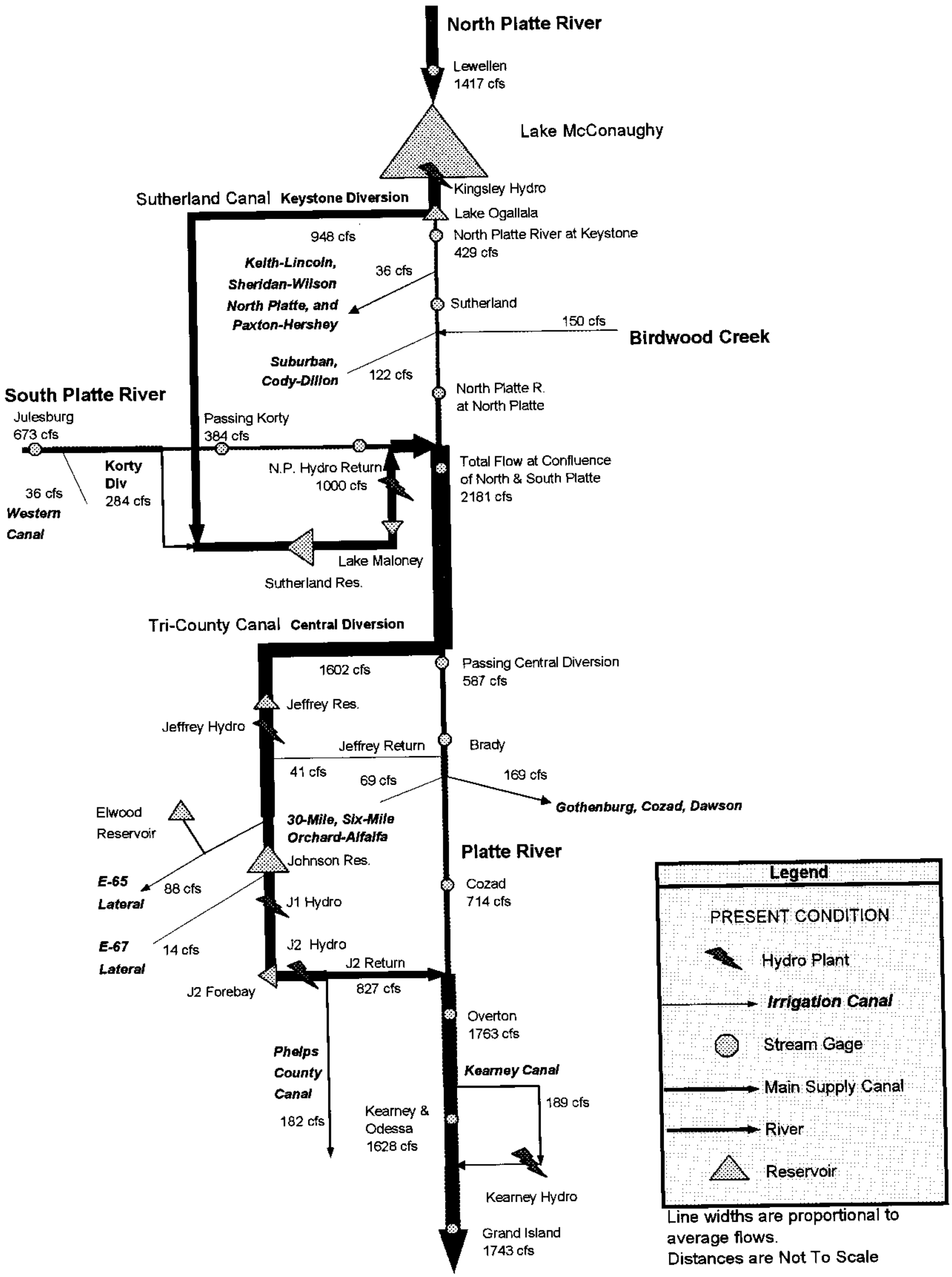


Figure SE-8. Example flow modification as water moves through the Platte River.

3.3.1 Comparison of Alternatives

Discharge data from the North, South, and Platte Rivers were evaluated on an annual and seasonal basis. The seasons of interest include spring (February-April) and early to mid summer (May-July). Spring flows directly affect water depth and channel wetted width for roosting cranes. Flow during the early to mid summer can affect the success of cottonwood regeneration (May 15-July 15), and occupation of channel sites by woody vegetation such as cottonwoods has been linked to channel narrowing (Simons & Associates, Inc. 2000).

3.3.1.1 North Platte River

The North Platte River is important to sandhill cranes because it not only provides water to the central Platte River, but its flows also directly affect about 5,000-8,000 sandhill cranes that use the channel for roosting at the upper end of Lake McConaughy (Clear Creek Wildlife Management Area and the channel west for about 2 miles), and some 150,000 sandhill cranes using the river between Sutherland and North Platte, NE (although most use now occurs between Hershey and North Platte). It is assumed that existing channel width and depth characteristics provide these cranes with roosting habitat and any in those characteristics would result in a change in habitat.

Lewellen to Clear Creek WMA Reach.—Spring **discharge** in the North Platte River immediately upstream from Lake McConaughy would be somewhat reduced during February and March, and then increase over present conditions during April for all action alternatives (Table 16). February and March flows under the Wet Meadow Alternative would be very similar to present conditions. Although no transect data are available for this reach, relationships between discharge and roosting habitat discussed under the site-scale evaluation indicate that reduced flows would likely translate into an increase in roosting depth (3-9 inch range) abundance during February and March. The situation would be reversed in April with increased flows translating into reduced roosting depth abundance. The largest increase in April flow (22.5 percent) would occur under the Wet Meadow Alternative.

Discharge during the cottonwood seed production period (May 15-July 15) would be mixed (Table SC-16). May flows would be greater than present conditions under all alternatives except the Water Emphasis and Wet Meadow alternatives, and June flows would be lower than present conditions for all action alternatives. Mean July flows would be from 13 to 60 percent higher than present July conditions.

Table SC-16. Mean monthly flows at the Lewellen guage (upstream of Clear Creek Wildlife Management Area) compared by alternative to present conditions for the spring migration and cottonwood regeneration periods.

Roosting Suitability System Scale: Clear Creek Wildlife Management Area (North Platte River)	Alternatives and Time Periods					
	Present Conditions	Governance Committee		Water Emphasis	Water Leasing	Wet Meadow
		Scenerio 1 (1980 cfs)	Scenerio 2 (3000 cfs)			
	1947-1994	2017	2017	2017	2017	2017
Lewellen						
Mean monthly flow (cfs)						
Spring Migration Period						
February	1303	1294	1294	1280	1271	1301
March	1360	1260	1260	1321	1244	1366
April	1385	1526	1526	1662	1505	1696
Cottonwood Regeneration						
May	1662	1714	1714	1555	1685	1569
June	2190	2119	2119	1845	2052	1859
July	1236	1394	1394	1981	1739	1613

Sutherland to North Platte Reach.—Hydrology information from several locations was examined to identify possible effects to sandhill crane roosting habitat from changes in **discharge** resulting from implementation of the action alternatives. Three general categories of information were examined: releases from Kingsley Dam, annual flows in the North Platte River, and mean monthly flows in the Sutherland to North Platte reach.

Operations at Kingsley Dam would change under the proposed action alternatives. Releases from the dam—both as operational releases and spills—are important in determining downstream channel characteristics. Outflow from Lake McConaughy would increase (up to 4.1 percent for the Water Emphasis Alternative) under all proposed alternatives (Table SC-17). However, the volume of total spills from Kingsley Dam would be reduced from 25.3 (Water Emphasis Alternative) to 54.6 percent (Wet Meadow Alternative) under these alternatives. Spills are important in maintaining downstream channel structure. Note that Kingsley Dam does not spill every year, and the magnitude of spills, when the dam does spill, would increase under all action alternatives except the Wet Meadow Alternative (Table SC-17). However, the frequency of spills would be reduced from once every 1.5 years under present conditions to a range of between once every 2.8 years to 3.7 years.

The North Platte River gauge at North Platte, NE was selected to represent hydrology within the Sutherland to North Platte reach because Birdwood Creek, with an average annual discharge of 108 kaf (see Hydrology Appendix) joins the river just downstream from Sutherland, and the reach is also a "gaining reach". On an annual basis, all proposed alternatives would reduce (when compared to present conditions) the average annual volume of water passing through the reach. The largest reduction would equal about 5.2 percent for the Water Leasing Alternative (Table SC-17).

Mean monthly flow values in the Sutherland to North Platte reach would change somewhat during the spring migration period (Table SC-17). February flows would increase somewhat under all proposed action alternatives (up to 5.5 percent for the Water Emphasis Alternative). Flows during March would be reduced under the Governance Committee (-3.7 percent) and Water Leasing (-4.7 percent) alternatives, but would increase under other alternatives (up to 20.4 percent under the Water Emphasis Alternative). April flows would all be reduced (down to -10.6 percent under the Water Leasing Alternative).

Mean monthly flow values would also change during the cottonwood seed production period in the Sutherland to North Platte reach (Table SC-17). May flows would be reduced under the Water Emphasis Alternative (-3.2 percent), and increase under all other alternatives (up to 14.7 percent under the Scenario 1 of the Governance Committee Alternative). Flows would be reduced from -2.8 to -32.5 percent under all proposed action alternatives during June and July (Table SC-17). Reduced flows during June and July may be cause for concern in terms of vegetation becoming established within the active channel. However, because July flows for each action alternative would range from 142.0 to 173.5 percent higher than June flows in each action alternative, the risk of additional vegetation becoming established within the active channel is reduced.

Table SC-17. Present (1947-1994) and estimated future conditions (2017) at various locations on the North Platte River under various alternatives. Parentheses following gauge locations refer to data contained within the Hydrology Appendix ("HYDROL" on the "M" drive). Values depict average annual water volumes in thousand acre feet (kaf) unless otherwise defined.

Roosting Suitability System Scale: North Platte River	Alternatives and Time Periods					
	Present Conditions	Governance Committee		Water Emphasis	Water Leasing	Wet Meadow
		Scenario 1 (1980 cfs)	Scenario 2 (3000 cfs)			
	1947-1994	2017	2017	2017	2017	2017
Lake McConaughy Outflow (Table 3)	997.4	1021.3	1014.6	1038.2	1022.1	1017.7
Kinglsly Dam Annual Spill (Table 6)	177.5	91.3	92.0	132.6	95.4	80.6
Spill magnitude (when spills)	275	313	316	374	352	258
Frequency of Spills (years)	1.5	3.4	3.4	2.8	3.7	3.2
(percent years with spills)	(65)	(29)	(29)	(35)	(27)	(31)
North Platte @ North Platte, NE (Table 42)	483.0	464.0	463.3	463.8	457.7	459.2
North Platte @ North Platte, NE (mean monthly flow - cfs) (Table 141)						
February	398	402	402	420	404	404
March	458	440	440	551	436	494
April	586	532	532	554	524	568
May	670	768	754	648	704	696
June	1219	965	984	837	971	823
July	1469	1403	1397	1366	1386	1428

3.3.1.2 South Platte River

Although sandhill cranes do not regularly use the South Platte River for extended periods, the river remains important as the only current source of large amounts of sediment for the central Platte River. (The reader is referred to the River Hydraulics and Sediment Transport sections in the Platte River PEIS for a detailed discussion of sediment dynamics within this system.) Discharge estimates at various gauges between Julesburg, CO, and North Platte, NE, were inspected to determine the magnitude of change in flows that would be expected from the action alternatives.

Flows in the South Platte River between Julesburg, CO and North Platte, NE have been considerably modified by irrigation and hydro power development (Figure SC-8). Only two of the proposed action alternatives would increase the volume of water leaving Colorado at Julesburg (Table SC-18). Discharge at Julesburg would range from a -1.7 percent reduction under the Governance Committee Alternative (Scenario 2) to a 3.0 percent increase under the Water Leasing Alternative. Withdrawals from the South Platte River at the Korty Diversion would be reduced under all action alternatives, with the largest reduction (-5.9 percent) occurring under the Water Emphasis Alternative. South Platte River flows at North Platte, NE would be mixed ranging from a small reduction (-2.0 percent) under the Governance Committee Alternative (Scenario 2) to a small increase (6.2 percent) under the Water Leasing Alternative. Return flows from the Sutherland hydroelectric power plant make up the largest proportion of flows constituting the Platte River at North Platte, NE, and these flows would increase from 4.9 to 6.5 percent under all action alternatives (Table SC-18). Finally, the percentage of Platte River water consisting of undiverted South Platte River water at North Platte, NE would range from a reduction of -2.5 percent (Governance Committee Alternative) to an increase of 3.8 percent (Water Leasing Alternative).

In summary, the proposed action alternatives would result in small changes ($\leq$6.5 percent) in discharge at various locations along the South Platte River. Because of the relatively small size of these changes and the co-mingling of South Platte River flows with North Platte River flows that occurs downstream in the Platte River, it is difficult to identify effects associated with these changes. Any effects to sandhill crane habitat will be credited to North Platte River and/or Platte River flows.

No seasonal flows were evaluated for the South Platte River.

Table SC-18. Present (1947-1994) and estimated future conditions (2017) at various locations on the South Platte River under various alternatives. Parentheses following gauge locations refer to data contained within the Hydrology Appendix ("HYDROL" on the "M" drive). Values depict average annual water volumes in thousand acre feet (kaf) unless otherwise defined.

Roosting Suitability System Scale: South Platte River	Alternatives and Time Periods					
	Present Conditions	Governance Committee		Water Emphasis	Water Leasing	Wet Meadow
		Scenario 1 (1980 cfs)	Scenario 2 (3000 cfs)			
	1947-1994	2017	2017	2017	2017	2017
Julesburg, CO (Table 38)	487.8	479.7	480.0	498.7	502.3	483.6
Korty Diversion (Table 19)	205.9	204.3	205.5	193.8	197.2	204.0
South Platte @ North Platte, NE (Table 41)	372.5	366.0	365.1	395.4	395.6	370.1
Sutherland (NPPD) Hydro Return (Table 44)	724.4	764.3	759.6	771.7	762.6	763.2
Platte River @ North Platte, NE (Table 45)	1579.9	1594.4	1588.0	1630.9	1615.9	1592.5
Percent of Platte River @ North Platte Represented by Undiverted South Platte Flows	23.6	23.0	23.0	24.2	24.5	23.2

3.3.1.3 Platte River

There would be some future increase in the amount of water available (up to 3.2 percent for the Water Emphasis Alternative) at North Platte, NE for the Platte River under all proposed action alternatives (Table SC-19). Downstream, withdrawals at the Central (Tri-County)Diversion would also increase (up to 4.6 percent for the Water Emphasis Alternative) under all action alternatives. The average annual volume of water passing the Central Diversion would be reduced (by as much as 4.8 percent under the Governance Committee Alternative Scenario 2) under all proposed action alternatives. Water passing the Brady and Cozad gauges would follow a similar trend with somewhat reduced flows under all alternatives except at Cozad under the Water Emphasis Alternative which would increase slightly (1.2 percent).

Johnson Power Plant 2 (J-2) return flows would increase (up to 11.2 percent for the Water Emphasis Alternative) under all proposed action alternatives. The percentage of J-2 water in the total discharge passing Overton would increase somewhat (up to 5.8 percent for the Governance Committee Scenario 2 Alternative) under all action alternatives. Finally, average annual flows passing Overton, Odessa, and Grand Island, NE would increase (up to 7.0 percent at Odessa for the Water Emphasis Alternative) under all action alternatives (Table SC-19).

Table SC-19. Present (1947-1994) and estimated future conditions (2017) at various locations on the Platte River under various alternatives. Parentheses following gauge locations refer to data contained within the Hydrology Appendix ("HYDROL" on the "M" drive). Values depict average annual water volumes in thousand acre feet (kaf) unless otherwise defined.

Roosting Suitability System Scale: Platte River	Alternatives and Time Periods					
	Present Conditions	Governance Committee		Water Emphasis	Water Leasing	Wet Meadow
		Scenario 1 (1980 cfs)	Scenario 2 (3000 cfs)			
	1947-1994	2017	2017	2017	2017	2017
Platte River @ North Platte (Table 45)	1579.9	1594.4	1588.0	1630.9	1615.9	1592.5
Central (Tri-County) Diversion (Table 17)	1160.4	1191.1	1187.3	1214.1	1200.2	1187.8
Tri-County Bypass (Table 16)	425.6	407.3	405.0	419.6	419.6	409.7
Brady (Table 48)	593.1	576.8	574.3	590.5	589.4	578.3
Cozad (Table 49)	517.4	496.0	493.8	523.6	516.7	492.6
Johnson #2 Return (Table 47)	599.3	649.2	645.4	666.8	659.5	634.8
Percent Overton Flow as J-2 Return	46.9	49.7	49.6	49.0	49.3	49.3
Overton (Table 53)	1277.6	1306.0	1300.0	1361.3	1337.1	1288.3
Odessa (Table 50)	1179.8	1208.9	1202.9	1262.1	1237.8	1189.6
Grand Island (Table 55)	1262.9	1293.6	1287.6	1347.4	1323.2	1273.6

Seasonal flows on the Platte River were evaluated using gauge data from Overton, Odessa, and Grand Island. At Overton, mean monthly flows for February would be reduced from present conditions by from -6.7 percent (Wet Meadow Alternative) to -0.4 percent (Water Emphasis Alternative) (Table SC-20). March flows at Overton would vary from a reduction of -4.9 percent under the Governance Committee Scenario 1 Alternative, to an increase of 8.7 percent under the Water Emphasis Alternative. April flows would be higher (up to 16.1 percent under the Water Emphasis Alternative) under all action alternatives. May flows would be higher (up to 29.3 percent for the Water Leasing Alternative), June flows would be lower (-10.6 percent for the Wet Meadow Alternative), and July flows would vary from -2.7 percent (Wet Meadow Alternative) to 5.4 percent (under the Water Leasing Alternative) (Table SC-20).

Seasonal flows predicted for Odessa would follow a pattern very similar to that exhibited at Overton. Mean monthly flows for February at Odessa would be reduced from present conditions by from -6.4 percent (Wet Meadow Alternative) to -0.8 percent (Water Emphasis) (Table SC-20). March flows at Odessa would vary from a reduction of -4.8 percent under the Governance Committee Scenario 1 Alternative, to an increase of 8.6 percent under the Water Emphasis Alternative, and April flows would be higher (up to 18.2 percent under the Water Emphasis Alternative) under all action alternatives. The cottonwood seed production period would experience both increases and decreases in flow when compared to present conditions; May flows would be higher (up to 32.5 percent for the Water Leasing Alternative), June flows would be lower (down -11.5 percent for the Wet Meadow Alternative), and July flows would vary from -3.1 (under the Wet Meadow Alternative) to 6.0 percent (under the Water Leasing Alternative) (Table SC-20).

Seasonal flows predicted for Grand Island would also follow a pattern similar to that exhibited at Overton and Odessa. Mean monthly flows for February at Grand Island would be reduced from present conditions by from -6.5 percent (Wet Meadow Alternative) to -0.4 percent (Water Emphasis Alternative) (Table SC-20). March flows at Grand Island would vary from a reduction of -3.2 percent under the Water Leasing Alternative, to an increase of 7.7 percent under the Water Emphasis Alternative. April flows would be higher (up to 15.3 percent under the Water Emphasis Alternative) under all action alternatives. Early summer flows would be mixed, with May exhibiting higher flows (up to 29.1 percent for the Governance Committee Scenario 1 and Water Emphasis Alternatives), lower flows in June (down to -10.7 percent for the Wet Meadow Alternative), and mixed flows in July (-2.6 percent for the Wet Meadow Alternative to 5.2 percent for the Water Leasing Alternative).

Table SC-20. Estimated discharge at Overton, Odessa, and Grand Island for present and future estimated spring migration (February-April)and cottonwood regeneration (May-July) periods (all alternatives). Parentheses refer to data contained within the Hydrology Appendix ("HYDROL" on the "M" drive). Values depict mean monthly flow in cubic feet per second (cfs).

Roosting Suitability System Scale: Platte River	Alternatives and Time Periods					
	Present Conditions	Governance Committee		Water Emphasis	Water Leasing	Wet Meadow
		Scenario 1 (1980 cfs)	Scenario 2 (3000 cfs)			
	1947-1994	2017	2017	2017	2017	2017
Overton (Table 54)						
February	2253	2126	2105	2244	2140	2103
March	2156	2050	2051	2343	2077	2133
April	1910	2121	2138	2217	2153	2175
May	2176	2807	2744	2805	2814	2675
June	2883	2756	2757	2663	2829	2577
July	1418	1422	1407	1481	1494	1380
Odessa (Table 135)						
February	2346	2219	2198	2337	2233	2195
March	2188	2082	2083	2376	2110	2165
April	1685	1896	1913	1992	1928	1950
May	1950	2582	2521	2575	2583	2448
June	2676	2551	2554	2452	2618	2368
July	1255	1264	1249	1317	1330	1216
Grand Island (Table 56)						
February	2321	2193	2173	2312	2207	2170
March	2434	2327	2329	2621	2355	2410
April	2012	2224	2240	2320	2255	2277
May	2197	2837	2773	2828	2837	2697
June	2871	2751	2752	2653	2819	2565
July	1522	1532	1517	1588	1601	1483

3.4 Food Suitability—Bridge Segment Scale

The GIS database produced acreage estimates of the applicable cover types [corn fields (vegetation code 21), lowland grasses (vegetation code 12), alfalfa fields (vegetation code 20), and upland grasses (vegetation code 11)] providing corn and invertebrate food for sandhill cranes.

3.4.1 Present Conditions

Corn-field acreage increased between 1982 and 1998 in the study area while other crop acreage declined (Table SC-21). In 1981, the Service published a study of the Central Platte Valley which documented information associated with waste corn as a food resource for livestock, cranes, and other migratory wildfowl (U.S. Fish and Wildlife Service 1981). The study sampled individual fields and provided estimates of yield (bushels/acre), harvest efficiency, magnitude of fall tillage, percent fields used by foraging livestock and their consumption, numbers and use by cranes and other wildfowl, and other information needed to compute the abundance of waste corn, and its consumption by various components of the ecosystem. While estimates for various statistics could be obtained at the county scale, it would be difficult to compare such estimates to the data collected at the field scale in the late 1970's. Aspects of the 1981 study are currently being replicated by U.S. Geological Survey scientists and that information will undoubtedly be important to the Adaptive Resources Management Process.

