ADAPTIVE MANAGEMENT ON THE PLATTE RIVER

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Platte River Recovery Implementation Program Adaptive Management Plan (AMP)
2012 "State of the Platte" Report – Technical Details

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PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2012 "STATE OF THE PLATTE" REPORT

Table of Contents

Introduction……………………………………………………………………………………..3

PRRIP "Big Questions"……………………………………………………………………………..3

2011 Tern and Plover Monitoring Results………………………………………………………..4

Tern and Plover Minimum Habitat Criteria………………………………………………………13

2011 Whooping Crane Monitoring Results…………………………………………………......14

Whooping Crane Minimum Habitat Criteria……………………………………………………..24

2011 Geomorphology/Vegetation Monitoring Results…………………………………………31

Elm Creek FSM "Proof of Concept" ……………………………………………………………..41

Sediment Augmentation Pilot-Scale Management Action……………………………………68

Cottonwood Ranch Flow Consolidation…………………………………………………………77

2011 Water Quality Monitoring Results…………………………………………………………83

Appendix A – Elm Creek FSM "Proof of Concept" Bar Clearing Plan……………………………..91

Big Questions

Program scientific activities are being implemented to address major Program scientific and technical uncertainties identified as "broad hypotheses" on Pages 14-17 of the AMP. The following set of ten "Big Questions" represents a condenses version of uncertainties related to target species use of the central Platte River, Program implementation and target species response, and assessing the results of management actions during the First Increment. Additional questions and uncertainties may enter the mix during the First Increment, but the list of Big Questions provides a template for linking specific hypotheses and performance measures to management objectives and the overall goals of the Program.

Big Questions = What we don't know but want to learn	
Target Species Use	
1)	Do terns, plovers, and whooping cranes use Program habitat complexes and/or habitat meeting Program minimum criteria in proportions greater than their availability?
2)	What is the relationship between concurrently available riverine and sandpit nesting habitat and tern and plover use and productivity?
3)	What is the relationship between availability of riverine nesting habitat meeting Program minimum criteria and tern and plover use and reproductive success?
4)	What is the relationship between availability of whooping crane roosting habitat meeting Program minimum criteria and whooping crane use?
5)	How does tern, plover, and whooping crane use of the central Platte River relate to overall population recovery objectives?
Physical Processes, Management Actions, & Species Response	
6)	How do short-duration high flows (SDHF), restoring sediment balance, and mechanical channel alterations contribute to the maintenance of channel width and creation of a braided river channel?
7)	What is the relationship between SDHF, sediment balance, and tern and plover riverine nesting habitat meeting Program minimum criteria?
8)	What is the relationship between SDHF, sediment balance, and whooping crane habitat meeting Program minimum criteria?
9)	Have Program water-related activities avoided adverse impacts to pallid sturgeon in the lower Platte River?
Next Steps	
10)	What uncertainties exist at the end of the First Increment, and how might the Program address those uncertainties in the Second Increment?

Table X. The Program's "Big Questions". These questions represent critical uncertainties about Program target species, physical processes, and the response of target species to management actions that will be the focus of the application of rigorous adaptive management in the First Increment. These Big Questions are generally based on statements of broad hypotheses on pages 14-17 of the AMP. These questions are a subset of those broad hypotheses; the subset was identified through a series of Technical Advisory Committee workshops in 2010 that focused on sequencing Program hypotheses and through subsequent development of this Synthesis Report.

PLATTE RIVER RECOVERY IMPLEMENTATAION PROGRAM
2011 Tern and Plover Monitoring Results

Monitoring Protocol: PRRIP Tern and Plover Monitoring Protocol
Monitoring Entity: ED Office lead; USGS, CPNRD, NPPD, FWS personnel
Dates of Field Activity: May 2011 through August 2011
Numbers of Years of Implementation: Five (2007-2011)
Analysis Entity: ED Office

Relevant Big Question(s)

#1 – Do terns and plovers use Program habitat complexes and/or habitat meeting Program minimum criteria in proportions greater than their availability?

#3 – What is the relationship between availability of riverine nesting habitat meeting Program minimum criteria and tern and plover use and productivity?