GIS analysis of cover types providing **invertebrate food** indicates some changes have occurred in the last 16 years. The comparison between 1982 and 1998 indicates increases in lowland grasses and reductions in alfalfa and upland grassland acreage (Table SC-22). Some lowland grasslands are “wet meadow” sites providing important habitat requirements for cranes. However, the increase in total acres of lowland grassland may reflect conversions of marginally productive farmland to the Conservation Reserve Program (CRP). CRP plantings generally consist of tall-grass prairie species that provide robust cover unsuitable for crane foraging.

Table SC-21. Acreages (1998 compared to 1982) for corn (GIS Veg Code = 21) and other crops (GIS Veg Code = 22) within 3.5 miles of the Platte River between about 3.5 miles west of Lexington to Chapman, NE.

Bridge Segment[1]	'82 Corn	'98 Corn	Change	Percent Change	'82 Other Crops	'98 Other Crops	Change	Percent Change
12a	5387	5323	-64	-1.2	566	866	300	53.0
11	15873	15907	34	0.2	3701	4746	1045	28.2
10	11230	11004	-226	-2.0	1389	3160	1771	127.5
9	12522	13492	970	7.7	3227	2841	-386	-12.0
8	15904	16336	432	2.7	1443	2015	572	39.6
7	12470	14399	1929	15.5	2076	1010	-1066	-51.3
6	15864	16811	947	6.0	2547	2247	-300	-11.8
5	24276	24105	-171	-0.7	3336	3578	242	7.3
4	10732	12489	1757	16.4	3626	2108	-1518	-41.9
3	14167	15263	1096	7.7	3307	2266	-1041	-31.5
2	15255	15426	171	1.1	2577	2944	367	14.2
1	23384	25567	2183	9.3	6532	5475	-1057	-16.2
Totals	177,064	186,122	9,058	5.1	34,327	33,256	-1,071	-3.1

[1]Segment 12a - 3.5 miles west of Overton to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

Table SC-22. Acreages (1998 compared to1982) for lowland grasses (GIS Veg Code = 12), alfalfa (GIS Veg Code = 20), and upland grasslands (GIS Veg Code = 11) within 3.5 miles of the Platte River between 3.5 miles west of Overton to Chapman, NE.

Bridge Segment[1]	'82 Lowland Grasses	'98 Lowland Grasses	Change	Percent Change	'82 Alfalfa	'98 Alfalfa	Change	Percent Change	'82 Upland Grasses	'98 Upland Grasses	Change	Percent Change
12a	755	639	-116	-15.4	1524	1338	-186	-12.2	1349	1678	329	24.4
11	1569	2372	803	51.2	5513	4118	-1395	-25.3	3415	3260	-155	-4.5
10	481	1554	1073	223.1	4853	2821	-2,032	-41.9	3849	3862	13	0.3
9	580	460	-120	-20.7	3494	3289	-205	-5.9	10791	10280	-511	-4.7
8	1382	1483	101	7.3	2181	978	-1203	-55.2	2458	2368	-90	-3.7
7	2103	2085	-18	-0.9	2108	1554	-554	-26.3	3394	3232	-162	-4.8
6	594	890	296	49.8	1723	884	-839	-48.7	2550	2840	290	11.4
5	735	712	-23	-3.1	792	514	-278	-35.1	6316	6713	397	6.3
4	2333	2801	468	20.1	1055	591	-463	-43.9	3558	3250	-308	-8.7
3	4473	5940	1467	32.8	2108	510	-1598	-75.8	3186	2915	-271	-8.5
2	3226	4063	837	25.9	1726	344	-1382	-80.1	1714	1872	158	9.2
1	3288	5351	2063	62.7	2772	1007	-1765	-63.7	6476	4861	-1615	-24.9
Totals	21,519	28,350	6,831	31.7	29,849	17,948	-11,901	-39.9	49,056	47,131	-1,925	-3.9

[1]Segment 12a -3.5 miles west of Overton to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

3.4.2 Comparison of Alternatives

As with the analysis of roost sites at the bridge segment scale, no site-specific comparisons can be made. However, example management plans have been developed for the purposes of analysis. These plans would convert existing land-cover types (e.g., **corn**) to lowland grasses (that provide **invertebrate food**) in various bridge segments (Table SC-23). In these examples, the Wet Meadow Alternative would provide the largest number of additional lowland grassland acres. A detailed discussion of land plans can be found in the Platte River PEIS.

Table SC-23. Example management scenarios in which additional acres of lowland grasses would be added to various bridge segments under various alternatives.

Bridge Segment[1]	Alternatives and Time Periods					
	Present Conditions	Governance Committee		Water Emphasis	Water Leasing	Wet Meadow
		Scenario 1	Scenario 2			
	1998 Coverage	2017	2017	2017	2017	2017
12a	639	0	0	0	0	0
11	2372	1045	919	495	919	919
10	1554	0	938	0	938	1667
9	460	0	594	0	594	919
8	1483	917	868	0	868	1344
7	2085	0	0	0	0	417
6	890	889	831	0	831	1282
5	712	163	0	377	0	621
4	2801	0	0	0	0	0
3	5940	0	0	0	0	0
2	4063	386	298	0	298	298
1	5351	304	0	0	0	263
Totals	28,350	3,704	4,448	872	4,448	7,729

[1]Segment 12a - ________ to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

A summary of resources believed important to sandhill cranes using the Platte River between Lexington and Chapman is presented with crane use in Table SC-24.

Table SC-24. Channel area, channel width greater than 501 feet, channel area cleared, lowland grasses, corn (1998 acres), and percent nocturnal and diurnal crane use (www.whoopingcrane.org) of study segments. Segments are located from about 3.5 miles west of Overton to Chapman, NE, and cover a band 3.5 miles both north and south of the Platte River.

Bridge Segment [1]	Total Channel Area	Channel Width >501 ft	Channel Cleared 1982-1997	Lowland Grasses	Corn	% Cranes Surveyed (nocturnal)	% Cranes Surveyed (diurnal)
12a	644	47	27	639	5323	0.0	1.2
11	838	69	5	2372	15907	0.2	2.1
10	644	350	540	1554	11004	1.0	5.7
9	889	92	39	460	13492	0.3	3.8
8	780	92	441	1483	16336	6.1	9.8
7	723	288	467	2085	14399	26.2	15.9
6	703	172	13	890	16811	3.3	17.0
5	946	238	130	712	24105	16.7	7.8
4	718	308	200	2801	12489	15.0	8.9
3	969	355	277	5940	15263	19.1	19.7
2	847	143	16	4063	1,426	11.6	6.6
1	1865	865	0	5351	25567	0.5	1.1
Totals	10,566	3,019	2154	28,350	186,122	100.00	99.6

[1] Segment 12a - ________ to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

4.0 Discussion

This assessment addresses sandhill cranes and their spring use of habitat along the North Platte and Platte Rivers in central Nebraska, and the potential effects of six alternatives currently being evaluated in the Platte River Programmatic EIS process. That process evaluates the effects of changing stream flows and managing additional lands along the Platte River for the benefit of whooping cranes, interior least terns, piping plovers, and pallid sturgeon. Sandhill crane use of the Platte River differs from that of the four target species, and thus the effects to sandhill cranes from implementation of any of these alternatives would also differ from predicted effects to the target species. In addition, use of the North Platte River by whooping cranes, interior least terns, and piping plovers is limited, but changes in flow to facilitate habitat benefits for these target species downstream may affect North Platte River reaches used by sandhill cranes.

The midcontinental population of sandhill cranes use the Central Platte Valley (North Platte and Platte Rivers, and adjacent lands) each spring to rest, feed, court, and ready themselves physiologically for the remainder of migration and then nesting in their holartic breeding grounds. This use is traditional, lasts 4-6 weeks, and involves most if not the entire midcontinental population. Sandhill cranes are gregarious and most utilization of habitat resources occurs in flocks varying in size from a few birds to aggregations of several thousand individuals. This gregarious behavior—at a traditional use site—is the focus used to formulate our concept of habitat suitability for this species. Basically, that concept is the greater the availability of habitat resources, the greater the number of sandhill cranes that can be accommodated at any unit area of interest. This is a simplistic approach to evaluating the complex relationship that exists between sandhill cranes and their environment. For example, human disturbance and competition with geese and ducks for food likely also defines habitat suitability for sandhill cranes using the Central Platte Valley. However, disturbance and potential competition for food are not addressed in this assessment.

We can assume that the pre-development North Platte and Platte Rivers were a dynamic system supporting diverse habitats. Historically, sandhill cranes likely roosted in the broad active channels and fed on plants and animals in adjacent wetlands, wet meadows, and suitable prairie sites between what is now present day Sutherland and Grand Island, Nebraska. Crane use was likely opportunistic and dispersed in order to efficiently exploit resources. Habitat resources and crane use of these resources have changed from historic conditions. The most obvious change has involved basin-wide channel narrowing resulting from occupation of much of the historic active river channel by woody vegetation. Cranes appear to prefer wide channels (> 500 feet on the Platte River) for roosting and have responded to channel narrowing by abandoning some sites in the western Central Platte Valley for remaining wide channel sites in the eastern valley. The concentration of sandhill cranes into remaining suitable roost sites has been facilitated by abundant waste grain (corn) in adjacent fields.

Spring migration habitat traditionally used by sandhill cranes in the Central Platte Valley consists of three main components: (1) secure roost sites within the active river channel, (2) feeding sites where cranes obtain waste grain (primarily corn from harvested fields), and (3) feeding sites where cranes obtain invertebrate food (from wet meadows, alfalfa fields, grazed pastures, and hay fields). This evaluation of sandhill crane spring habitat is focused on the abundance of suitable roost sites, and the abundance of waste corn and invertebrate food. It is assumed that cranes prefer roosting sites that provide suitable water depth and an unobstructed view (measured as unobstructed channel width). Water depth and width are also characteristics of the channel, and thus the channel becomes the focus of this analysis. Food is evaluated indirectly as the relative abundance of lowland grasslands and alfalfa (invertebrate food), and corn fields.

4.1 Roost-Site Suitability—Multi-Scale Analysis

Cranes likely key on features at both the macro- and micro-habitat levels when selecting roosting and/or feeding sites. For example, the Central Platte Valley crosses the north-south migration route perpendicular to the direction of travel and the river channel (macro-habitat feature) likely signals the arrival at this traditional stopover area. Once in the channel, cranes appear to favor sites that are secure and of the proper water depth (micro-habitat feature) to support roosting. Surrounding features such as corn fields and grasslands may also influence selection of a roost site.

Roost sites are the base of crane activity centers and thus the focus of our assessment of habitat suitability. It is assumed in this assessment that the suitability of roost sites can be characterize and quantified by an evaluation of the depth of water available for roosting and the unobstructed width of the channel. The relationship between roosting depth and discharge is discussed in the assessment, and then used at the site (transect) scale to estimate roosting depth abundance at future alternative flows. The relationship between roosting depth and discharge is then extrapolated to the system scale to estimate the direction of change in roosting depth abundance when only future discharge data are available.

Unobstructed channel width is also a measure of roosting habitat suitability used in this assessment. The GIS database was used to estimate unobstructed channel width at the bridge segment scale, with the focus on channel area > 501 feet. Present conditions (1998 estimates) are compared to various future channel management scenarios that would level islands and thus increase the area of channel width > 501 feet.

4.1.1 Roosting-Depth Abundance

Optimum water depth for roosting sandhill cranes ranges from 4 to 8 inches, with depths greater than 14 inches unsuitable. We selected a depth range of 3-9 inches to represent suitable roosting depth. Two techniques and two sets of transect data were used to evaluate the relationship between discharge and roosting-depth abundance in the 3-9 inch range. PHABSIM was used with data from eight sites located between just downstream of the J-2 return (Site 2) and Chapman (Site 12A), and the SEDVEG Model was used with 29 transects located between Lexington and Chapman, to document the relationship between discharge and roosting depth abundance.

The PHABSIM analysis indicated that roosting depth is maximized between 800 cfs and 1,600 cfs (mean of 1,175 cfs). In order to translate the above relationships into estimates of roosting depth abundance under present conditions, mean March flows (1947-1994) were selected to represent discharge during the spring roosting period. Mean March flows ranged from 2,157 cfs (Overton gauge) to 2,435 cfs (Grand Island gauge), and are greater than flows that would maximize roosting depth in the 3-9 inch depth range. Mean March flows for the action alternatives would provide similar or somewhat increased roosting depth abundance under existing channel morphology when compared to present conditions. The Water Emphasis Alternative is an exception to this generalization and would provide somewhat less roosting depth abundance at each site when mean March flows are used as the measure of central tendency.

Some action alternatives contain provisions for island clearing and leveling for the purpose of increasing various components of channel habitat for target species. Island leveling would radically alter channel morphology at some sites in some bridge segments. To address this situation, the SEDVEG Model was used at the site scale to evaluate future abundance of roosting depth in the 3-9 inch range at 29 transects. Island leveling would vary, with proposed alternatives either supporting no leveling, leveling in two bridge segments, or supporting leveling in six bridge segments and initially directly affecting up to a maximum of 8 miles of channel. Although only a maximum of six transects were altered to simulate island leveling, the analysis indicates that changes would likely occur in all of the 29 transects.

SEDVEG Model output was converted to mean transect length within the 3-9 inch depth category for comparative purposes. Mean length was evaluated for all 29 transects and also for the Lexington to Kearney reach (11 transects) and the Kearney to Chapman reach (18 transects). Present condition analyses indicate that mean transect length in the 3-9 inch depth range would increase under fixed-bed conditions and remain similar under moveable-bed conditions when all 29 transects are compared for years 4-13. At the reach level, mean length would be reduced under both the fixed-bed and moveable-bed conditions in the Lexington to Kearney reach, while mean transect length within the 3-9 inch depth range would increase under both conditions in the Kearney to Chapman reach when compared to years 4-13 under present conditions.

The SEDVEG Model indicates that during the 9 years (years 4-13) of island leveling, there would be an overall (mean value for 29 transects) reduction in roosting depth abundance under all action alternatives except the Governance Committee Alternative: Scenario 2. In the Lexington to Kearney reach, roosting depth abundance would increase under all action alternatives, except the Governance Committee Alternative: Scenario 1, over present conditions during years 4-13. During the same period, action alternatives would support reduced roosting habitat in the Kearney to Chapman reach.

Under the fixed and moveable-bed conditions, mean transect lengths in the 3-9 inch depth range (all 29 transects) are greater than present conditions for all action alternatives except the Governance Committee Scenario 1 Alternative. A similar pattern exists for the Lexington to Kearney and Kearney to Chapman reaches which would support increased mean transect lengths over present conditions for all alternatives except the Governance Committee Scenario 1 Alternative. Under this alternative, only the moveable bed condition in the Kearney to Chapman reach would support an increase in mean transect length in the 3-9 inch depth range.

The above discussion deals with mean values for multiple transects. At the individual transect level, it appears that as habitat increases at managed sites, habitat is generally reduced at non-managed sites. Quite often in reaches exhibiting increases in mean transect length within the 3-9 inch depth range, individual transects experiencing reductions in roosting habitat outnumber those experiencing increases. There are currently no consensus management objectives for sandhill crane habitat, and sandhill crane habitat is not the focus of this study. However, the analysis indicates that while island leveling (simulated in this analysis) for target species benefits may increase roosting depth abundance for sandhill cranes in the vicinity of managed sites, non-managed sites may actually loose roosting habitat (reductions in transect length within the 3-9 inch depth range) under the proposed action alternatives. This may serve to further concentrate sandhill cranes in remaining suitable habitat. Managers should weigh these possibilities carefully.

4.1.2 Unobstructed Channel Width

We compared total channel area and unobstructed channel width > 501 feet from GIS coverages for 1982 and 1998 occurring in 12 bridge segments between Overton and Chapman, NE, to determine present conditions. Area coverage defined as channel in 1982 (includes herbaceous islands) is similar to 1998 defined channel (does not include herbaceous islands), as is unobstructed channel width > 501 feet (calculated as area).

Treating herbaceous islands as part of the channel in 1982 is a logical approach to determining unobstructed area. Photography used in developing the 1982 database was acquired late in the growing season following several months of low flow. The May, June, and July flows recorded at the Overton gage in 1982 were all less than 50 percent of the mean monthly volume calculated for the period of record, and August 1982 flows were only 65.5 percent of mean August flows. These conditions would have permitted herbaceous vegetation to develop on exposed low elevation sediment deposits. Any sediment deposit with sufficient elevation to escape periodic flooding would have developed and supported woody vegetation (and been classified as such in the 1982 GIS coverage) prior to island clearing initiated in the mid-1980's.

Four of the five action alternatives propose some form of island leveling and would thus increase unobstructed channel width to some degree. No individual alternative proposes to manage lands in more than six bridge segments, or more than a total of approximately 8 miles of river channel. Example scenarios of land management activities would increase unobstructed channel width from 21.1 percent to 32.0 percent within 2 or 6 bridge segments. Implementation of any habitat management plan would have site-specific effects, i.e., no two sites are identical and any clearing and leveling would result in different acreage values for unobstructed width—depending upon features at the implementation site. In addition, the actual locations at which management would occur will not be selected until after the preferred alternative is implemented.

Channel management activities within the Central Platte Valley have focused on clearing of woody vegetation from islands within the river. Clearing is currently viewed by the Service as an initial step in the process of increasing unobstructed channel width that would occur with complete island removal. Crane use data from the Platte River Whooping Crane Maintenance Trust, Inc. (www.whoopingcrane.org) indicate high crane usage between Kearney and Shelton (bridge segments 8, 7, and 6) and between Alda and State Highway 281 (segment 3). These four bridge segments have likely received the majority of channel management efforts, and in 1998 and 1999, accounted for over 60 percent of sandhill crane usage. However, such usage cannot be explained by abundant "wide channels" (other segments have as much or more unobstructed width) when cleared islands are treated as obstructions. These four segments support 30.0 percent of the total channel area, 30.0 percent of unobstructed channel width greater than 501 feet, 34.5 percent of lowland grasses, and 33.3 percent of the corn within 3.5 miles of the river channel. It appears that we do not completely understand the mechanisms of crane habitat selection along the Platte River.

There is no "official" management objectives for spring sandhill crane habitat. However, dispersing use throughout the river from Lexington to Chapman is one option. If dispersal is a management goal, then alternatives containing plans for island clearing and leveling dispersed throughout the crane-use area would likely prove most beneficial. Since four bridge segments currently support over 60 percent of crane usage, it would be interesting to disperse management activities around and through these four segments—for example in segments 11-9, 5-4, and 2—and observe crane response.

4.1.3 Discharge

Roosting suitability at the system scale was evaluated via discharge data from various stream gauges located on the North, South, and Platte Rivers. Alternative data were compared to present conditions on an annual and seasonal basis (February-April and May-July). Spring flows directly affect conditions for roosting cranes, and early to mid summer (May 15-July 15) flows can affect the success of cottonwood establishment on exposed substrates. Occupation of channel sites by woody vegetation such as cottonwoods during periods of low flow has been linked to channel narrowing. It is assumed that future changes in stream flow would be reflected as changes in sandhill crane roosting habitat through the same relationships between discharge and roosting depth abundance previously described for site-scale evaluations. Unfortunately, few cross-sectional transects are available outside the Lexington to Chapman reach of the Platte River. We are however, assuming that the relationships described for the central Platte River also exist in the North Platte River channel, and changes in future measures of discharge would represent future changes in roosting depth abundance when compared to present conditions.

Although various South Platte River gauges were evaluated for changes in flow that might affect sites used by cranes downstream, sandhill cranes do not traditionally use the South Platte River. Detected changes in flow were small and were obscured once flows from the South Platte and North Platte Rivers merged to form the Platte River. For these reasons, only changes in discharge for the North Platte and Platte Rivers are discussed.

4.1.3.1 North Platte River

Two North Platte River sites traditionally used by sandhill cranes were evaluated for possible changes in discharge that could affect roosting suitability. Discharge at Lewellen would follow a pattern of somewhat lower flows during February and March and higher flows during April under all action alternatives. The one exception to this pattern would be slightly higher (+6 cfs) March flows under the Wet Meadow Alternative. Flows during the cottonwood seed production period—when compared to present conditions— would be mixed during May, lower in June, and higher in July (Figure SC-9).

Note that June supports the highest mean monthly flows for this period (May-July) under present conditions, and although July flows for the action alternatives would be greater than present condition July flows, these flows would be less than June present condition flows (Figure SC-9). Future June and July flows lower than the historic June mean monthly flow may expose non-vegetated substrate during the cottonwood seed production period. The future response of woody vegetation to this type of discharge pattern is difficult to interpret. However, it is likely that under the action alternatives some additional woody vegetation would become established within the active channel at this site.

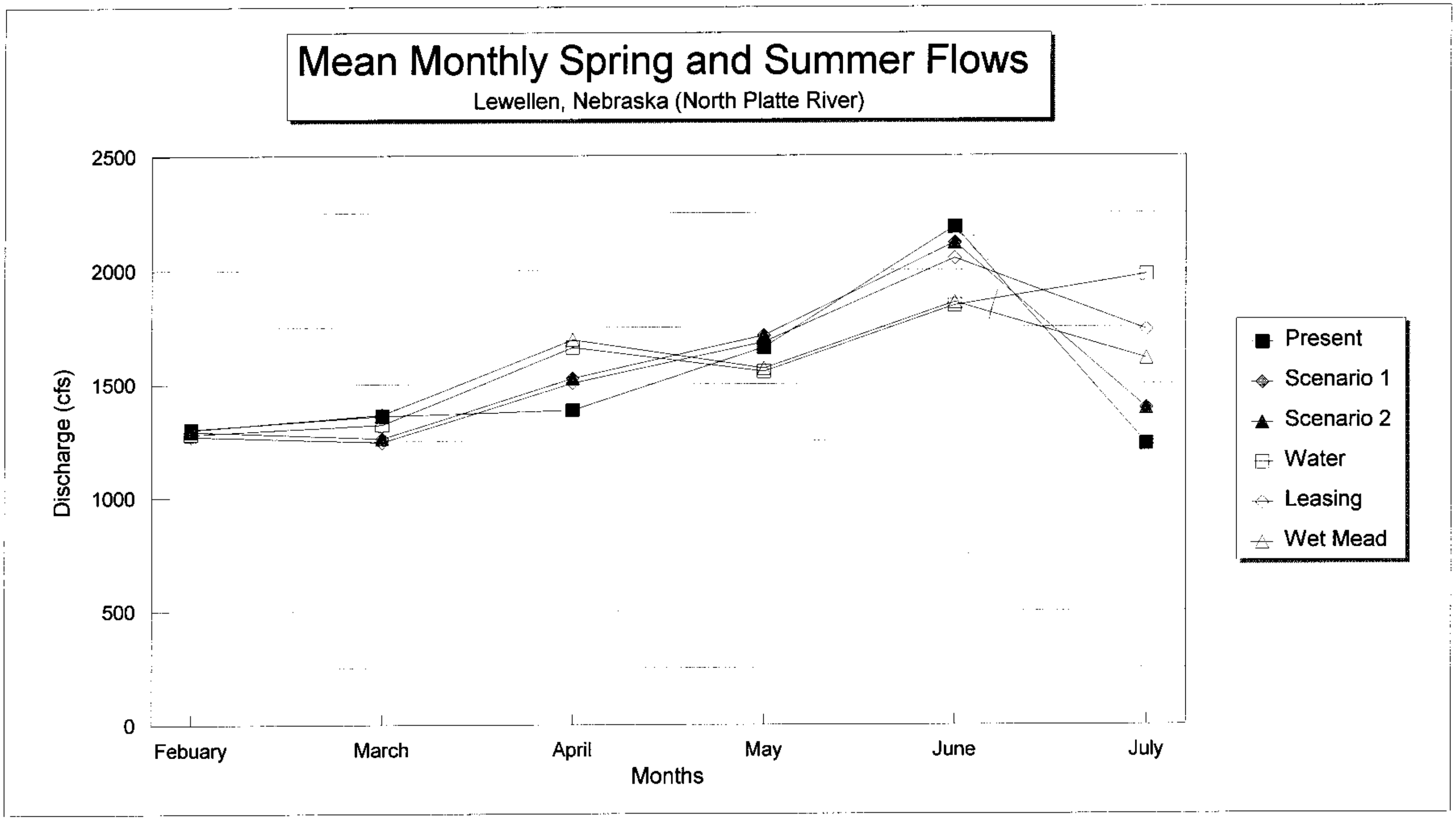


Figure SC-9. North Platte River mean monthly discharge passing Lewellen, Nebraska under present conditions and five action alternatives. Note that the monthly values for each alternative are connected by lines to aid illustration and do not represent continuous data.

The second site evaluated on the North Platte River is located between Sutherland and North Platte, Nebraska, although most of the use by the estimated 150,000 sandhill cranes occurs between Hershey and North Platte. The average volume of Kingsley Dam spills would increase under all action alternatives except the Wet Meadow Alternative. However, the frequency in which these spills would occur would be reduced under all action alternatives. The average annual discharge of the North Platte River at North Platte would also be reduced— indicating that potential benefits to the river channel from increased spill volumes would likely not be realized. Seasonally, February flows would be mixed, but similar to present conditions, March flows would also be mixed, April flows somewhat lower, May mixed, and June and July flows lower than present conditions (Figure SC-10).

A reduction in the frequency of spills from Kingsley Dam, reduced average annual discharge passing North Platte, and reduced flows in June and July, indicate the possibility of additional establishment of woody vegetation within the Sutherland to North Platte reach of the North Platte River. Woody vegetation establishment would likely result in channel narrowing and perhaps deeper flows during the spring migration period, and an assumed reduction in roosting habitat suitability. Established survey sites exist in this reach but have not been re-surveyed since the early 1980's. Current survey information is needed for this reach. Both the Lewellen to Clear Creek WMA and this reach should be a candidates for research and monitoring studies under the Adaptive Resource Management Process. Data are needed to assess whether management actions (changes in discharge) designed to benefit target species downstream may affect sandhill crane roosting habitat in the Lewellen to Clear Creek WMA and/or the Sutherland to North Platte reaches of the North Platte River.

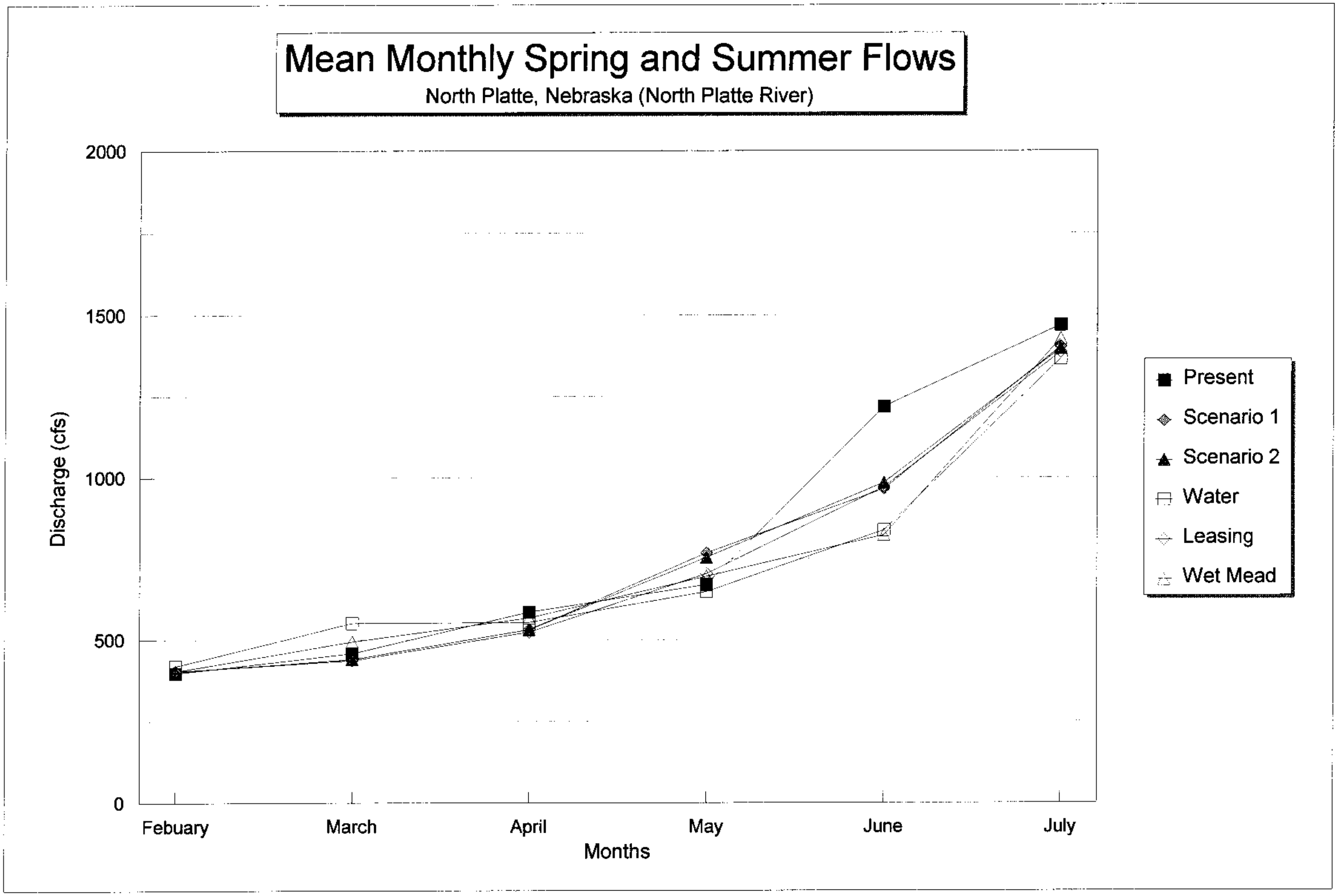


Figure SC-10. North Platte River mean monthly discharge passing North Platte, Nebraska under present conditions and five action alternatives. Note that the monthly values for each alternative are connected by lines to aid illustration and do not represent continuous data.

4.1.3.2 Platte River

Data from several stream gauges within the Platte River Basin were inspected to identify any changes from present conditions that may affect sandhill crane roosting habitat in the future. In general, average annual discharge would increase at most sites within the basin. This is true for the Platte River at North Platte, for withdrawals at the Central Diversion, for J-2 return flows, and for water passing Overton, Odessa, and Grand Island. The river between the Central Diversion and the J-2 return would support somewhat reduced flows, but this reach no longer supports sandhill cranes.

We also evaluated potential changes in discharge during the spring migration period (February-April) and the summer period (May-July) when cottonwood trees release their seeds and young plants become established on exposed sediment deposits. Mean monthly flows would be less than present conditions in February, mixed in March, and greater than present conditions in April for all action alternatives. This pattern exists at the Overton, Odessa, and Grand Island gauges (Figures SC -11, SC-12, and SC-13). As discussed in the site-scale evaluation of roosting suitability, we are assuming that flows less than present conditions would increase transect length in the 3-9 inch depth range, while flows greater than present conditions would reduce roosting depth abundance.

Mean monthly flows during the summer months would be greater than present conditions during May, less than present conditions in June, and mixed in July at all three gauges. The future response of woody vegetation to this type of discharge pattern is difficult to interpret. However, for the purposes of this analysis, we are assuming that vegetation has likely established on all suitable sites above the highest mean monthly flow (present conditions June) of the summer months. Given this assumption, additional woody vegetation may become established via lower mean June flows under the action alternatives. Additional vegetation in the active channel would reduce unobstructed channel width and may alter the stage-discharge relationship used to establish the present condition argument for roosting depth abundance.

There are a number of uncertainties involved in the above assessment of changes in flow and the effect on roosting depth abundance at the Platte River system scale. First, the evaluation is based on mean monthly discharge data. Individual years would exhibit a range of variation in flow. Second, it is unknown how the Service will utilize water in the Environmental Account (EA) stored in Lake McConaughy. The mean monthly hydrology data used in the above assessment does not include EA water. If vegetation does become initially established in June, will it be eliminated by higher flows the following May? Finally, it is unknown where island leveling would occur and how any particular site within the channel would respond to these management activities. Research and monitoring studies will occur under the Adaptive Resource Management Process. The response of woody vegetation to changes in flows and island leveling should be the focus of these studies.

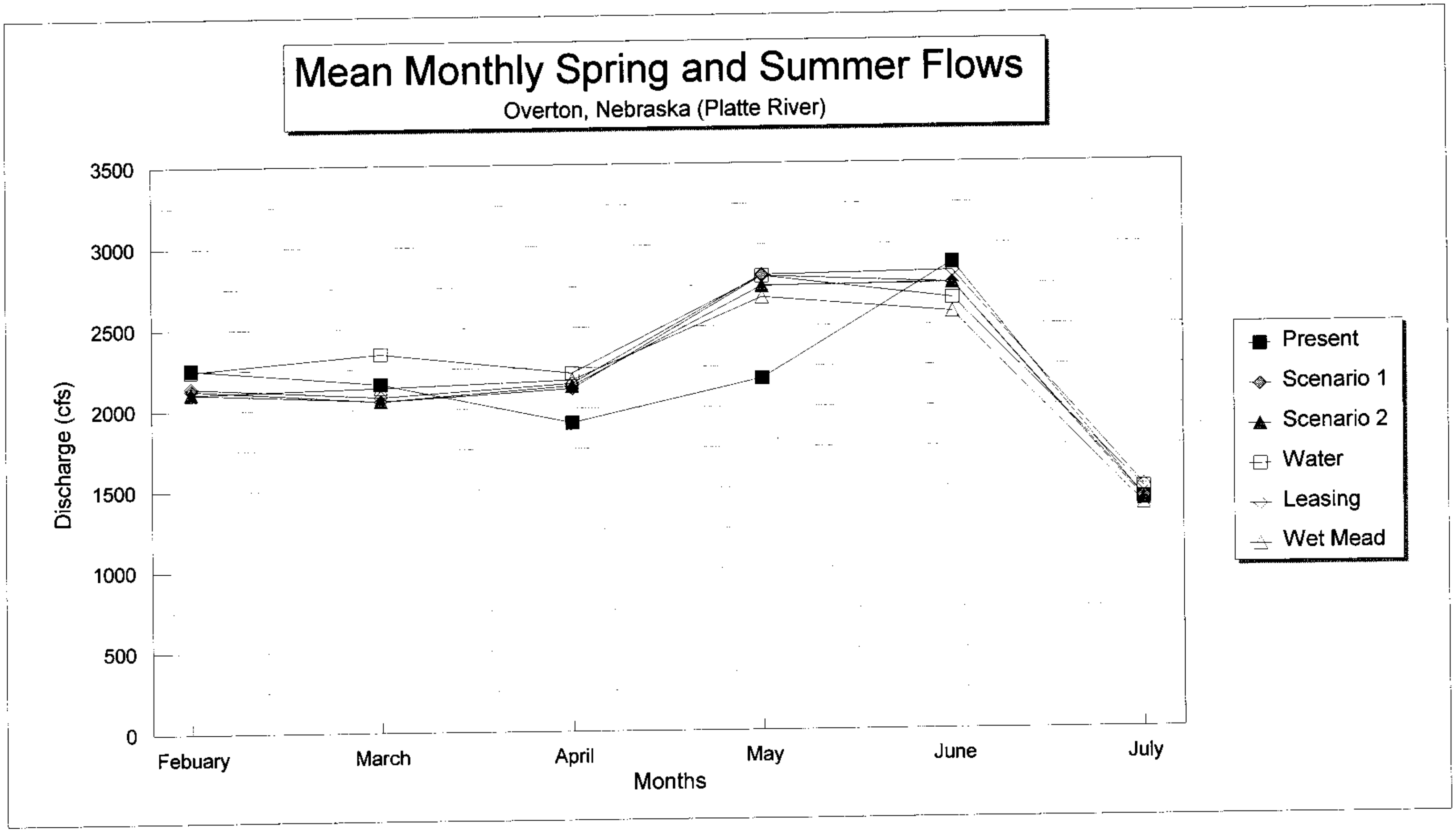


Figure SC-11. Platte River mean monthly discharge passing Overton, Nebraska under present conditions and five action alternatives. Note that the monthly values for each alternative are connected by lines to aid illustration and do not represent continuous data.

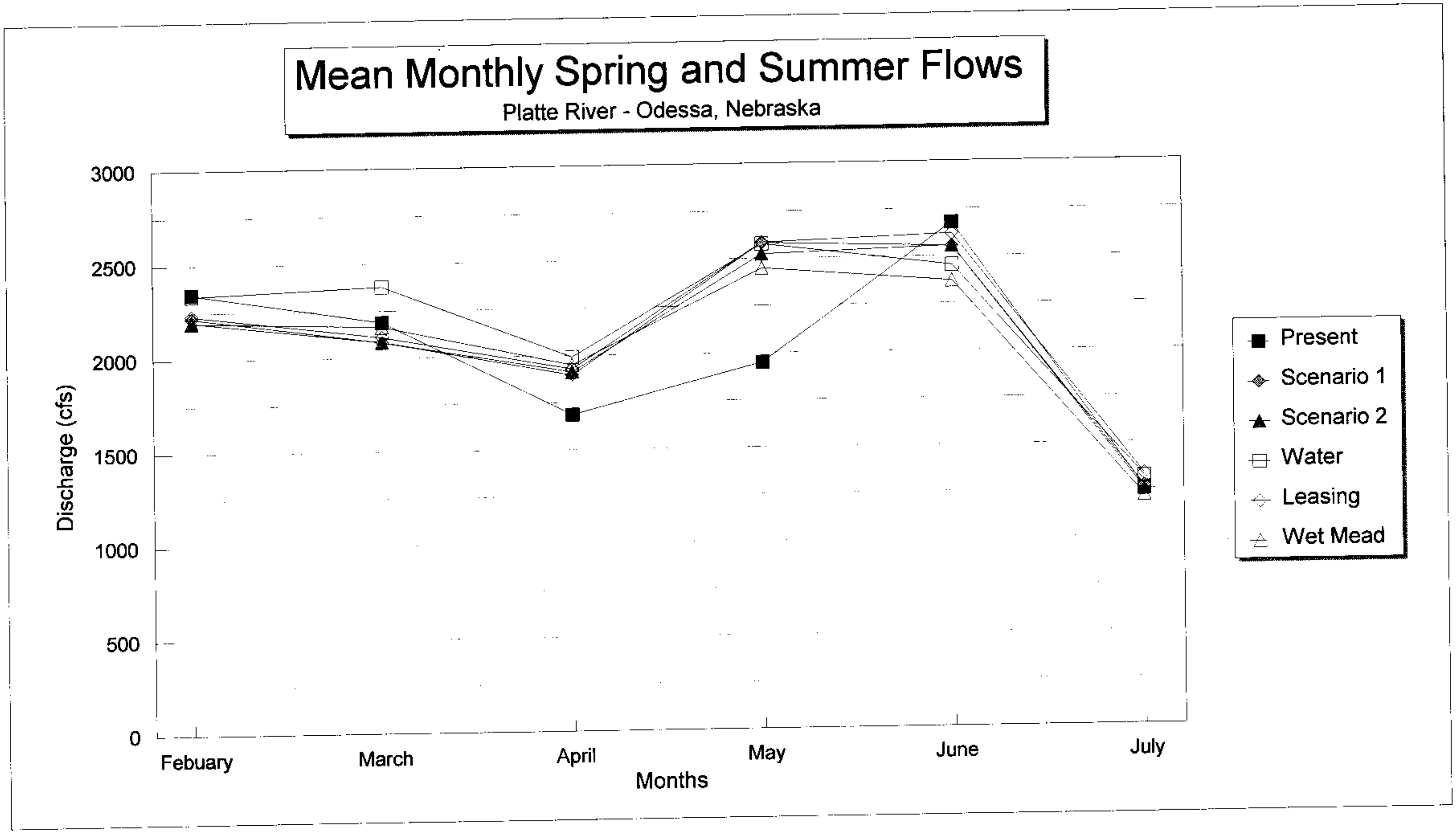


Figure SC-12. Platte River mean monthly discharge passing Odessa, Nebraska under present conditions and five action alternatives. Note that the monthly values for each alternative are connected by lines to aid illustration and do not represent continuous data.

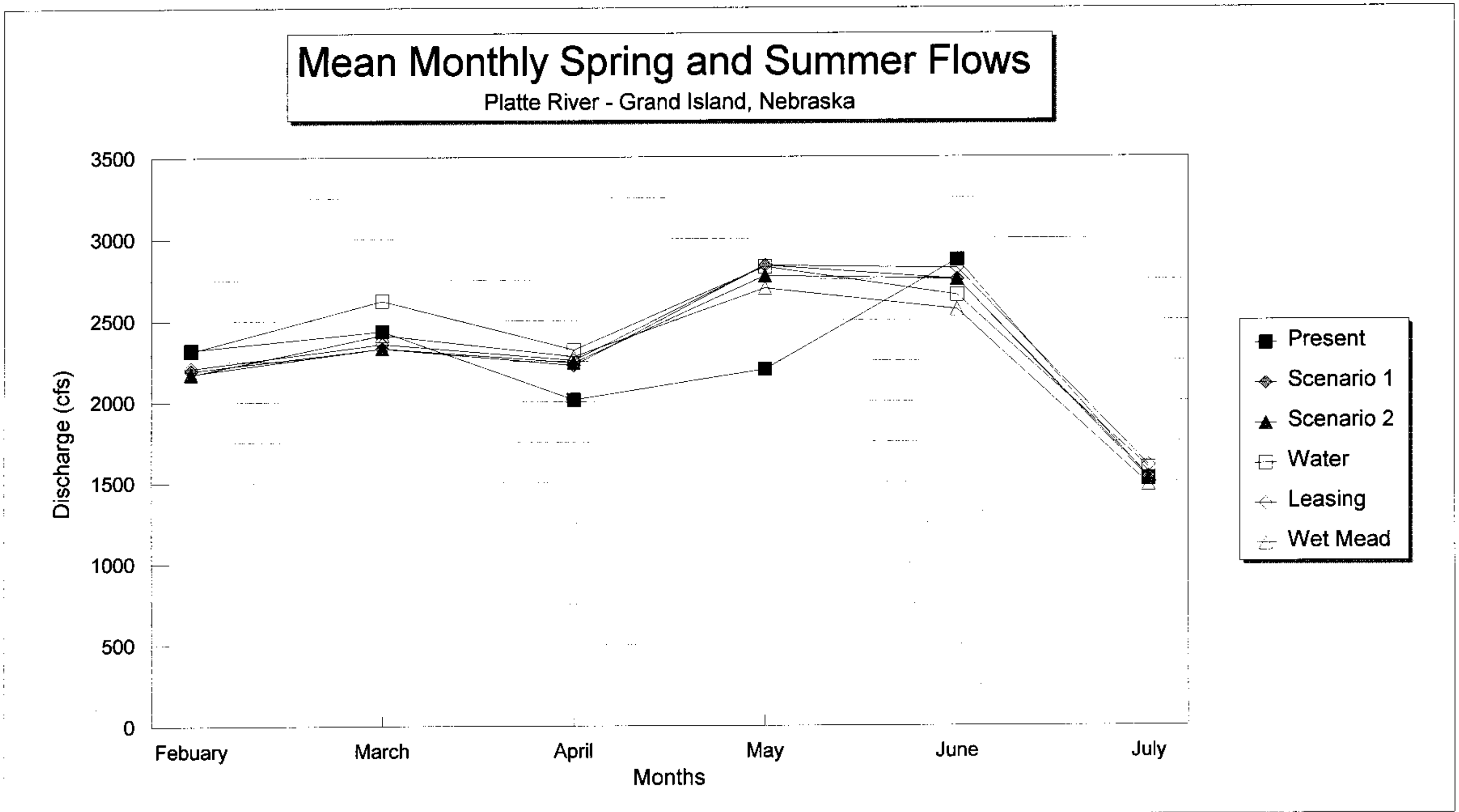


Figure SC-13. Platte River mean monthly discharge passing Grand Island, Nebraska under present conditions and five action alternatives. Note that the monthly values for each alternative are connected by lines to aid illustration and do not represent continuous data.