Relevant Tier 1 Hypotheses from AMP

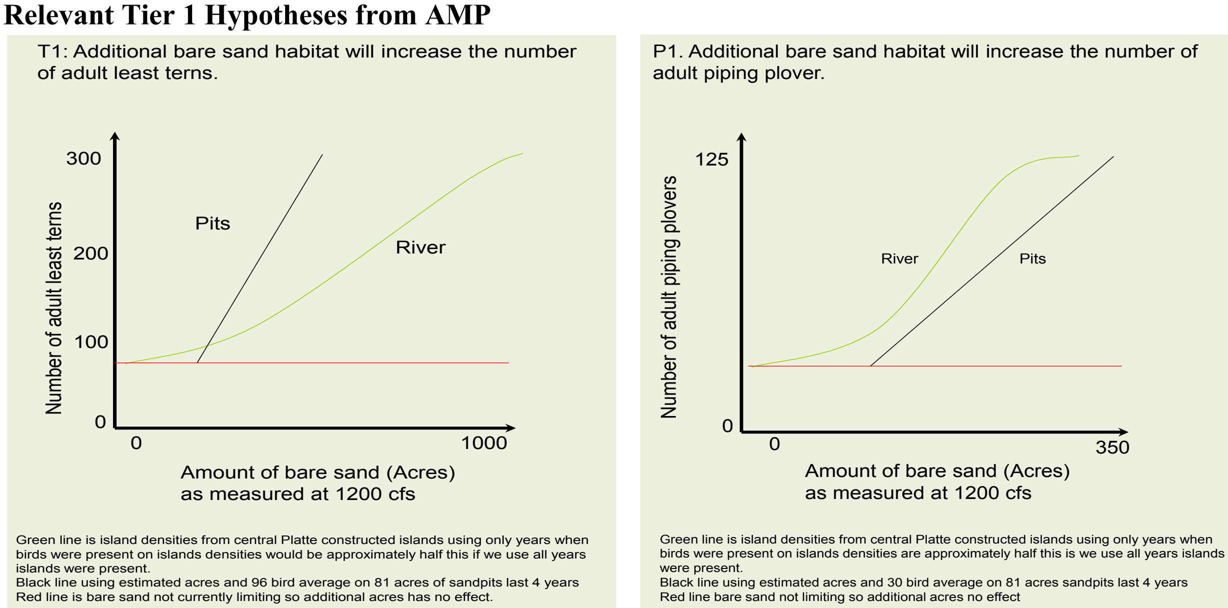


Figure 1. Hypothesized responses of terns and plovers to on- and off-channel habitat availability within the Program Associated Habitat Area.

Performance Measures and Benchmarks

Table 1. Program defined least tern and piping plover habitat and productivity Performance Measures and Benchmarks. Benchmarks are based on various Program documents and will be finalized during 2012.

Performance Measure	Benchmarks	
	Minimum	Target
Acres of in-channel bare sand	150	640
Acres of sandbars meeting MHC	90	384
Acres of off-channel habitat meeting MHC	80	200
Tern nesting pairs	75	126
Tern nesting pairs/acre of in- and off-channel habitat meeting MHC	0.67/acre	1.00/acre
Increase in proportion of terns observed on the river during mid-month surveys (i.e. 10%-25% increase over 2001-2006 average)	10%	25%
Tern fledge ratio	0.70	1.00
Plover nesting pairs	32	64
Plover nesting pairs/acre of in- and off-channel habitat meeting MHC	0.17/acre	0.20/acre
Increase in proportion of plovers observed on the river during mid-month surveys (i.e. 10%-25% increase over 2001-2006 average)	10%	25%
Plover fledge ratio	1.17	1.75

2011 Summary of Activities

- Seven of twelve sandpit sites monitored for tern and plover productivity were actively managed during 2011. The Program created a 40-acre off-channel nesting area (50/50 sand/water ratio) at Cottonwood Ranch, increased the suitable nesting area at Newark sandpit by ~10 acres, and removed vegetation from ~30 acres of nesting habitat at Broadfoot South and Dyer sandpits prior to the 2011 nesting season. A pre-emergent herbicide was applied to the nesting areas at Lexington, Dyer, Blue Hole, Johnson, Cottonwood Ranch, Broadfoot South, and Newark sandpits and the nesting areas were protected from predators with electrified fencing and trapping.
- Tern and plover monitoring and research conducted during 2011 was a collaborative effort between personnel of Headwaters Corporation, Nebraska Public Power District, United States Fish and Wildlife Service-Grand Island Field Office, Central Platte Natural Resources District, and USGS-Northern Prairie Wildlife Research Center. We conducted surveys of the Program Associated Habitat area (Platte River and sandpits within 3.5 miles of the Platte River between Lexington and Chapman, NE) to document tern and plover habitat use and productivity on or about the first and fifteenth of May, June, and July and the first of August. Sandpit sites with active nests or broods were surveyed from within (grid searches) and outside the nesting colony twice per week. We documented numbers of tern and plover adults, nests, chicks, and fledglings observed as well as habitat characteristics believed to influence tern and plover use and productivity during each survey. In addition, we banded tern and plover adults and chicks to allow us to quantify dispersal, colonization, and renesting events.