4.2 Food Suitability—Bridge Segment Scale

The U.S. Geological Survey is currently attempting to replicate components of the Service's 1981 study (Krapu 2003). However, until these data are available, conclusions on the abundance of waste corn and its ability to provide adequate food for all ecosystem components can not be made. As discussed previously, harvesting efficiency has increased since the 1981 study, numbers of waterfowl using the Central Platte Valley have increased, cranes are foraging further from the Platte River, and fat storage in larger sandhill cranes and white-fronted geese has been reduced (Krapu et al. in press). The abundance and adequacy of waste corn to provide food for sandhill cranes and other wildfowl should be the focus of continuing studies.

Some action alternatives would convert cropland (e.g., corn ground) to grassland. If the abundance of waste corn is becoming an issues for sandhill cranes and other wildfowl, then this management activity should be carefully evaluated through the Adaptive Resource Management Process.

5.0 Conclusions

This study was conducted in support of the Platte River Programmatic EIS process. That process evaluates the effects of changing stream flows and managing additional lands along the Platte River for the benefit of whooping cranes, interior least terns, piping plovers, and pallid sturgeon. This assessment addresses sandhill cranes and their spring use of habitat along the North Platte and Platte Rivers in central Nebraska, and the potential effects of six alternatives currently being evaluated in the Platte River Programmatic EIS process. Predicted conditions of indicators for sandhill crane roosting and feeding habitat suitability resulting from implementation of the five action alternatives are compared to present conditions in Table SC-25.

Sandhill crane roosting habitat is the focus of this assessment, and cranes roost in the open channel of the North Platte and Platte Rivers. Therefore, a large portion of this assessment is devoted to comparisons between future channel conditions and existing (present) conditions. For example, water depth and channel width under existing channel conditions support over 500,000 sandhill cranes each spring. Existing mean March flows provide depths that support roosting, but are higher than flows that would maximize roosting depth abundance in the 3-9 inch depth range. Mean March flows would be lower than present conditions under four of the five action alternatives, and therefore increase roosting depth abundance in an unaltered future Platte River channel. However, the channel would be altered by island leveling in four of the five action alternatives. In the short-term (years 4-13), island clearing in the Platte River channel would increase unobstructed channel width and roosting depth abundance at managed sites and reduce roosting habitat (transect length within the 3-9 inch depth range) at non-managed sites (Table SC-25). This would likely result in more cranes using managed sites.

Table SC-25. Summary of impact indicator values for sandhill cranes by alternative.

Resource Issue/Scale/ Impact Indicator/Measurement Unit	Alternatives					
	Present Conditions	Governance Committee		Water Emphasis	Water Leasing	Wet Meadow
		Scenario 1 (1980 cfs)	Scenario 2 (3000 cfs)			
Roosting suitability						
Site scale - roosting depth availability						
PHABSIM mean March flows (cfs)[1]	2435	2327	2329	2622	2355	2410
SEDVEG # transects reduced (9 years)						
Lexington-Kearney (n = 11)	-	-10	-7	-9	-7	-8
Kearney-Chapman (n = 18)	-	-11	-15	-14	-14	-13
Bridge segment scale - unobstructed channel width > 501 feet (acres)	3016	3016	3981	3651	3981	3981
System scale - discharge						
Lewellen (mean cfs)						
February	1303	1294	1294	1280	1271	1301
March	1360	1260	1260	1321	1244	1366
April	1385	1526	1526	1662	1505	1696
May	1662	1714	1714	1555	1685	1569
June	2190	2119	2119	1845	2052	1859
July	1236	1394	1394	1981	1739	1613
Kingsly Dam - ave. annual spill (kaf)	275	313	316	374	352	258
Frequency of spills (years)	1.5	3.4	3.4	2.3	3.6	3.2
North Platte - ave. annual flow (kaf)	483	464	463	464	458	459
North Platte (mean cfs)						
February	398	402	402	420	404	404
March	458	440	440	551	436	494
April	586	532	532	554	524	568
May	670	768	754	648	704	696
June	1219	965	984	837	971	823
July	1469	1403	1397	1366	1386	1428
Invertebrate food suitability						
Bridge-segment scale - acres in lowland grassland	31021	32660	32660	31894	32660	37353

[1]Although flows from the Overton, Odessa/Kearney, and Grand Island gauges were evaluated, only the mean March flows for Grand Island are presented in this summary.

No island clearing or leveling would occur on the North Platte River, but flows would change to benefit target species downstream in the Platte River. In the Lewellen to Clear Creek WMA reach, spring flows would be somewhat higher than present conditions in April, but these changes alone would likely not affect crane roosting habitat. During summer however, June flows would be lower than existing (present) conditions and July flows would be lower than existing June flows. Lower flows may expose sediment deposits and these substrates may be colonized by woody vegetation. Additional woody vegetation in the active channel would likely result in reduced channel width and deeper water. Such changes would result in reduced crane roosting habitat.

A similar situation exists in the Sutherland to North Platte reach of the North Platte River. Here however, the highest flows of the May-July cottonwood seed production period would occur in July.

Higher flows in July would likely eliminate most of the vegetation that may become established in June. This reach would also experience a reduced frequency of spills from Kingsley Dam and a reduction in average annual flows in the North Platte River under the action alternatives. Together, these changes in flow may result in a reduction of roosting habitat in this reach.

Summer flows at Overton, Odessa, and Grand Island on the Platte River would follow a pattern similar to the flow pattern in the Lewellen to Clear Creek WMA reach of the North Platte River. June flows under the action alternatives would be lower than existing June flows and July flow would be lower than all June flows. Whether this pattern would result in increased woody vegetation depends on may factors including island leveling and how water in the Environmental Account is used for the central Platte River.

While this analysis has focused on roosting habitat and the river channel, the issue of food abundance and its adequacy to meet the needs of sandhill cranes and other wildfowl can not be addressed at this time. However, there are indications that food may be becoming an issue of concern for future management.   For example, harvesting efficiency has increased since the last comprehensive studies in the late 1970's, numbers of waterfowl using the Central Platte Valley have increased, cranes are foraging further from the Platte River, and fat storage in larger sandhill cranes and white-fronted geese has been reduced. The abundance and adequacy of waste corn to provide food for sandhill cranes and other wildfowl should be the focus of continuing studies.

In conclusion, as stated several times in this assessment, sandhill cranes are not the focus of proposed actions under evaluation within the Platte River Programmatic EIS process. The results of implementing any of the proposed five action alternatives on sandhill crane habitat would be mixed. Sandhill cranes using the Platte River would likely benefit from an increase in roosting depth abundance and unobstructed channel width at managed sites.   However, when data from individual transects are inspected, it appears that while roosting depth at managed sites increases, many non-managed sites experience a reduction in roosting depth abundance. Reductions in habitat at non-managed sites may result in cranes becoming more concentrated at managed sites. Potential channel changes from island leveling and changes in flows on the North Platte River should be monitored for effects to sandhill crane habitat.

LITERATURE CITED

Armbruster, M.. J., and A. H. Farmer. 1981. Draft sandhill crane habitat suitability model. Pages 136-143 *in* J. C. Lewis, ed. Proceedings 1981 crane workshop. National Audubon Society, Tavernier, FL.

Bovee, K. D. 1982. A guide to stream habitat analysis using the instream flow incremental methodology. Instream Flow Information Paper 12. U.S. Fish and Wildlife Service, FWS/OBS-82/26. 248 pp.

Bovee, K. D., and R. T. Milhous. 1978. Hydraulic simulation in instream flow studies: theory and techniques. Instream Flow Information Paper 5. U.S. Fish and Wildlife Service, FWS/OBS-78/33. 130 pp.

Currier, P. J., and J. W. Ziewitz. 1987. Application of a sandhill crane model to the management of habitat along the Platte River. Pages 315-325 *in* J. C. Lewis, ed. Proceedings 1985 crane workshop. Platte River Whooping Crane Critical Habitat Maintenance Trust, Grand Island, NE.

Currier, P. J., G. R. Lingle, and J. G. VanDerwalker. 1985. Migratory bird habitat on the Platte and North Platte Rivers in Nebraska. The Platte River Whooping Crane Critical Habitat Maintenance Trust, Grand Island, NE. 183 pp.

Eschner, T. R., R. F. Hadley, and K.D. Crowley. 1983. Hydrologic and morphologic changes in channels of the Platte River Basin in Colorado, Wyoming, Nebraska: a historical perspective. Pages ____-_____*in* ________ ed. Hydrologic and geomorphic studies of the Platte River Basin. U.S. Geological Survey Professional Paper 1277-A. Washington, D.C.

Farrar, J. 1998. Snow geese—a riddle wrapped in a mystery inside an enigma. Nebraska Game and Parks.

Friedman, J. M., W. R. Osterkamp, M. L. Scott, and G. T. Auble. 1998. Downstream effects of dams on channel geometry and bottomland vegetation: regional patterns in the Great Plains. Wetlands 18(4):619-633.

Johnson, W. C. 1998. Adjustment of riparian vegetation to river regulation in the Great Plains, USA. Wetlands 18(4):608-618.

Johnson, W. C., and S. E. Boettcher. 1999. Restoration of the Platte River: what is the target? Land and Water.

Krapu, G. L. 1999. Sandhill cranes and the Platte River. Pages 103-117 *in* K.P. Able, ed. Gatherings of angels. Chapter 7. Cornell University Press, Ithaca, NY. 193 pp.

Krapu, G.L. 2003. The role of the Platte River in contributing to needs of the midcontinental population of sandhill cranes. Unpublished Report. U.S. Geological Survey. Jamestown, ND.

Krapu, G. L, D. E. Facey, E. K. Fritzell, and D. H. Johnson. 1984. Habitat use by migrant sandhill cranes in Nebraska. J. Wildl. Manage. 48:407-417.

Krapu, G. L, G. C. Iverson, K. J. Reinecke, and C. M. Boise. 1985. Fat deposition and usage by Arctic-nesting sandhill cranes during spring. Auk 102:362-368.

Krapu, G. L., B. Gehring, D. E. Facey, and M. I. Meyer. 1987. A resource inventory of sandhill cranes staging areas in Nebraska. Pages 364-370 *in* J. C. Lewis, ed. Proceedings 1985 crane workshop. Platte River Whooping Crane Critical Habitat Maintenance Trust, Grand Island, NE.

Krapu, G.L., K.J. Reinecke, D.G. Jorde, and S.G. Simpson. 1995. Spring-staging ecology of midcontinent greater white-fronted geese. J. Wildl. Manage. 59:736-746.

Krapu, G.L., D.A. Brandt, and D.A. Buhl. In press. Evidence of a decline in fat storage by midcontinental sandhill cranes. Proceedings of the Ninth North American Crane Workshop.

Melvin, S. M. And S. A. Temple. 1981. Migrational ecology of sandhill cranes: a review. Pages 73-87 *in* J. C. Lewis, ed. Proceedings 1981 crane workshop. National Audubon Society, Tavernier, FL.

Milhous, R. T., D. L. Wegner, and T. Waddle. 1984. Users' guide to the physical habitat simulation system (PHABSIM). Instream Flow Information Paper 11. U.S. Fish and Wildlife Service, FWS/OBS-81/13 (revised).

Murphy, P.J., and T.J. Randle. 2003. Platte River channel: History and restoration. Draft report. U.S. Bureau of Reclamation, Denver, CO.

Murphy, P.J., T.J. Randle, and R.K. Simons. 2001. Platte River sediment transport and riparian vegetation model. Draft Technical Report - Technical Service Center, Bureau of Reclamation. Denver. 63 pp.

Norling, B.S., S.H. Anderson, and W.A. Hubert. 1990. The influence of water depth, unobstructed area, and disturbance features on the selection of roost sites by sandhill cranes along the Platte River, Nebraska. Wyoming Cooperative Wildlife Research Unit Project Report to Bureau of Reclamation, Grand Island, Nebraska.

Peake, J., M. Peterson, and M. Laustrup. 1985. Interpretation of vegetation encroachment and flow relationships in the Platte River by use of remote sensing techniques. Unpublished Report - Department of Geography and Geology, University of Nebraska, Omaha. 36 pp.

Platte River Whooping Crane Maintenance Trust, Inc. 1998. Habitat management, restoration, and acquisition plan for the Big Bend Reach of the Platte River in central Nebraska. Platte River Whooping Crane Maintenance Trust, Inc., Wood River, Nebraska.

Poff, N. L., J. D. Allan, M. B. Bain, J. R. Karr, K. L. Prestegaard, B. D. Richter, R. E. Sparks, and J. C. Stromberg. 1997. The natural flow regime—a paradigm for river conservation and restoration. BioScience 47(11):769-784.

Randle, T.J., a nd M.A. Samad. 2003. Platte River flow and sediment transport between North Platte and Grand Island, Nebraska (1895-1999). U.S. Bureau of Reclamation. Denver, CO.

Reinecke, K.J., and G.L. Krapu. 1986. Feeding ecology of sandhill cranes during spring migration in Nebraska. J. Wildl. Manage. 50(1):71-79.

Simons & Associates, Inc. 2000. Physical history of the Platte River in Nebraska: focusing upon flow, sediment transport, geomorphology, and vegetation. Final Report—Delivery Order No.114. Fort Collins, CO.

Simons, R.K., and D.B. Simons. 1994. An analysis of Platte River channel changes. Pages ___-____ *in* S.A. Schumm and B.R. Winkley, eds. The variability of large alluvial rivers. ASCE Press.

Sparling, D. W., and G. L. Krapu. 1994. Communal roosting and foraging behavior of staging sandhill cranes. Wilson Bulletin 106(1):62-77.

Stanford, J. A., J. V. Ward, W. J. Liss, C. A. Frissell, R. N. Williams, J. A. Lichatowich, and C. C. Coutant. 1996. A general protocol for restoration of regulated rivers. Regulated Rivers: Research and Management 12:391-413.

Tacha, T. C., P. A. Vohs, and G. C. Iverson. 1984. Migration routes of sandhill cranes from mid-continental North America. J. Wildl. Manage. 48(3):___-___.

U.S. Bureau of Reclamation. 1989. Prairie Bend Unit— P-S MBP, Nebraska. Regional Director’s Planning Report/Draft Environmental Statement: Hydrology Appendix, Volume 1 of 3.

U.S. Fish and Wildlife Service. 1981. The Platte River ecology study: special research report. U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, ND.

VerCauteren, T. L. 1998. Local scale analysis of sandhill crane use of lowland grasslands along the Platte River, Nebraska. Master of Science Thesis, University of Nebraska, Lincoln.

Walkinshaw, L. H. 1956. Two visits to the Platte Rivers and their sandhill crane migration. Nebraska Bird Review 24:18-21.

Williams, G.P. 1978. The case of the shrinking channels—the North Platte and Platte Rivers in Nebraska. U.S. Geological Survey Circular 781. 48 pp.

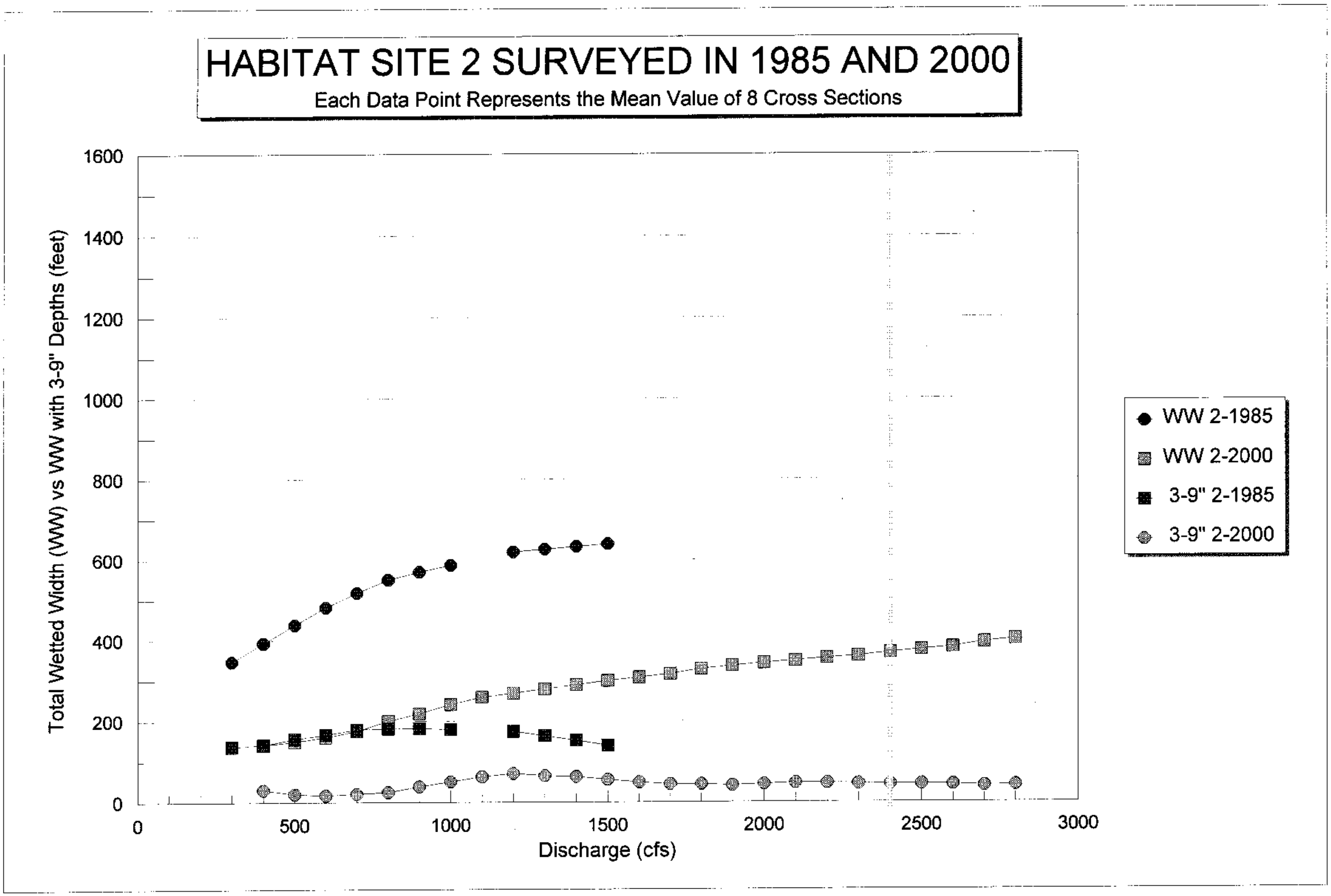
Ziewitz, J.W. 1989. Whooping crane riverine roosting habitat suitability model. Pages 71-81 *in* _______________ed. Proceedings of the 1988 North American crane workshop.

Sandhill Cranes Appendix

SPRING HABITAT USE IN NEBRASKA

Biological Attachment A

This attachment contains discharge-roosting depth abundance relationship information for eight habitat transect sites on the Platte River in central Nebraska. Sites were originally surveyed between 1983 and 1986, and were re-surveyed between 1998 and 2001. Data for each site includes a graphic comparison of total wetted width and wetted width supporting 3-9 inch depths, and supporting tabular data, for each survey period.



1985 (2-3) Measured Flow = 642 cfs
2000 2 Measured Flow = 984 cfs

Site 2-3

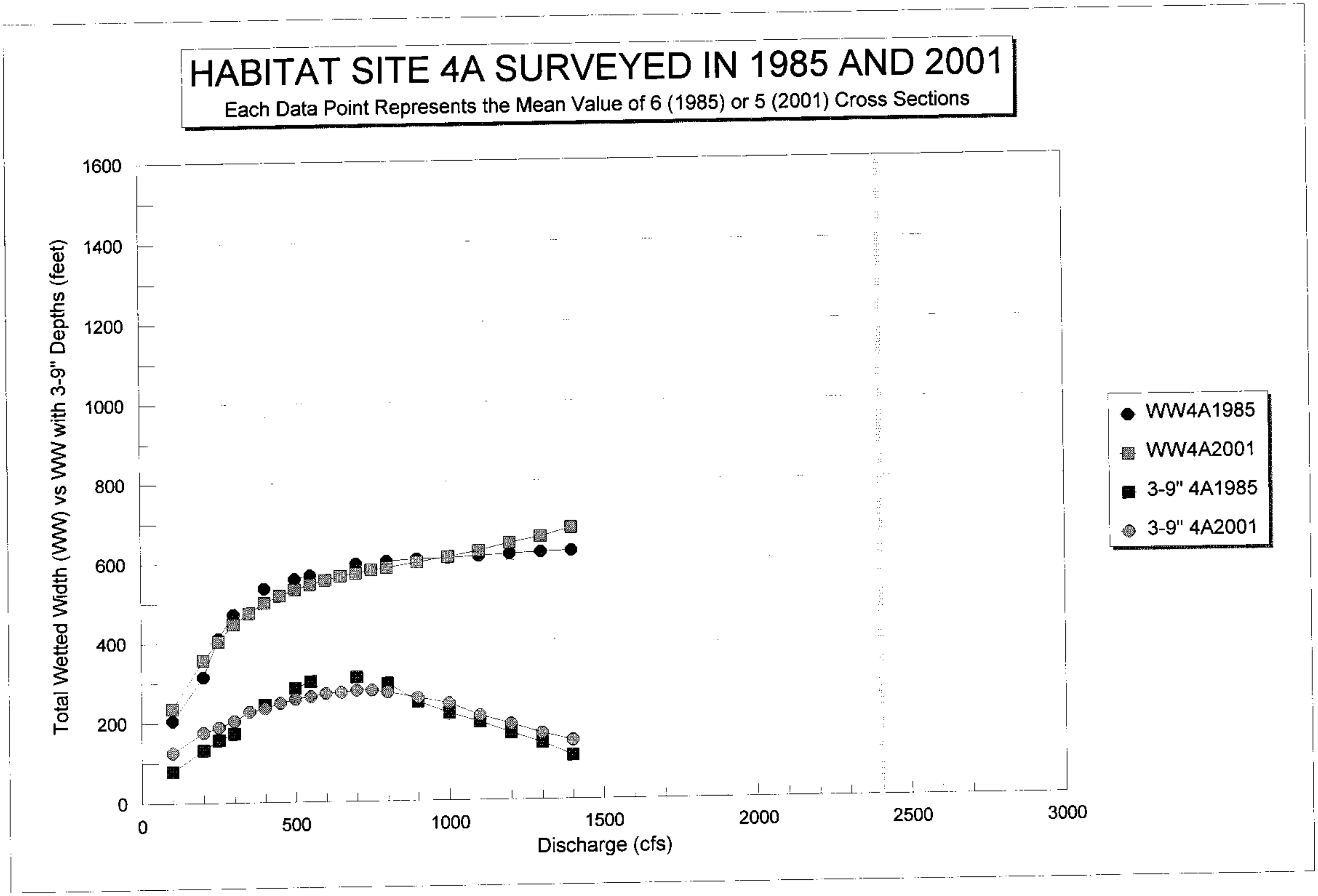
Summary of eight cross sections
Measured Flow (Q) = 642 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	WW (3-12"	Percent WW (3-9")	Percent WW (3-12"	Mean Depth
300	347.32	254.36	117.23	62.69	137.13	191.67	39.48	55.19	0.62
400	393.19	306.43	164.50	88.44	141.93	217.99	36.10	55.44	0.69
500	438.76	355.32	199.33	131.23	155.99	224.09	35.55	51.07	0.75
600	482.20	393.17	226.87	166.46	166.30	226.71	34.49	47.02	0.79
700	517.80	426.90	247.44	191.74	179.46	235.16	34.66	45.42	0.83
800	550.41	462.12	280.82	214.78	181.30	247.34	32.94	44.94	0.87
900	569.57	493.29	311.33	232.46	181.96	260.83	31.95	45.79	0.92
1000	586.80	518.34	339.00	247.18	179.34	271.16	30.56	46.21	0.97
1200	619.03	562.36	388.33	298.86	174.03	263.50	28.11	42.57	1.06
1300	626.15	577.57	414.29	319.32	163.28	258.25	26.08	41.24	1.11
1400	632.30	590.80	438.88	344.11	151.92	246.69	24.03	39.01	1.16
1500	638.88	600.06	460.36	366.91	139.70	233.15	21.87	36.49	1.21

Site 2-2000 Summary of eight cross sections

Measured Flow Q 984 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	WW (3-12"	Percent WW (3-9")	Percent WW (3-12"	Mean Depth
400	141.20	134.32	104.11	86.64	30.21	47.68	21.40	33.77	1.39
500	149.08	140.32	119.64	102.17	20.68	38.15	13.87	25.59	1.53
600	160.37	147.36	130.42	116.82	16.94	30.54	10.56	19.04	1.62
700	175.29	157.30	136.08	125.41	21.22	31.89	12.11	18.19	1.66
800	199.85	166.51	141.49	134.24	25.02	32.27	12.52	16.15	1.62
900	219.00	186.38	147.98	138.43	38.40	47.95	17.53	21.89	1.63
1000	241.44	206.63	155.92	143.23	50.71	63.40	21.00	26.26	1.62
1100	259.33	225.41	162.56	149.76	62.85	75.65	24.24	29.17	1.64
1200	268.70	244.27	173.67	156.57	70.60	87.70	26.27	32.64	1.70
1300	279.41	258.16	193.21	162.50	64.95	95.66	23.25	34.24	1.76
1400	289.34	268.66	206.26	172.64	62.40	96.02	21.57	33.19	1.81
1500	299.71	277.37	221.71	185.87	55.66	91.50	18.57	30.53	1.85
1600	308.09	286.39	237.67	202.48	48.72	83.91	15.81	27.24	1.90
1700	316.32	295.19	251.18	214.49	44.01	80.70	13.91	25.51	1.95
1800	328.77	304.30	260.37	228.44	43.93	75.86	13.36	23.07	1.97
1900	336.28	310.66	270.13	243.15	40.53	67.51	12.05	20.08	2.02
2000	342.67	320.08	276.21	253.45	43.87	66.63	12.80	19.44	2.06
2100	348.95	329.56	282.51	261.51	47.05	68.05	13.48	19.50	2.11
2200	355.11	335.96	289.36	270.64	46.60	65.32	13.12	18.39	2.15
2300	360.58	341.97	297.09	275.99	44.88	65.98	12.45	18.30	2.20
2400	369.03	347.56	303.27	281.22	44.29	66.34	12.00	17.98	2.22
2500	376.06	352.98	308.71	287.10	44.27	65.88	11.77	17.52	2.25
2600	382.40	357.61	313.97	293.65	43.64	63.96	11.41	16.73	2.28
2700	394.51	363.07	323.25	300.47	39.82	62.60	10.09	15.87	2.28
2800	402.24	371.60	330.05	305.11	41.55	66.49	10.33	16.53	2.30



1985 (4A3) Measured Flow = 227 cfs
2001 4A Measured Flow = 468 cfs (284 cfs and 653 cfs)

Habitat Transect Site 4A-3 Summary of 6 Cross Sections Data Reformulated 12-04-01

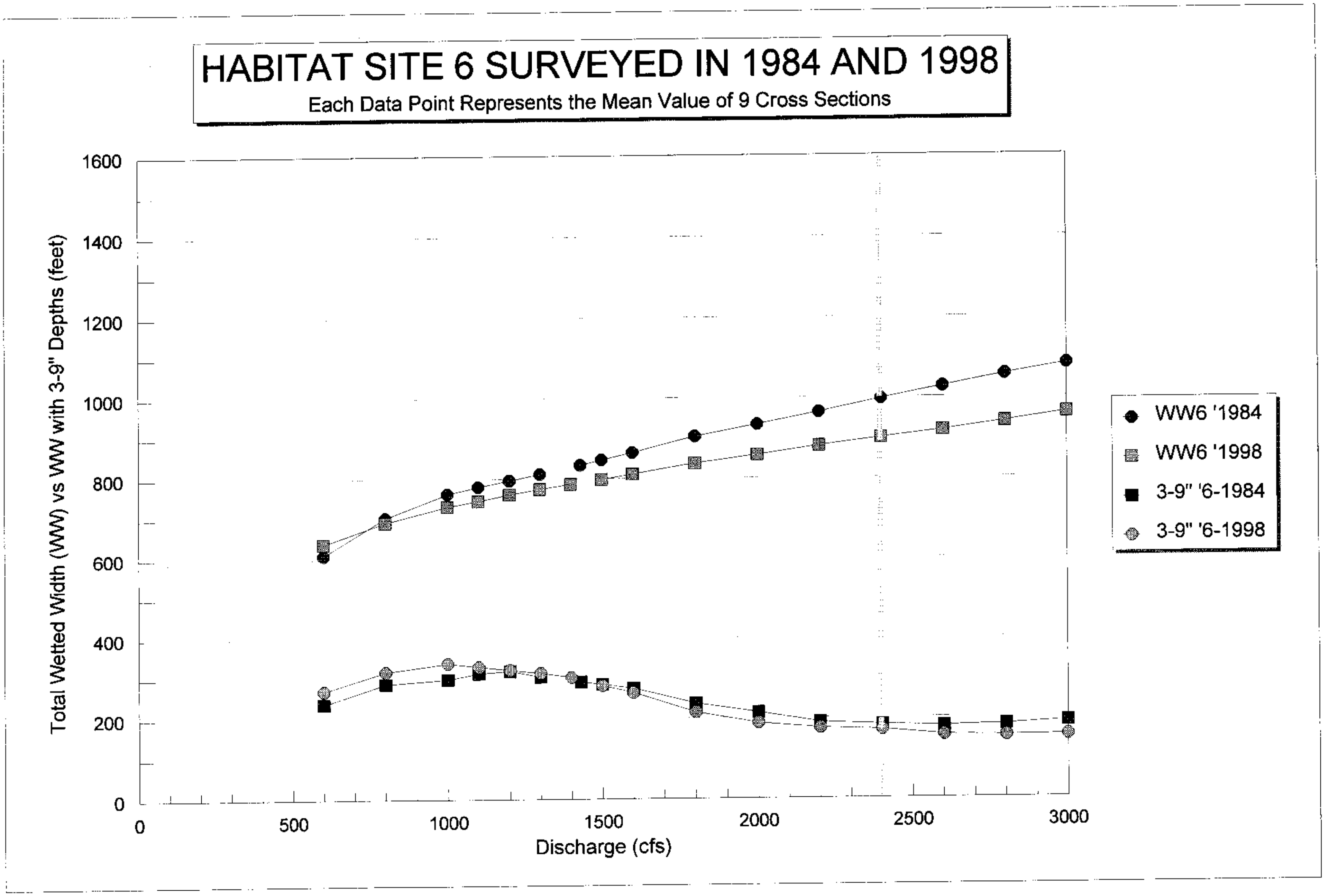
Measured Flow Q = 227

Flow (cfs)	Wet Width	WW > 0.25'	WW >0.75	WW > 1.0	WW 3-9"	Percent WW 3-9"	Depth	WW >3-12"
100	205.16	111.22	32.44	15.12	78.78	38.40	0.42	96.10
200	314.29	203.51	72.13	33.88	131.38	41.80	0.48	169.63
250	411.20	238.82	82.50	45.29	156.32	38.02	0.45	193.53
300	471.63	269.47	97.38	56.23	172.09	36.49	0.47	213.24
400	535.54	371.99	128.08	76.64	243.91	45.54	0.53	295.35
500	558.31	443.94	160.07	92.04	283.87	50.84	0.61	351.90
550	567.28	474.90	174.03	101.19	300.87	53.04	0.65	373.71
700	595.33	539.45	228.70	132.66	310.75	52.20	0.74	406.79
800	601.28	556.26	262.21	157.99	294.05	48.90	0.81	398.27
900	605.71	576.43	328.86	182.39	247.57	40.87	0.87	394.04
1000	607.92	589.07	371.23	210.22	217.84	35.83	0.93	378.85
1100	612.27	597.57	402.43	242.75	195.14	31.87	0.99	354.82
1200	616.92	601.36	434.44	298.54	166.92	27.06	1.04	302.82
1300	620.44	605.20	463.73	331.67	141.47	22.80	1.09	273.53
1400	623.18	606.91	498.64	366.80	108.27	17.37	1.14	240.11

Habitat Transect Site 4A-2001 Summary of 5 Cross Sections Data Collected 10-26-01

Measured Flow Q = 284 cfs

Flow (cfs)	Wet Width	WW > 0.25'	WW > 0.75'	WW > 1.0'	WW 3-9"	Percent WW 3-9"	Depth	WW 3-12"
100	235.63	138.11	12.62	6.11	125.49	53.26	0.35	132
200	356.46	219.21	44.08	11	175.13	49.13	0.4	208.21
250	403.79	253.52	65.9	15.67	187.62	46.46	0.43	237.85
300	446.35	288.99	85.08	24.62	203.91	45.68	0.45	264.37
350	473.93	332.81	106.34	34.52	226.47	47.79	0.48	298.29
400	499.54	359.31	124.82	47.57	234.49	46.94	0.51	311.74
450	516.8	390.75	143.34	61.92	247.41	47.87	0.54	328.83
500	531.68	419.68	162.54	72.08	257.14	48.36	0.57	347.6
550	544.3	445.22	182.41	87.34	262.81	48.28	0.6	357.88
600	554.84	465.3	194.81	99.86	270.49	48.75	0.63	365.44
650	564.98	481.92	209.35	113.29	272.57	48.24	0.65	368.63
700	571.61	497.78	220.17	124.57	277.61	48.57	0.68	373.21
750	579.21	513.52	236.95	139.07	276.57	47.75	0.71	374.45
800	584.73	524.03	251.97	150.13	272.06	46.53	0.73	373.9
900	597.17	543.75	286.06	180.14	257.69	43.15	0.78	363.61
1000	609.79	559.11	316.05	200.03	243.06	39.86	0.82	359.08
1100	625.5	571.96	360.17	220.99	211.79	33.86	0.86	350.97
1200	644.07	582.68	393.61	246.19	189.07	29.36	0.89	336.49
1300	658.75	592.54	427.4	271.59	165.14	25.07	0.92	320.95
1400	680.66	602.91	456.56	298.96	146.35	21.5	0.94	303.95



1984 (6-1) Measured Flow = 1,400 cfs
1998 6 Measured Flow = 1,300 cfs

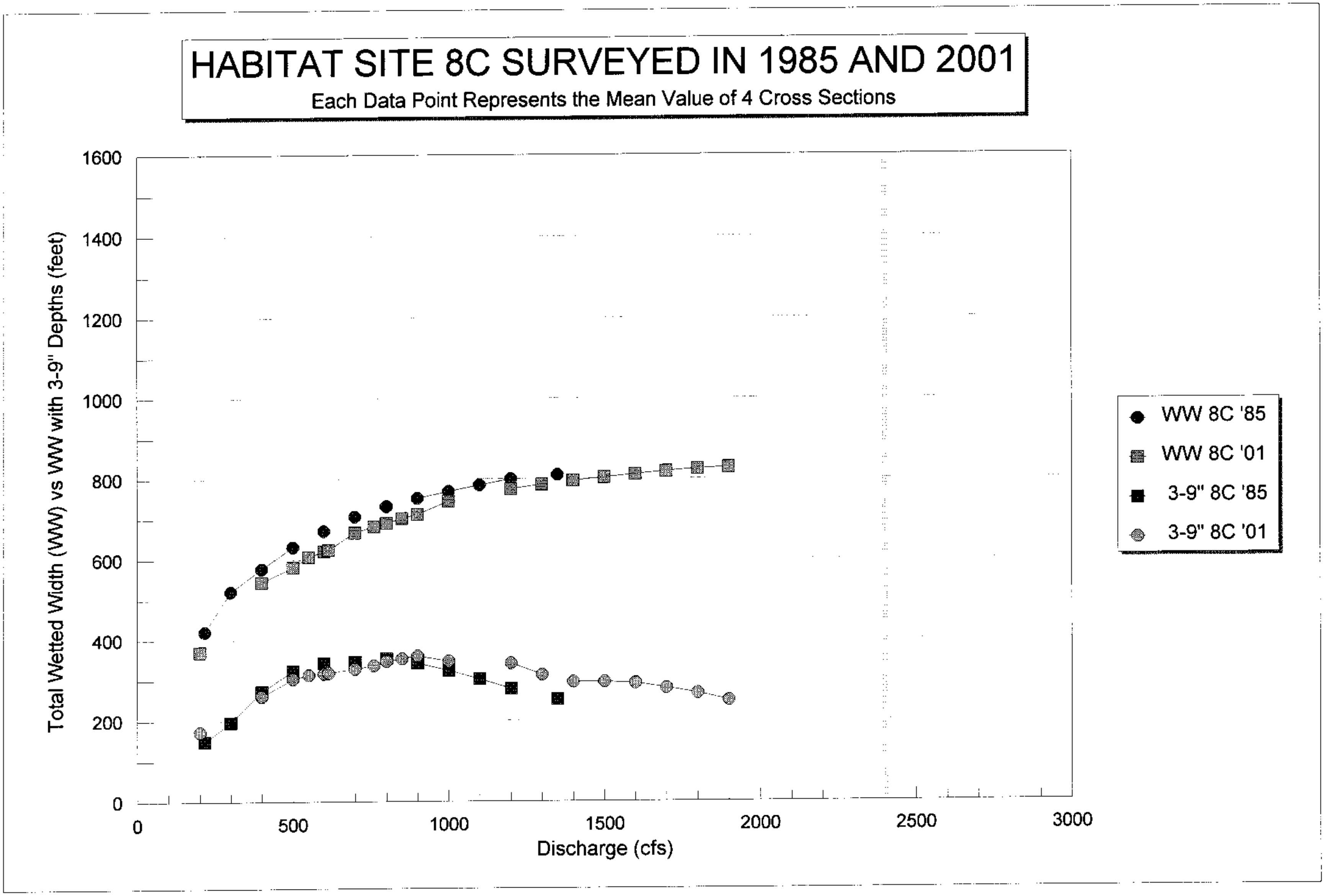
Site 6-1 Summary of 9 Cross Sections — Data Collected 03-10-84

Measured Flow Q = 1,422 cfs

Flow (cfs)	Wet. Width	WW >0.25	WW >0.75	WW > 1.0	WW (3-9")	WW (3-12"	Percent WW (3-9")	Percent WW (3-12"	Mean Depth
600	609.52	449.24	211.64	131.29	237.60	317.95	38.98	52.16	0.62
800	702.86	556.18	268.63	179.89	287.55	376.29	40.91	53.54	0.69
1000	762.31	631.65	332.83	223.17	298.82	408.48	39.20	53.58	0.76
1100	779.78	671.84	358.82	243.21	313.02	428.63	40.14	54.97	0.80
1200	795.54	705.93	386.13	267.64	319.80	438.29	40.20	55.09	0.84
1300	811.20	727.90	423.56	289.55	304.34	438.35	37.52	54.04	0.88
1430	833.32	755.74	464.42	319.64	291.32	436.10	34.96	52.33	0.92
1500	846.22	766.20	480.85	337.44	285.35	428.76	33.72	50.67	0.93
1600	863.81	780.27	505.75	360.25	274.52	420.02	31.78	48.62	0.96
1800	903.55	806.66	570.43	408.93	236.23	397.73	26.14	44.02	1.01
2000	932.78	834.62	621.35	465.42	213.27	369.20	22.86	39.58	1.06
2200	963.03	862.96	674.42	504.32	188.54	358.64	19.58	37.24	1.10
2400	995.97	896.52	714.70	559.26	181.82	337.26	18.26	33.86	1.13
2600	1025.88	920.00	742.18	600.95	177.82	319.05	17.33	31.10	1.17
2800	1055.89	946.97	765.37	648.53	181.60	298.44	17.20	28.26	1.20
3000	1081.94	974.33	784.13	690.04	190.20	284.29	17.58	26.28	1.23

Site 6-1998 Summary of 9 Cross Sections
Measured Flow Q = 1,300 cfs

Flow (cfs)	Wet. Width	WW >0.25	WW >0.75	WW > 1.0	WW (3-9")	WW (3-12"	Percent WW (3-9")	Percent WW (3-12"	Mean Depth
600	637.83	444.74	174.74	101.06	270.00	343.68	42.3	53.9	0.56
800	691.42	553.27	235.56	136.77	317.71	416.50	46.0	60.2	0.65
1000	731.20	634.44	295.94	182.10	338.50	452.34	46.3	61.9	0.73
1100	745.01	658.57	328.33	205.65	330.24	452.92	44.3	60.8	0.77
1200	760.71	678.32	356.85	227.51	321.47	450.81	42.3	59.3	0.81
1300	773.94	699.75	385.37	244.62	314.38	455.13	40.6	58.8	0.84
1400	785.89	714.24	411.31	268.96	302.93	445.28	38.5	56.7	0.97
1500	797.52	726.85	444.93	291.93	281.92	434.92	35.3	54.5	0.90
1600	810.04	737.31	473.41	315.48	263.90	421.83	32.6	52.1	0.93
1800	836.29	761.28	547.58	363.96	213.70	397.32	25.6	47.5	0.98
2000	856.89	783.30	596.61	411.96	186.69	371.34	21.8	43.3	1.04
2200	879.40	804.81	630.78	457.94	174.03	346.87	19.8	39.4	1.08
2400	898.65	829.62	660.19	522.42	169.43	307.20	18.9	34.2	1.13
2600	916.79	845.13	689.57	567.48	155.56	277.65	17.0	30.3	1.17
2800	938.86	864.34	710.69	599.66	153.65	264.68	16.4	28.2	1.20
3000	961.02	883.89	728.98	629.40	154.91	254.49	16.1	26.5	1.24