2011 Results

Terns and Plovers

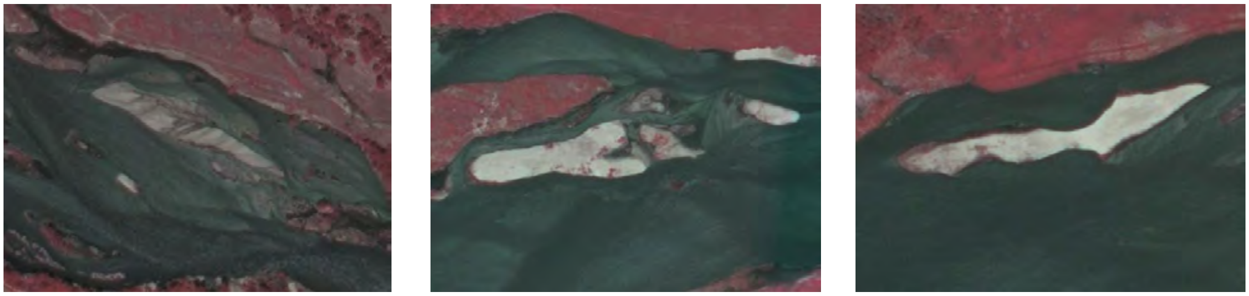
- All least tern and piping plover nesting occurred on sandpit sites during 2011 (Table 2).
- Least tern use of the river for foraging remained fairly high during early June and August when many adults were initiating nests and tending to fledglings, respectively, despite the season-long natural high flow event that inundated or laterally eroded nearly all riverine nesting habitat.
- We observed a season high 57 least tern pair within the Program Associated Habitats during the 15-July survey when there were 19 active nests and 16 active broods at sandpit sites (Table 2).
- We observed 90 interior least tern nests, 125 chicks, and 98 fledglings which equates to a fledge ratio of 1.09 fledglings/nest or 1.72 fledglings/pair during 2011 (Figure 2).
- River use by piping plovers declined sharply after May 15 which likely was the result of the near-complete loss of sandbar foraging and nesting habitat within the Program Associated Habitat Area.
- We documented 25 pair of piping plovers during the 1-July survey when there were 5 active nest and 8 broods present; however, we observed 22 active nests and broods during the 1-June survey when we only observed 22 pair with the Program Associated Habitats (Table 2).
- We observed 34 piping plover nests, 88 chicks, and 46 fledglings and an overall fledge ratio of 1.35 fledglings/nest or 1.84 fledglings/pair during 2011 (Figure 2).

Table 2. Numbers of interior least tern and piping plover adults, nests, chicks, broods, and fledglings observed within Program Associated Habitats during semi-monthly river and sandpit surveys, 2011.

	Interior least tern					Piping plover				
Survey	Adults	Nests	Chicks	Broods	Fledglings	Adults	Nests	Chicks	Broods	Fledglings
1 May	0	0	0	0	0	35	5	0	0	0
15 May	18	0	0	0	0	45	15	0	0	0
1 Jun	93	4	0	0	0	45	21	3	1	0
15 Jun	101	32	0	0	0	48	8	26	12	0
1 Jul	99	30	11	5	0	51	5	21	8	18
15 Jul	114	19	32	16	12	26	4	13	5	17
1-Aug	94	3	26	13	53	5	0	5	2	11

Habitat

- The natural high-flow event during 2011 inundated or laterally eroded away most in-channel bare sand habitat.
- Two consecutive season-long natural high flow events resulted in a net loss of in-channel nesting habitat meeting the Program's minimum habitat criteria. During mid-June, there was approximately 6 acres of sandbar habitat exposed that met the Program's minimum habitat criteria.
- Program management actions between the 2010 and 2011 nesting seasons increased off-channel nesting habitat availability by approximately 50 acres.



Aerial images of constructed and managed tern and plover nesting sites available for nesting 15 June, 2011.

Table 3. Program defined least tern and piping plover habitat and productivity Performance Measures and Benchmarks. Numbers in red font are preliminary and will be updated once habitat availability assessments are finalized.