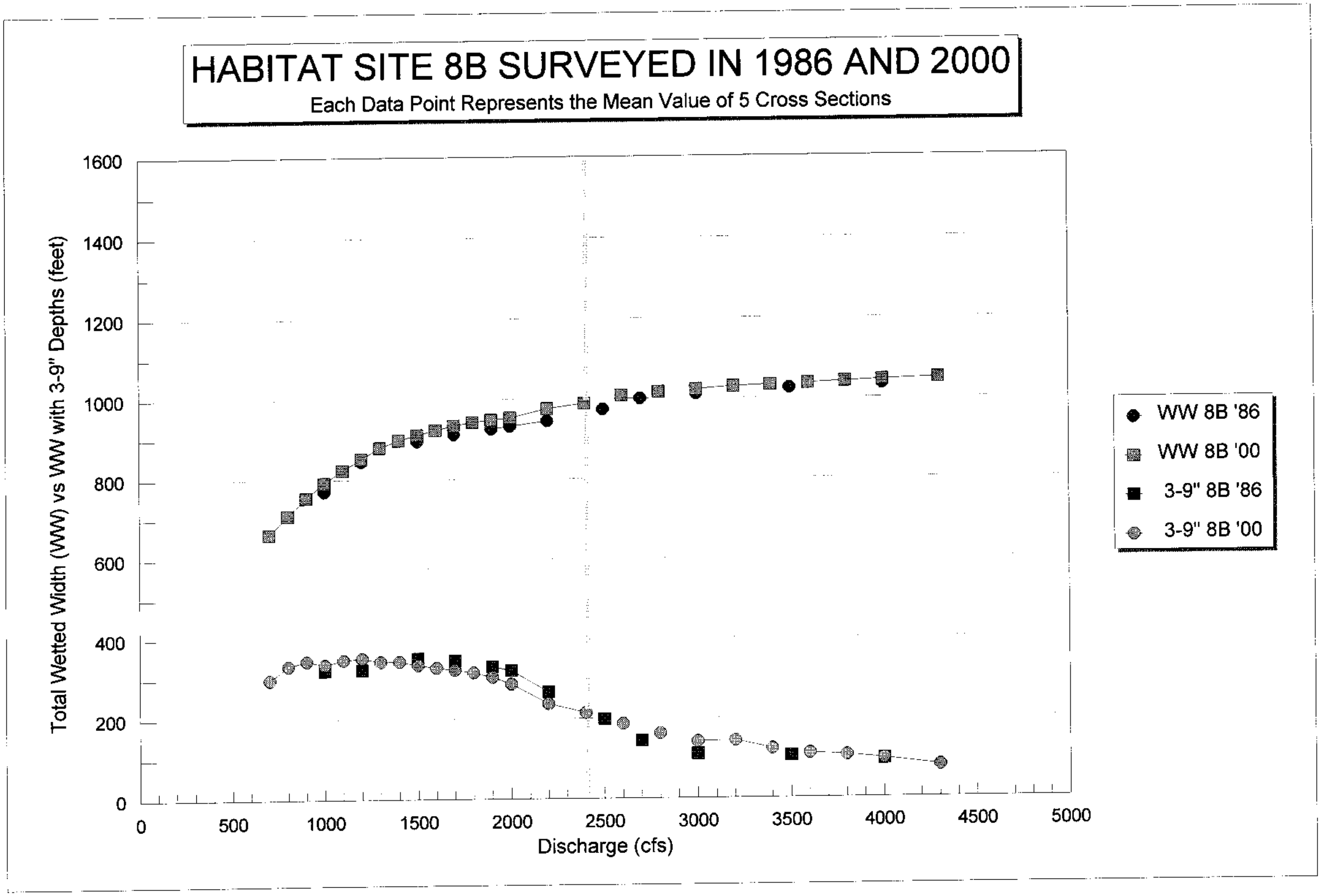
1985 (8C3) Measured Flow = 540 cfs
2001 8C Measured Flow = 688 cfs

Site 8C-3 | Summary of Measured Discharge Q = 537 cfs | Data Collecited 7-19-85

Flow (cfs)	Wet Width	WW >0.25"	WW >0.75"	WW > 1.0'	WW 3-9"	Percent WW 3-9"	WW 3-12"
216	421.05	237.4	88.55	29.84	148.85	35.35	207.56
300	520.71	310.63	114.44	57.47	196.19	37.68	253.16
400	577.4	414.39	141.72	83.98	272.67	47.22	330.41
500	631.7	489.73	165.86	106.1	323.87	51.27	383.63
600	671.34	537.95	195.59	124.74	342.36	51	413.21
700	706.75	576.61	230.71	141.25	345.9	48.94	435.36
800	732.36	621.64	267.55	159.32	354.09	48.35	462.32
900	751.99	651.11	309.46	180.58	341.65	45.43	470.53
1000	768.75	679.29	355.5	201.02	323.79	42.12	478.27
1100	784.77	702.85	400.82	225.61	302.03	38.49	477.24
1200	799.46	724.46	446.39	253.24	278.07	34.78	471.22
1350	809.3	746.91	495.6	300.35	251.31	31.05	446.56

Habitat Transect 8C-2001 | Summary of Measured Discharge Q = 700 cfs | Data Collected 10-25-01

Flow (cfs)	Wet Width	WW >0.25"	WW >0.75"	WW > 1.0'	WW 3-9"	Percent WW 3-9"	WW 3-12"
200	370.98	210.08	37.6	14.92	172.48	46.49	195.16
400	544.28	348.99	88.22	34.79	260.77	47.91	314.2
500	581.17	422.7	119.58	55.82	303.12	52.16	366.88
550	606.81	447.38	134.19	65.6	313.19	51.61	381.78
600	620.38	471.99	155.62	71.18	316.37	51	400.81
615	624.28	478.35	159.65	72.84	318.7	51.05	405.51
700	667.4	514.91	187.12	83.75	327.79	49.11	431.16
760	681.78	540.36	203.75	91.43	336.61	49.37	448.93
800	690.45	561.41	214.55	106.25	346.86	50.24	455.16
850	702.29	584.78	231.78	116.44	353	50.26	468.34
900	711.79	594.71	234.72	125.31	359.99	50.58	469.4
1000	744.77	613.93	267.36	148.96	346.57	46.53	464.97
1200	774.81	673.86	332.83	191.18	341.03	44.01	482.68
1300	785.67	689.36	376.85	214.22	312.51	39.78	475.14
1400	795.02	702.88	408.29	230.26	294.59	37.05	472.62
1500	803.03	727.79	433.34	252.18	294.45	36.67	475.61
1600	810.42	748.61	456.46	273.83	292.15	36.05	474.78
1700	818.22	763.82	484.07	296.53	279.75	34.19	467.29
1800	824	772.41	505.67	330.66	266.74	32.37	441.75
1900	827.45	781.07	532.2	355.08	248.87	30.08	425.99



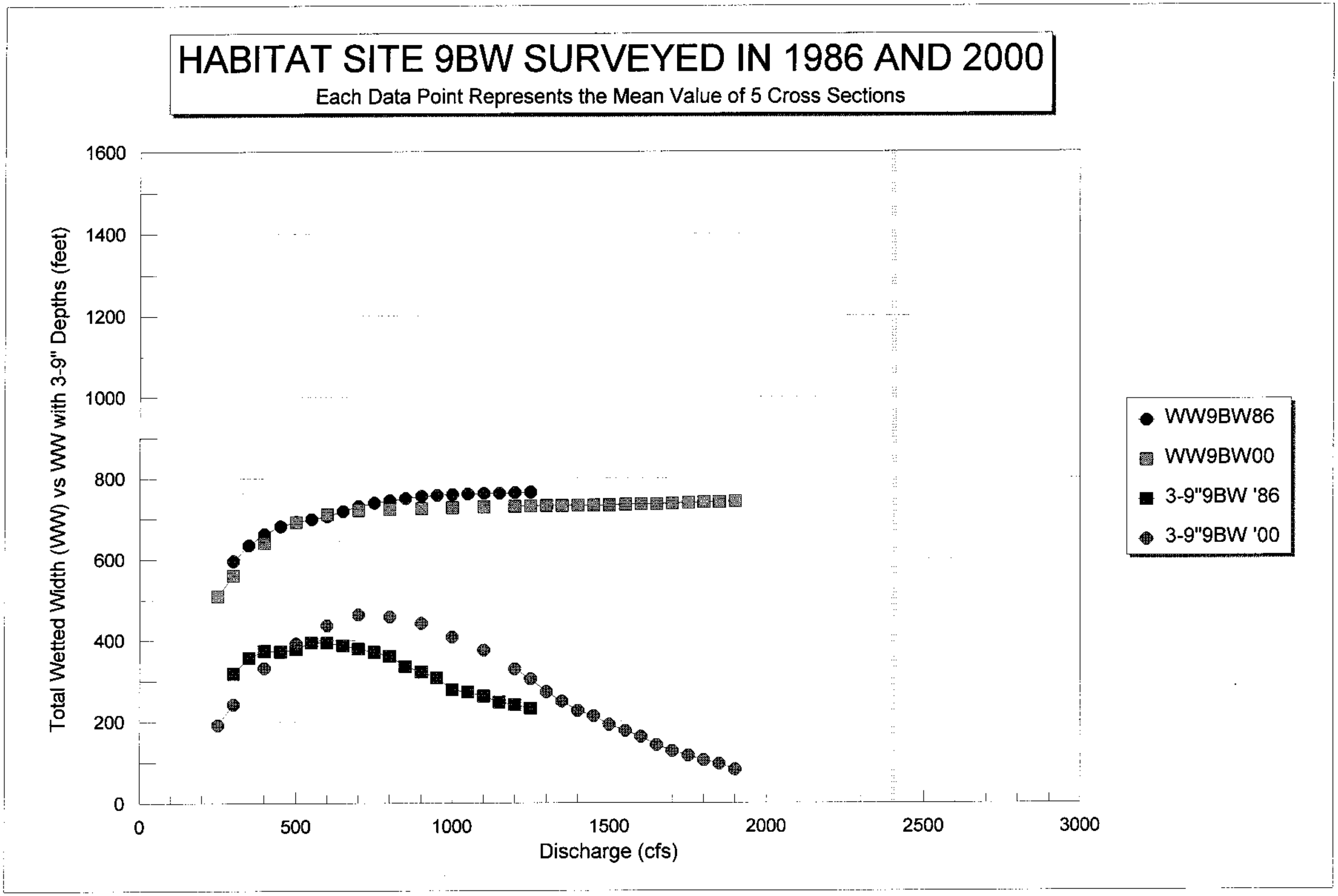
1986 (8B4) Measured Flow = 1,802
2000 8B Measured Flow = 1,750

Site 8B-4 Summary of 5 cross sections obtained in the mid 1980's.
Measured Flow Q = 1,802 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	WW (3-12"	Percent WW (3-9")
1000	771.06	577.91	255.43	171.14	322.48	406.77	41.82
1200	845.78	665.16	341.30	197.92	323.86	467.24	38.29
1500	895.57	798.38	446.89	267.73	351.49	530.65	39.25
1700	912.54	843.68	497.94	327.41	345.74	516.27	37.89
1900	926.17	880.74	549.94	394.76	330.80	485.98	35.72
2000	932.07	891.79	571.78	424.22	320.01	467.57	34.33
2200	944.82	904.15	638.17	477.11	265.98	427.04	28.15
2500	973.12	923.05	725.77	534.57	197.28	388.48	20.27
2700	999.64	933.77	790.27	587.33	143.50	346.44	14.36

Habitat Tra nsect 8B-2000 Summary of five cross sections
Measured Flow Q = 1,750 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	Percent WW (3-9")	WW (3-12"
700	663.7	487.1	188.6	125.7	298.4	45.0	361.4
800	710.5	547.2	213.8	140.7	333.3	46.9	406.5
900	754.8	587.3	241.0	154.6	346.2	45.9	432.7
1000	792.8	622.6	286.3	177.0	336.3	42.4	445.6
1100	824.6	679.2	330.6	196.4	348.6	42.3	482.8
1200	852.0	717.6	366.0	216.3	351.6	41.3	501.3
1300	879.7	741.8	397.8	245.8	344.0	39.1	495.9
1400	898.3	770.7	426.8	274.1	344.0	38.3	496.7
1500	911.4	802.3	467.3	303.5	335.0	36.8	498.8
1600	923.4	823.7	495.9	337.4	327.8	35.5	486.3
1700	934.6	845.6	523.4	365.1	322.3	34.5	480.6
1800	942.9	870.8	555.6	392.7	315.2	33.4	478.1
1900	948.1	887.0	582.9	413.6	304.1	32.1	473.4
2000	953.3	899.8	613.7	443.4	286.1	30.0	456.4
2200	975.7	921.0	684.3	491.8	236.6	24.3	429.1
2400	988.2	937.5	723.5	540.1	214.0	21.7	397.4
2600	1007.6	949.3	763.0	590.4	186.3	18.5	358.9
2800	1016.0	965.3	803.4	648.0	161.9	15.9	317.3
3000	1022.1	978.4	837.7	697.0	140.7	13.8	281.4
3200	1028.8	1003.5	860.8	729.1	142.7	13.9	274.4
3400	1032.4	1011.7	889.5	763.5	122.2	11.8	248.2
3600	1035.8	1018.9	908.2	800.4	110.7	10.7	218.5
3800	1040.2	1026.1	920.4	832.7	105.6	10.2	193.4
4000	1044.0	1029.5	933.1	854.8	96.4	9.2	174.7
4300	1048.9	1034.0	955.1	887.4	78.8	7.5	146.5



1986 (9BW8) Measured Flow = 604 cfs
2000 9BW Measured Flow = 700 cfs

Habitat Transect Site 9BW-8

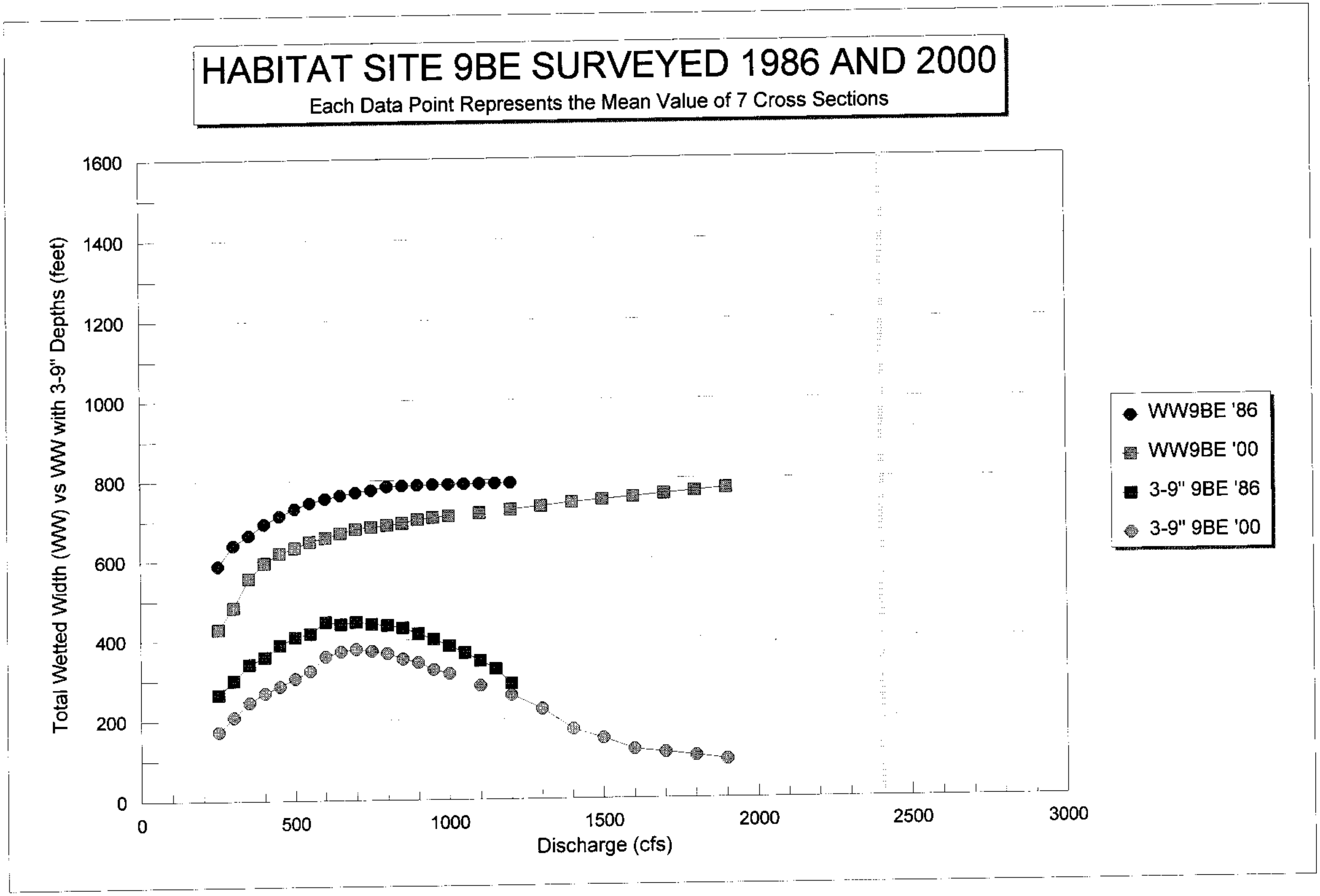
Summary of 5 Cross Sections
Measured Flow Q = 604 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	WW (3-12"	Percent WW (3-9")	Percent WW (3-12"	Mean Depth
300	596.05	399.64	81.00	33.89	318.64	365.75	53.46	61.36	0.43
350	634.82	457.41	100.93	39.64	356.48	417.77	56.15	65.81	0.46
400	662.85	491.35	117.48	47.98	373.87	443.37	56.40	66.89	0.49
450	681.66	515.79	143.35	55.86	372.44	459.93	54.64	67.47	0.52
500	692.50	538.65	160.27	68.38	378.38	470.27	54.64	67.91	0.55
550	698.85	576.97	181.63	76.53	395.34	500.44	56.57	71.61	0.58
600	706.25	605.34	211.13	85.08	394.21	520.26	55.82	73.67	0.61
650	719.13	626.07	238.89	97.37	387.18	528.70	53.84	73.52	0.64
700	730.82	653.10	274.00	110.89	379.10	542.21	51.87	74.19	0.66
750	739.04	669.78	298.54	126.90	371.24	542.88	50.23	73.46	0.69
800	744.82	681.55	320.78	140.03	360.77	541.52	48.44	72.70	0.71
850	750.38	690.63	354.51	154.81	336.12	535.82	44.79	71.41	0.74
900	755.51	694.58	372.97	169.85	321.61	524.73	42.57	69.45	0.76
950	758.20	698.89	390.78	187.36	308.11	511.53	40.64	67.47	0.78
1000	759.71	703.49	424.98	209.38	278.51	494.11	36.66	65.04	0.81
1050	760.77	713.97	441.96	230.67	272.01	483.30	35.75	63.53	0.84
1100	762.13	720.84	458.62	251.29	262.22	469.55	34.41	61.61	0.86
1150	763.07	731.30	483.97	282.07	247.33	449.23	32.41	58.87	0.89
1200	763.99	737.51	497.02	296.66	240.49	440.85	31.48	57.70	0.91
1250	765.00	742.45	510.30	317.13	232.15	425.32	30.35	55.60	0.93

Habitat Transect 9BW-2000 Summary of 5 Cross Sections

Measured Flow Q = 698 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	Percent WW (3-9")
250	509.72	254.71	62.52	40.04	192.19	37.71
300	560.55	310.81	68.59	44.39	242.22	43.21
400	640.36	424.45	92.63	53.65	331.82	51.82
500	691.5	506.51	114.71	62.26	391.80	56.66
600	711.33	569.77	132.70	70.17	437.07	61.44
700	721.29	621.15	157.90	86.82	463.25	64.23
800	723.60	658.37	200.29	100.69	458.08	63.31
900	725.58	689.36	246.91	113.79	442.45	60.98
1000	727.27	707.61	299.83	126.14	407.78	56.07
1100	728.90	714.63	338.99	143.20	375.64	51.54
1200	730.42	721.82	392.60	164.44	329.22	45.07
1250	731.09	722.73	417.84	175.96	304.89	41.70
1300	731.76	723.65	451.42	197.40	272.23	37.20
1350	732.19	724.43	475.47	214.36	248.96	34.00
1400	732.63	725.13	498.66	233.79	226.47	30.91
1450	733.08	725.92	512.40	254.58	213.52	29.13
1500	733.51	726.57	534.67	280.26	191.90	26.16
1550	734.69	727.22	549.95	296.16	177.27	24.13
1600	735.87	727.88	565.21	312.04	162.67	22.11
1650	736.59	728.44	586.03	328.00	142.41	19.33
1700	737.77	729.09	601.65	343.50	127.44	17.27
1750	738.98	729.88	613.62	364.21	116.26	15.73
1800	740.15	730.53	625.54	390.77	104.99	14.18
1850	741.25	731.00	634.77	409.38	96.23	12.98
1900	742.43	731.43	649.44	438.01	81.99	11.04



1986 (9BE6) Measured Flow = 530 cfs
2000 9BE Measured Flow = 657 cfs

Habitat Transect 9BE-6

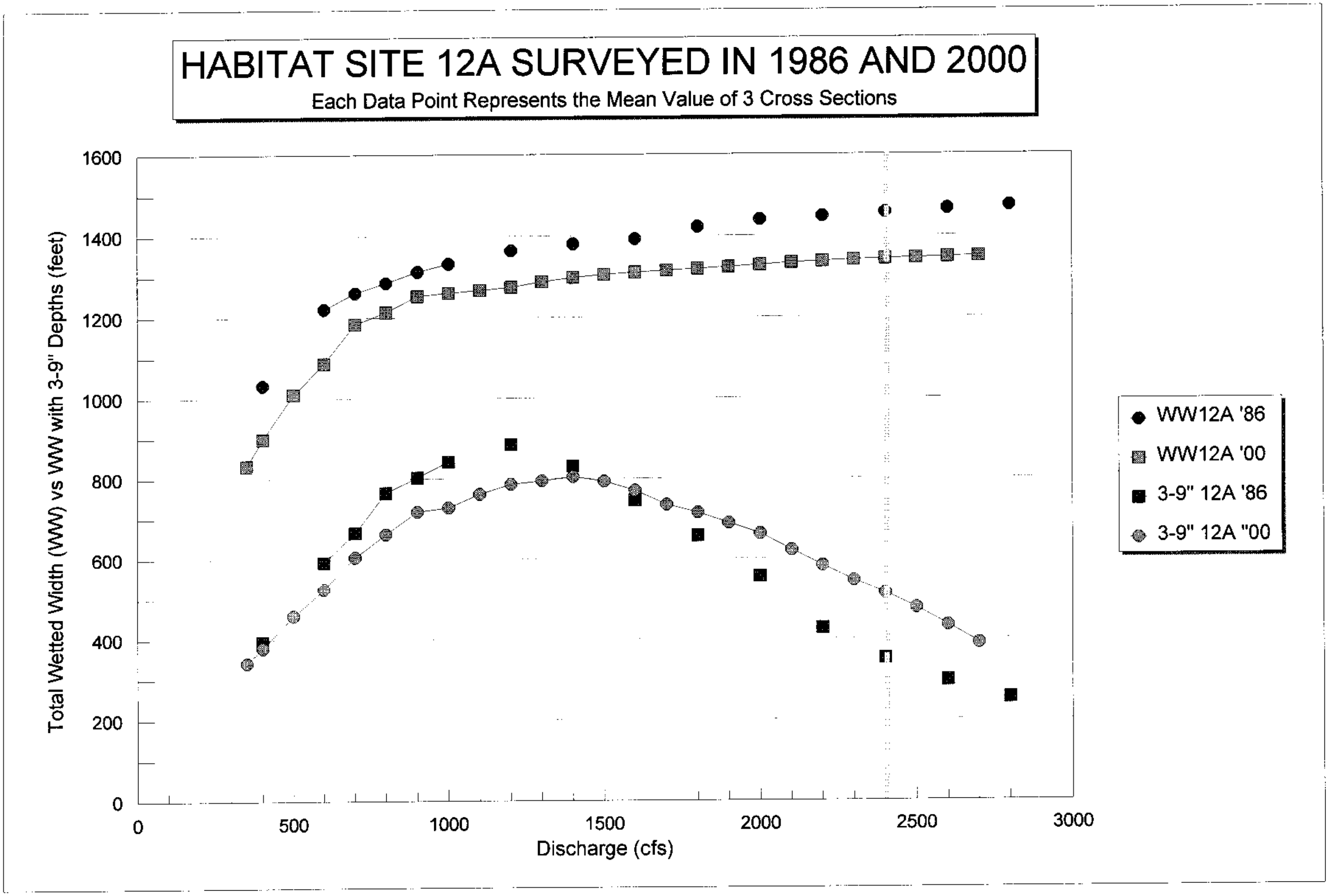
Summary of 7 Cross Sections
Measured Flow Q = 530 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")
250	587.85	330.35	64.48	25.87	265.87
300	639.10	380.70	80.03	30.09	300.67
350	663.96	436.64	95.25	38.05	341.39
400	692.75	483.09	124.16	45.87	358.93
450	712.39	533.62	145.18	57.23	388.44
500	730.41	574.07	165.62	68.36	408.45
550	744.39	601.88	184.78	77.10	417.10
600	754.84	644.09	198.61	94.40	445.48
650	763.01	659.73	220.13	104.58	439.60
700	770.09	683.23	238.05	121.07	445.18
750	775.07	700.67	260.48	134.05	440.19
800	784.38	717.55	280.69	147.72	436.86
850	786.00	726.25	296.34	158.11	429.91
900	787.38	736.97	321.79	172.28	415.18
950	788.54	747.43	347.03	180.77	400.40
1000	789.15	755.29	371.05	200.79	384.24
1050	789.74	761.31	395.10	211.47	366.21
1100	790.22	765.81	419.87	223.46	345.94
1150	790.76	770.04	444.54	241.97	325.50
1200	791.27	773.75	484.65	258.42	289.10

Habitat Transect 9BE-2000 Summary of 7 Cross Sections

Measured Flow Q = 657 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	Percent WW (3-9")
250	428.95	249.22	76.26	47.02	172.96	40.32
300	482.85	295.82	86.79	55.01	209.03	43.29
350	556.75	345.63	100.04	62.05	245.59	44.11
400	594.83	387.74	119.05	69.86	268.69	45.17
450	619.04	424.09	138.89	76.67	285.20	46.07
500	632.07	457.70	153.17	82.13	304.53	48.18
550	647.47	490.83	167.52	88.69	323.31	49.93
600	656.64	546.14	186.82	96.98	359.32	54.72
650	668.12	574.31	203.14	106.54	371.17	55.55
700	678.48	599.26	222.21	119.31	377.05	55.57
750	683.81	613.30	240.93	132.23	372.37	54.46
800	687.60	624.26	258.12	144.85	366.14	53.25
850	692.19	634.49	282.82	155.43	351.67	50.81
900	701.60	646.32	303.52	167.12	342.80	48.86
950	706.49	653.18	328.22	182.04	324.96	46.00
1000	709.45	663.11	348.25	195.34	314.86	44.38
1100	716.67	674.45	390.15	223.17	284.30	39.67
1200	724.92	686.38	426.63	249.08	259.75	35.83
1300	733.05	692.52	468.11	283.02	224.41	30.61
1400	741.69	703.96	531.14	316.48	172.82	23.30
1500	747.81	710.55	560.64	350.75	149.91	20.05
1600	754.48	716.85	595.35	386.68	121.50	16.10
1700	761.43	723.45	609.85	417.60	113.60	14.92
1800	768.47	730.27	625.70	455.43	104.57	13.61
1900	775.04	736.75	641.27	512.18	95.48	12.32



1986 (12A4) Measured Flow = 1,068 cfs
2000 12A Measured Flow = 930 cfs

Habitat Transect Site 12A-4 Summary of 3 Cross Sections

Measured Flow Q = 1,068 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW 3-9"	WW 3-12"	Percent WW 3-9"	Percent WW 3-12"
400	1031.53	514.51	119.94	40.67	394.57	473.84	38.25	45.94
600	1220.44	779.26	187.27	83.80	591.99	695.46	48.51	56.98
700	1260.77	876.21	210.52	98.49	665.69	777.72	52.80	61.69
800	1285.46	1000.89	235.55	109.48	765.34	891.41	59.54	69.35
900	1312.67	1063.37	260.28	131.31	803.09	932.06	61.18	71.00
1000	1332.52	1129.35	286.97	151.85	842.38	977.50	63.22	73.36
1200	1363.79	1231.93	346.72	193.12	885.21	1038.81	64.91	76.17
1400	1380.2	1275.81	444.92	226.11	830.89	1049.70	60.20	76.05
1600	1392.79	1314.65	568.92	260.89	745.73	1053.76	53.54	75.66
1800	1421.96	1344.43	687.08	302.06	657.35	1042.37	46.23	73.31
2000	1439.61	1365.07	808.91	350.14	556.16	1014.93	38.63	70.50
2200	1447.61	1377.71	950.51	421.74	427.20	955.97	29.51	66.04
2400	1457.47	1389.02	1037.61	529.64	351.41	859.38	24.11	58.96
2600	1466.07	1412.32	1115.74	628.02	296.58	784.30	20.23	53.50
2800	1473.09	1427.16	1173.65	718.42	253.51	708.74	17.21	48.11

Site 12A-2000

Summary of Three Cross Sections
Data collected 10-20-00
Measured Flow Q 930 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW 3-9"	WW 3-12"	Mean Depth	Percent WW 3-9"	Percent WW 3-12"
350	832.46	421.67	79.81	25.75	341.86	395.92	0.33	41.07	47.56
400	899.18	473.63	94.26	28.82	379.37	444.81	0.34	42.19	49.47
500	1009.45	577.60	118.42	35.48	459.18	542.12	0.37	45.49	53.70
600	1086.92	665.65	140.87	49.64	524.78	616.01	0.40	48.28	56.67
700	1183.64	768.72	164.19	70.22	604.53	698.50	0.42	51.07	59.01
800	1213.12	851.20	189.42	84.88	661.78	766.32	0.45	54.55	63.17
900	1253.22	932.25	214.35	103.03	717.90	829.22	0.48	57.28	66.17
1000	1260.11	947.08	219.62	106.61	727.46	840.47	0.49	57.73	66.70
1100	1267.11	999.95	238.69	117.33	761.26	882.62	0.52	60.08	69.66
1200	1274.10	1050.49	265.54	128.04	784.95	922.45	0.55	61.61	72.40
1300	1287.77	1095.97	302.25	144.17	793.72	951.80	0.58	61.64	73.91
1400	1297.78	1153.39	349.14	158.36	804.25	995.03	0.61	61.97	76.67
1500	1305.05	1195.07	402.54	170.37	792.53	1024.70	0.64	60.73	78.52
1600	1310.79	1217.00	447.14	191.87	769.86	1025.13	0.67	58.73	78.21
1700	1314.80	1237.90	503.65	206.24	734.25	1031.66	0.69	55.84	78.47
1800	1319.03	1261.07	546.83	222.05	714.24	1039.02	0.72	54.15	78.77
1900	1323.17	1267.28	578.99	242.81	688.29	1024.47	0.74	52.02	77.43
2000	1328.01	1273.58	611.55	268.25	662.03	1005.33	0.77	49.85	75.70
2100	1333.09	1281.79	661.11	295.79	620.68	986.00	0.80	46.56	73.96
2200	1337.13	1290.75	708.18	316.39	582.57	974.36	0.82	43.57	72.87
2300	1340.59	1296.58	751.61	360.57	544.97	936.01	0.84	40.65	69.82
2400	1342.73	1302.88	789.35	405.03	513.53	897.85	0.86	38.25	66.87
2500	1345.13	1308.66	831.83	439.75	476.83	868.91	0.89	35.45	64.60
2600	1347.27	1312.96	879.67	468.47	433.29	844.49	0.91	32.16	62.68
2700	1348.99	1316.53	927.67	520.73	388.86	795.80	0.93	28.83	58.99

Sandhill Cranes Appendix

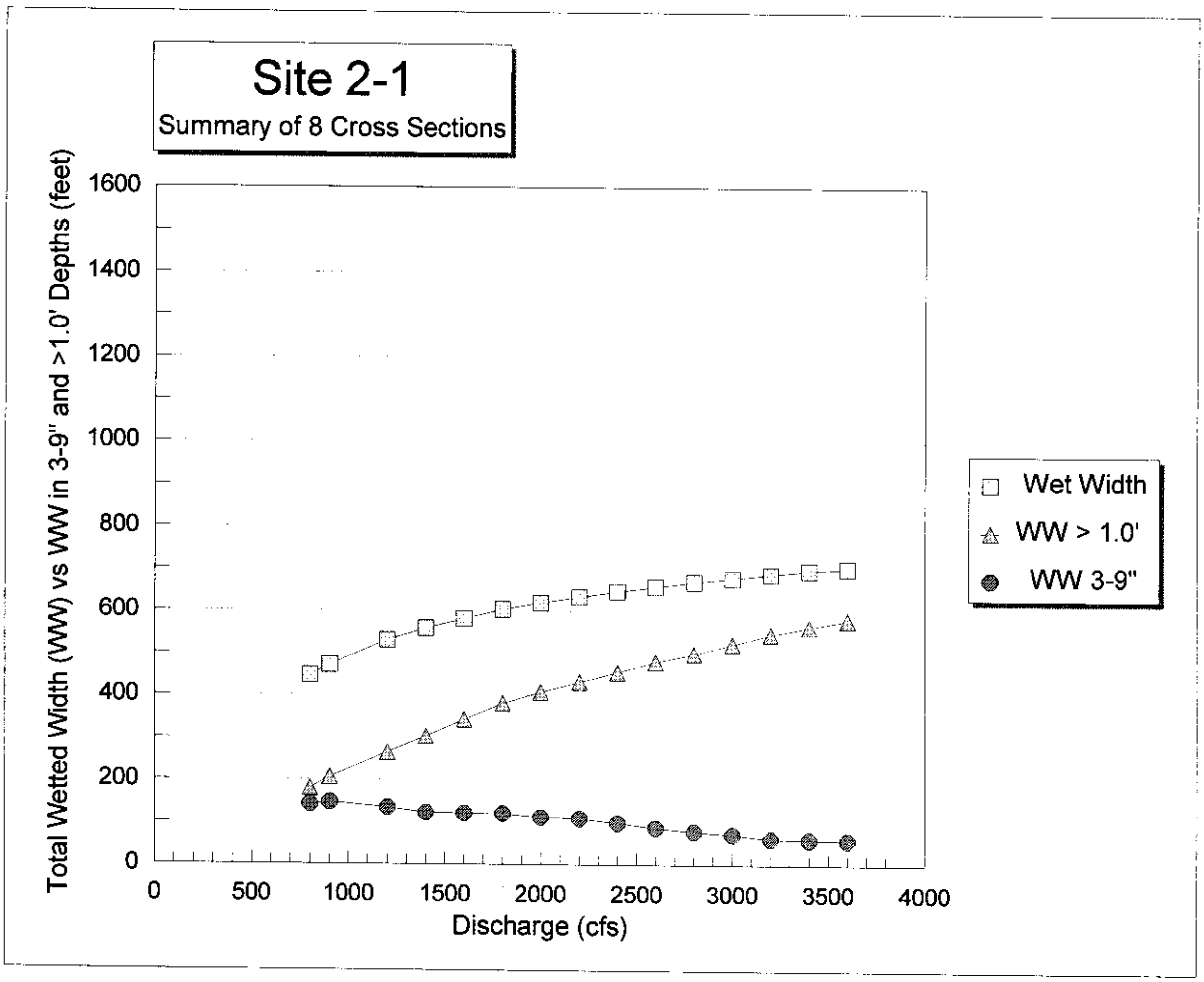
SPRING HABITAT USE IN NEBRASKA

Biological Attachment B

This attachment contains discharge-roosting depth abundance relationship information for eight habitat transect sites on the Platte River in central Nebraska. Sites were originally surveyed between 1983 and 1986. Data for each site includes a graphic depiction of total wetted width, wetted widths supporting 3-9 inch depths and depths greater than 12 inches, and supporting tabular data.

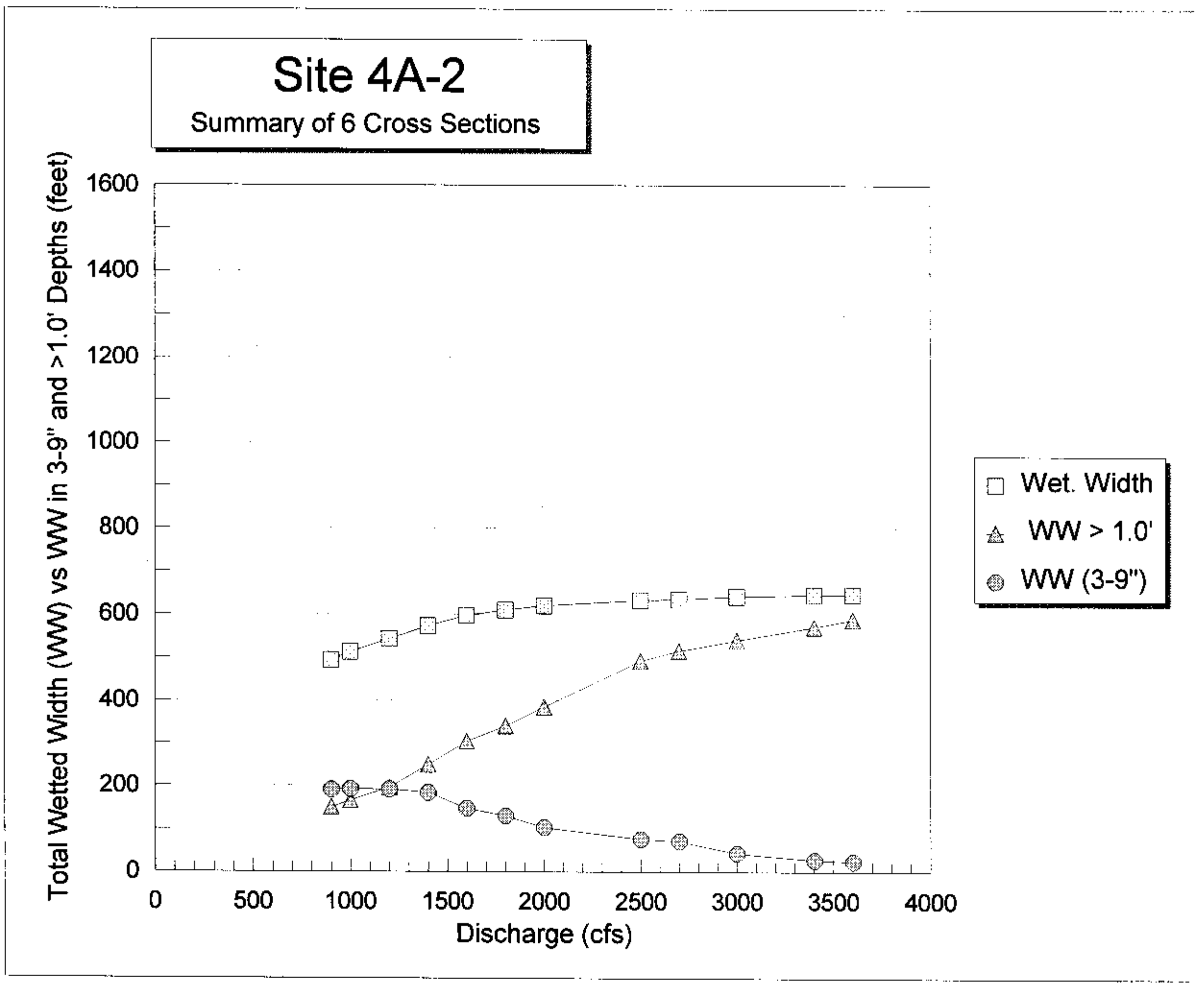
Habitat Site 2-1 | Summary of 8 Cross Sections | Data Collected 10-10-84
Measured Flow Q = 2,062 cfs

Flow (cfs)	Wet Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW 3-9"	Percent WW 3-9"
800	446.68	385.55	243.23	180.16	142.32	31.86
900	470.22	412.09	264.57	205.66	147.52	31.37
1200	530.29	468.57	334.03	264.57	134.54	25.37
1400	558.77	501.53	379.12	303.23	122.41	21.91
1600	581.19	533.94	412.62	343.02	121.32	20.87
1800	603.71	559.44	439.04	380.68	120.40	19.94
2000	619.92	579.95	467.60	407.96	112.35	18.12
2200	633.71	600.61	491.13	431.44	109.48	17.28
2400	647.64	615.44	516.80	454.81	98.64	15.23
2600	658.30	627.27	539.63	479.70	87.64	13.31
2800	669.34	640.76	562.23	499.16	78.53	11.73
3000	679.15	650.81	579.21	522.47	71.60	10.54
3200	688.95	659.93	598.09	546.24	61.84	8.98
3400	697.94	669.89	609.97	564.09	59.92	8.59
3600	702.45	678.90	620.23	580.51	58.67	8.35



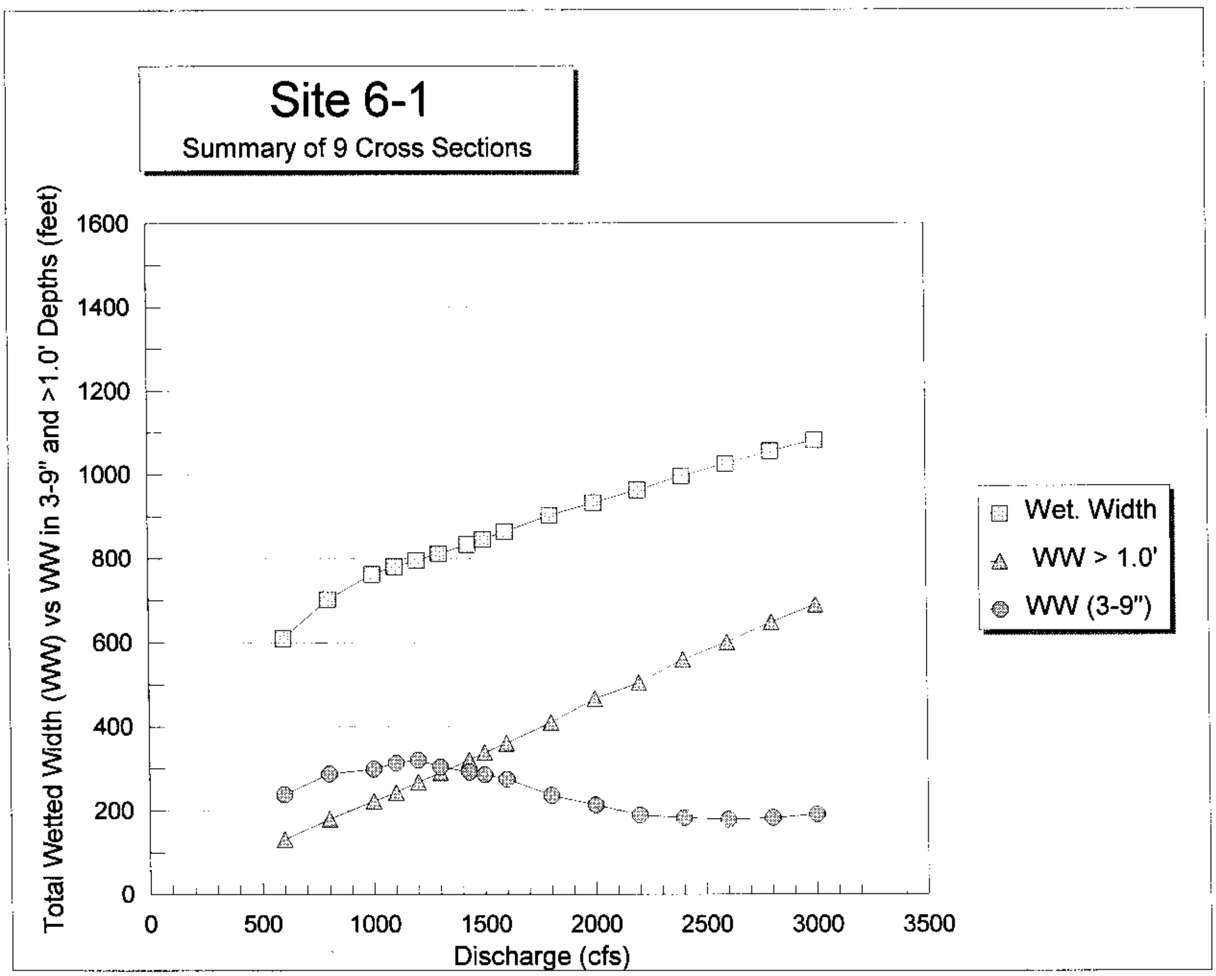
Habitat Site 4A-2 Summary of 6 Cross Sections Data Collected 3-26-85
Measured Flow Q = 1,861 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	Percent WW (3-9")
900	493.42	397.40	206.98	150.22	190.42	38.59
1000	512.43	426.62	234.77	165.39	191.85	37.44
1200	542.62	491.77	301.01	195.60	190.76	35.16
1400	573.00	529.52	346.17	248.67	183.35	32.00
1600	597.25	546.52	399.33	303.49	147.19	24.64
1800	610.54	573.35	443.25	339.99	130.10	21.31
2000	620.60	593.74	490.65	384.30	103.09	16.61
2500	632.72	619.84	543.26	492.54	76.58	12.10
2700	635.46	626.93	555.58	515.53	71.35	11.23
3000	641.61	631.92	589.18	540.44	42.74	6.66
3400	645.51	637.13	610.33	571.31	26.80	4.15
3600	646.68	640.95	617.10	588.44	23.85	3.69



Habitat Site 6-1 | Summary of 9 Cross Sections | Data Collected 10-3-84
Measured Flow Q = 1,422 cfs

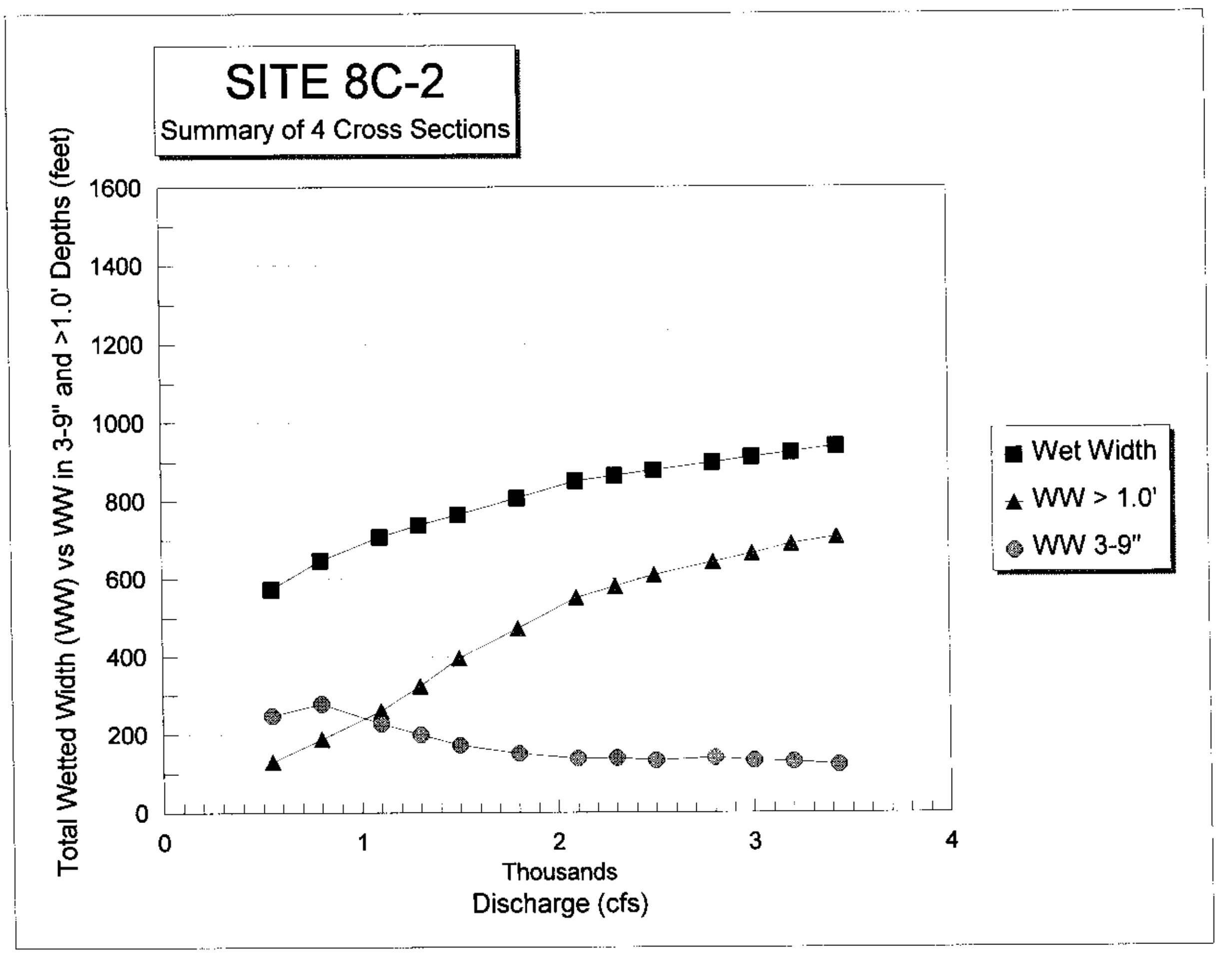
Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	Percent WW (3-9")
600	609.52	449.24	211.64	131.29	237.60	38.98
800	702.86	556.18	268.63	179.89	287.55	40.91
1000	762.31	631.65	332.83	223.17	298.82	39.20
1100	779.78	671.84	358.82	243.21	313.02	40.14
1200	795.54	705.93	386.13	267.64	319.80	40.20
1300	811.20	727.90	423.56	289.55	304.34	37.52
1430	833.32	755.74	464.42	319.64	291.32	34.96
1500	846.22	766.20	480.85	337.44	285.35	33.72
1600	863.81	780.27	505.75	360.25	274.52	31.78
1800	903.55	806.66	570.43	408.93	236.23	26.14
2000	932.78	834.62	621.35	465.42	213.27	22.86
2200	963.03	862.96	674.42	504.32	188.54	19.58
2400	995.97	896.52	714.70	559.26	181.82	18.26
2600	1025.88	920.00	742.18	600.95	177.82	17.33
2800	1055.89	946.97	765.37	648.53	181.60	17.20
3000	1081.94	974.33	784.13	690.04	190.20	17.58



Site 8C-2 | Summary ol 4 Cross Sections | Data Collected 4-18-85

Measured Discharge Q = 1,373 cfs

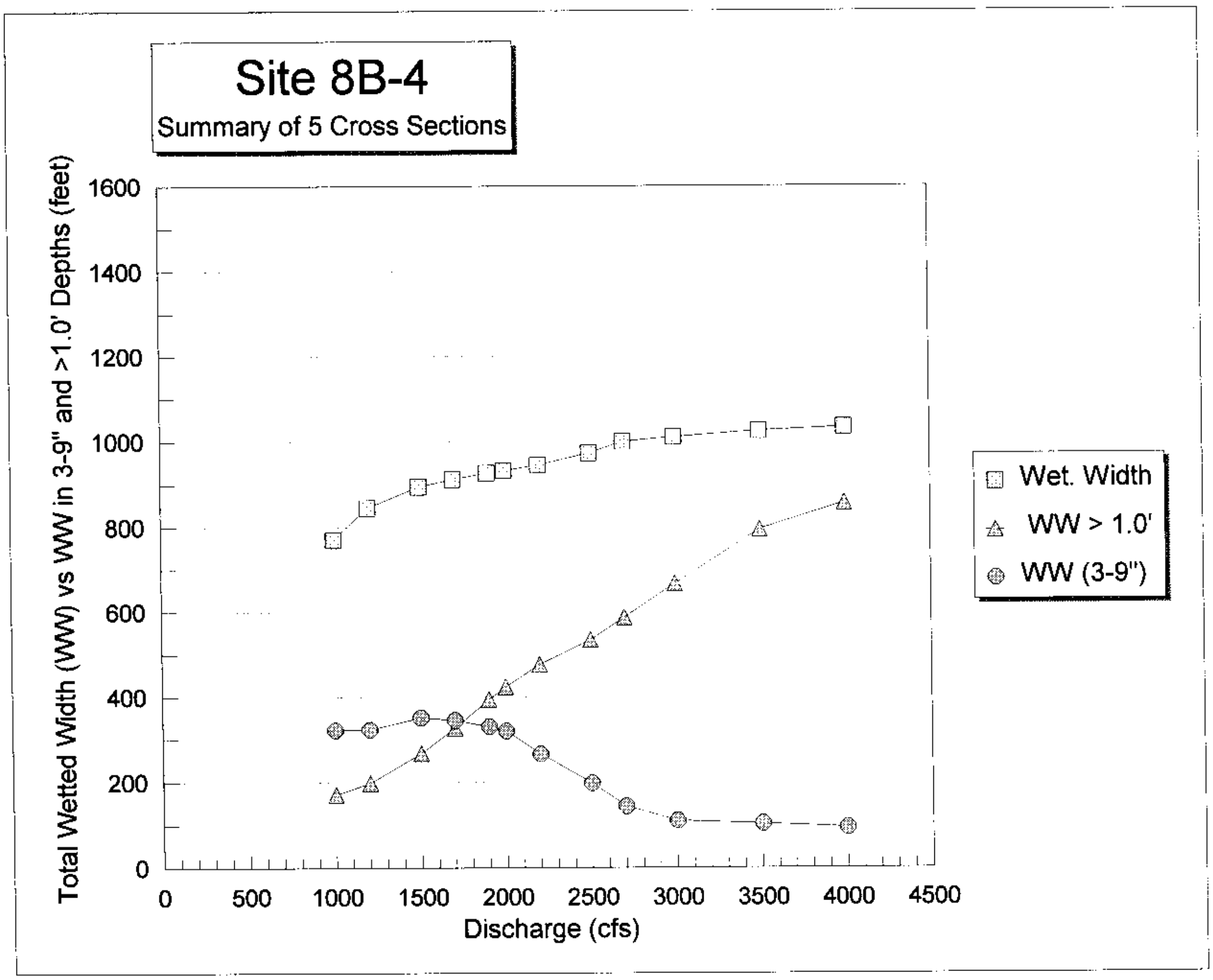
Flow (cfs)	Wet Width	WW >0.25"	WW >0.75"	WW > 1.0'	WW 3-9"	Percent WW 3-9"
550	572.75	443.41	195.51	129.04	247.90	43.28
800	646.29	563.24	284.60	188.19	278.64	43.11
1100	706.55	636.29	408.79	260.78	227.50	32.20
1300	737.43	669.47	469.64	324.11	199.83	27.10
1500	764.39	702.45	530.13	395.56	172.32	22.54
1800	807.11	739.58	589.22	472.95	150.36	18.63
2100	851.40	775.32	638.19	551.30	137.13	16.11
2300	864.98	799.39	660.70	579.97	138.69	16.03
2500	879.33	821.60	689.67	609.35	131.93	15.00
2800	898.53	856.68	717.11	643.19	139.57	15.53
3000	912.49	867.15	734.46	664.08	132.69	14.54
3200	924.83	879.32	749.55	688.94	129.77	14.03
3430	940.73	892.49	771.15	706.94	121.34	12.90



Habitat Site 8B-4 | Summary of 5 Cross Sections | Data Collected 5-21-86

Measured Flow Q = 1,802 cfs

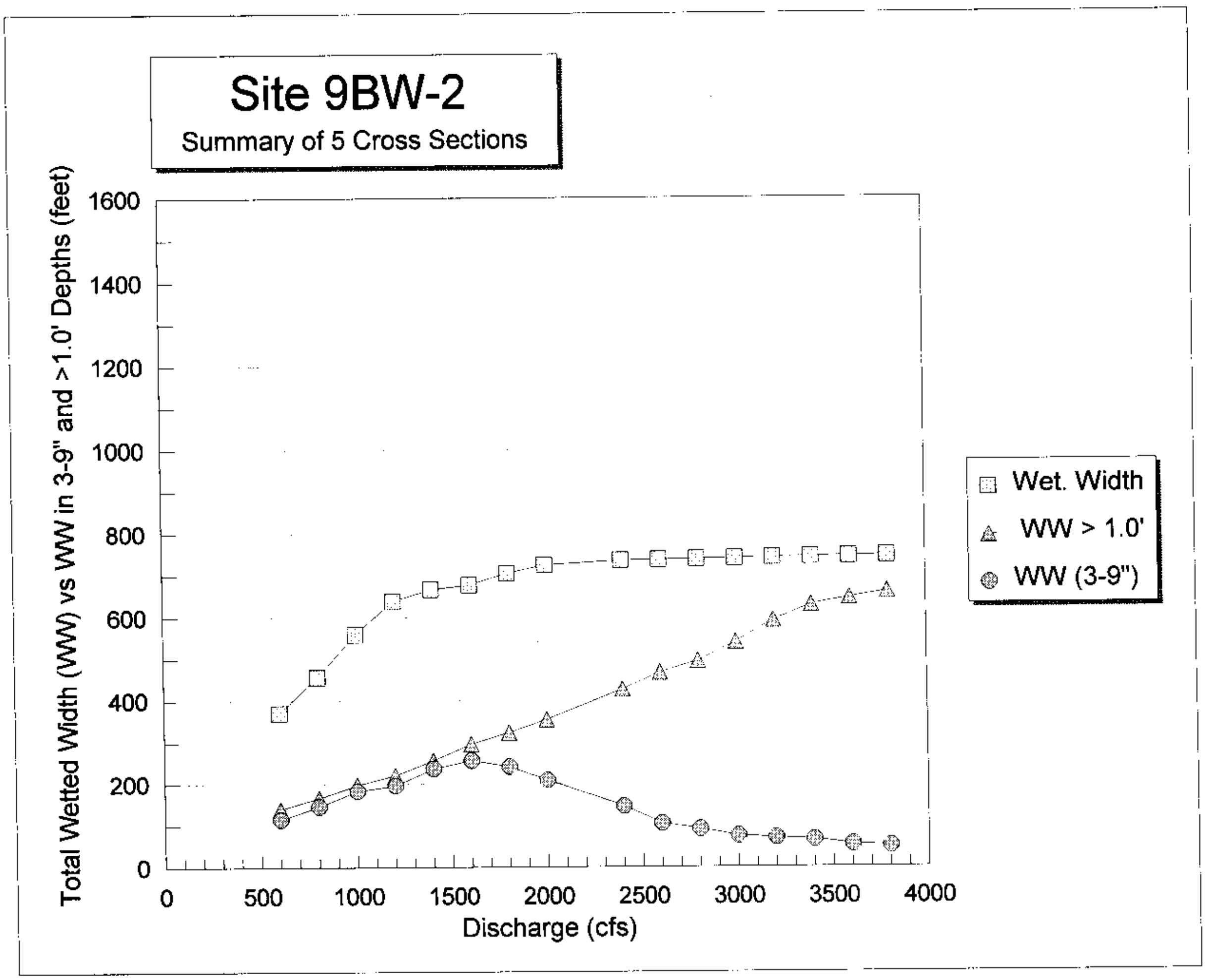
Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	Percent WW (3-9")
1000	771.06	577.91	255.43	171.14	322.48	41.82
1200	845.78	665.16	341.30	197.92	323.86	38.29
1500	895.57	798.38	446.89	267.73	351.49	39.25
1700	912.54	843.68	497.94	327.41	345.74	37.89
1900	926.17	880.74	549.94	394.76	330.80	35.72
2000	932.07	891.79	571.78	424.22	320.01	34.33
2200	944.82	904.15	638.17	477.11	265.98	28.15
2500	973.12	923.05	725.77	534.57	197.28	20.27
2700	999.64	933.77	790.27	587.33	143.50	14.36
3000	1010.66	952.09	841.74	667.53	110.35	10.92
3500	1024.59	999.07	895.06	795.71	104.01	10.15
4000	1033.72	1013.71	918.64	857.99	95.07	9.20



Habitat Site 9BW-2 Summary of 5 Cross Sections Data Collected 3-31-83

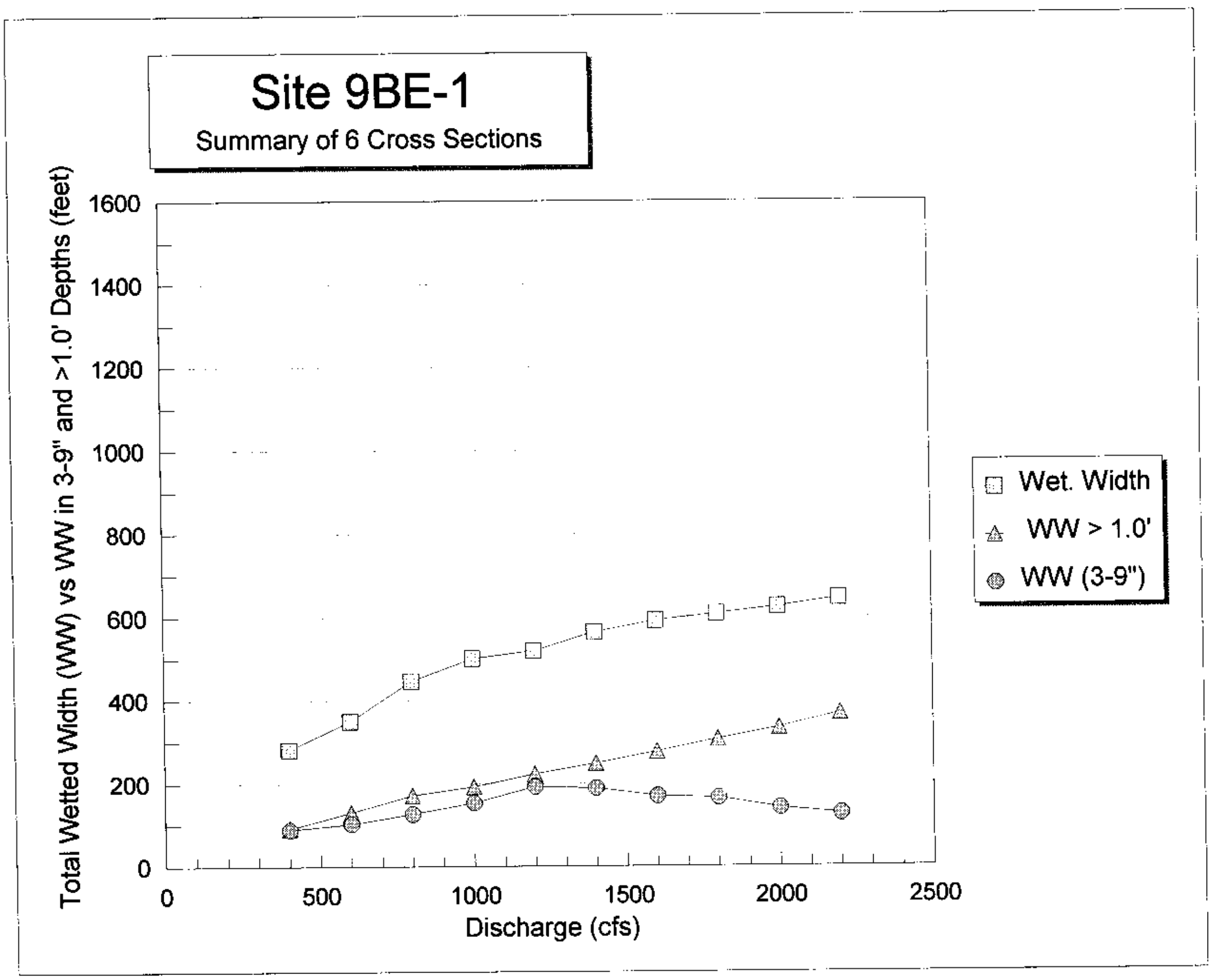
Measured Flow Q = 1,568 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	Percent WW (3-9")
600	370.03	286.87	172.37	140.08	114.50	30.94
800	456.89	353.58	208.11	166.23	145.47	31.84
1000	559.02	431.04	248.59	196.88	182.45	32.64
1200	637.86	493.92	298.00	220.18	195.92	30.72
1400	666.42	568.76	332.52	255.67	236.24	35.45
1600	676.81	633.10	377.51	295.57	255.59	37.76
1800	704.54	658.98	418.42	322.34	240.56	34.14
2000	723.88	671.29	462.82	353.75	208.47	28.80
2400	734.58	706.41	561.19	426.01	145.22	19.77
2600	736.35	712.07	607.79	466.39	104.28	14.16
2800	738.12	729.55	639.09	493.79	90.46	12.26
3000	739.74	733.54	659.45	538.21	74.09	10.02
3200	741.39	735.19	666.05	590.71	69.14	9.33
3400	742.93	736.70	671.54	627.66	65.16	8.77
3600	744.35	738.09	684.87	644.36	53.22	7.15
3800	745.78	739.49	690.94	659.14	48.55	6.51



Habitat Site 9BE-1 Summary of 6 Cross Sections Data Collected 3-23-83
Measured Flow Q = 1,098 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW (3-9")	Percent WW (3-9")
400	280.96	217.97	128.79	92.65	89.18	31.74
600	350.20	282.68	179.68	129.94	103.00	29.41
800	446.58	333.66	207.36	171.64	126.30	28.28
1000	501.60	398.88	245.88	192.27	153.00	30.50
1200	519.38	472.56	280.16	222.57	192.40	37.04
1400	564.57	504.10	316.40	247.92	187.70	33.25
1600	591.93	517.50	348.09	275.91	169.41	28.62
1800	608.27	560.76	396.62	305.91	164.14	26.98
2000	624.39	577.00	436.71	333.30	140.29	22.47
2200	645.02	597.76	471.45	367.93	126.31	19.58



Habitat Site 12A-4 Summary of 3 Cross Sections Data Collected 6-13-86
Measured Flow Q = 1,068 cfs

Flow (cfs)	Wet. Width	WW > 0.25	WW > 0.75	WW > 1.0'	WW 3-9"	Percent WW 3-9"
400	1031.53	514.51	119.94	40.67	394.57	38.25
600	1220.44	779.26	187.27	83.80	591.99	48.51
700	1260.77	876.21	210.52	98.49	665.69	52.80
800	1285.46	1000.89	235.55	109.48	765.34	59.54
900	1312.67	1063.37	260.28	131.31	803.09	61.18
1000	1332.52	1129.35	286.97	151.85	842.38	63.22
1200	1363.79	1231.93	346.72	193.12	885.21	64.91
1400	1380.2	1275.81	444.92	226.11	830.89	60.20
1600	1392.79	1314.65	568.92	260.89	745.73	53.54
1800	1421.96	1344.43	687.08	302.06	657.35	46.23
2000	1439.61	1365.07	808.91	350.14	556.16	38.63
2200	1447.61	1377.71	950.51	421.74	427.20	29.51
2400	1457.47	1389.02	1037.61	529.64	351.41	24.11
2600	1466.07	1412.32	1115.74	628.02	296.58	20.23
2800	1473.09	1427.16	1173.65	718.42	253.51	17.21