Performance Measure	2011 Results
Acres of in-channel bare sand	100
Acres of sandbars meeting MHC	6
Acres of off-channel habitat meeting MHC	529
Tern nesting pairs	57
Tern nesting pairs/acre of in- and off-channel habitat meeting MHC	0.11
Increase in proportion of terns observed on the river during mid-month surveys (i.e. 10%-25% increase over 2001-2006 average)	24%
Tern fledge ratio (Fledglings/nest : fledglings/pair)	1.09 : 1.72
Plover nesting pairs	25
Plover nesting pairs/acre of in- and off-channel habitat meeting MHC	0.05
Increase in proportion of plovers observed on the river during mid-month surveys (i.e. 10%-25% increase over 2001-2006 average)	–48%
Plover fledge ratio (Fledglings/nest : fledglings/pair)	1.35 : 1.84

Comparative Results and Trends

Terns and Plovers

- The number of adult least tern pair observed during system-wide surveys of Program Associated Habitats (Figure 2) has not met the Program's Target or Minimum Performance Benchmarks (Table 1); however, recent counts have increased despite unfavorable riverine nesting conditions (Figure 2).
- The number of least tern nests observed within the Program Associated Habitats has increased steadily since 2007(Figure 2). We observed 84% more least tern nests during 2011 than 2007.
- Least tern fledge ratios (Figure 2) have met or exceeded the Program's Minimum Performance Benchmark of 0.70 fledglings/nest (Table 1) since 2007 and the fledge ratio the past 2 years met or exceeded the Program's Performance Benchmark Target of 1.00 fledglings/nest.

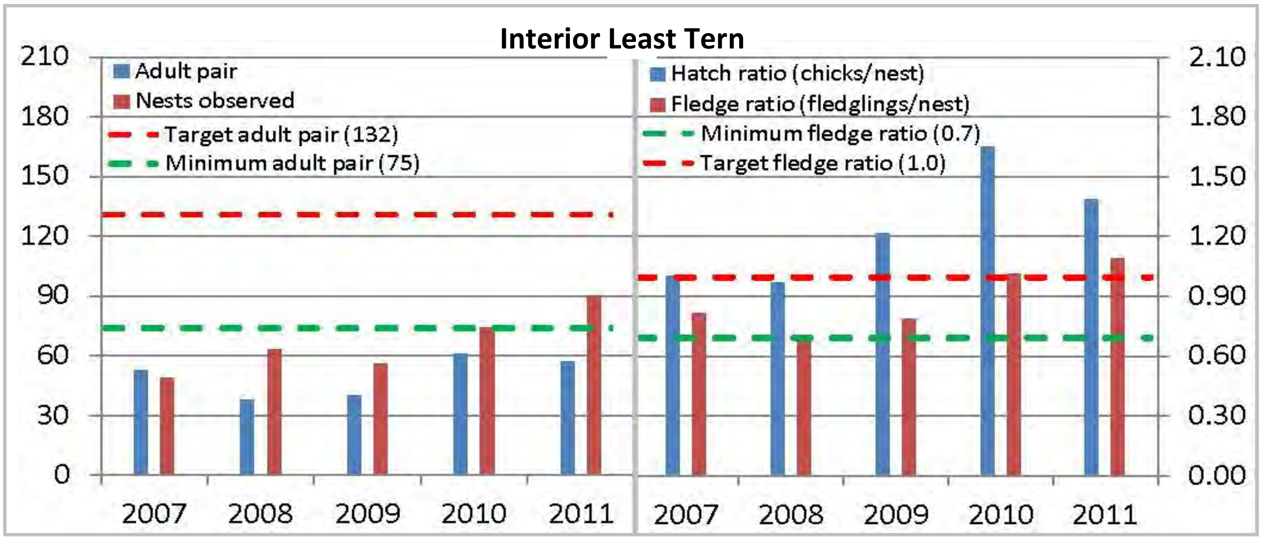


Figure 2. Numbers of interior least tern pair and nests (left) and the hatch and fledge ratios (right) observed within Program Associated Habitats, 2007 – 2011. Dashed lines represent Program defined minimum and target Performance Benchmarks.

- The number of adult piping plover pair observed during system-wide surveys of Program Associated Habitats (Figure 3) has not met the Program's Target Performance Benchmark (Table 1); however, recent counts have exceeded the Program's Minimum Performance Benchmark despite unfavorable nesting conditions on the river (Figure 3).
- The number of piping plover nests observed within the Program Associated Habitats has increased steadily since 2007(Figure 3). We observed 70% more piping plover nests during 2011 than 2007.
- Piping plover fledge ratios (Figure 3) have met or exceeded the Program's Minimum Performance Benchmark of 1.17 fledglings/nest (Table 1) the past 2 years; however, fledge ratios have not met the Program's Performance Benchmark Target of 1.75 fledglings/nest since the Program was initiated.

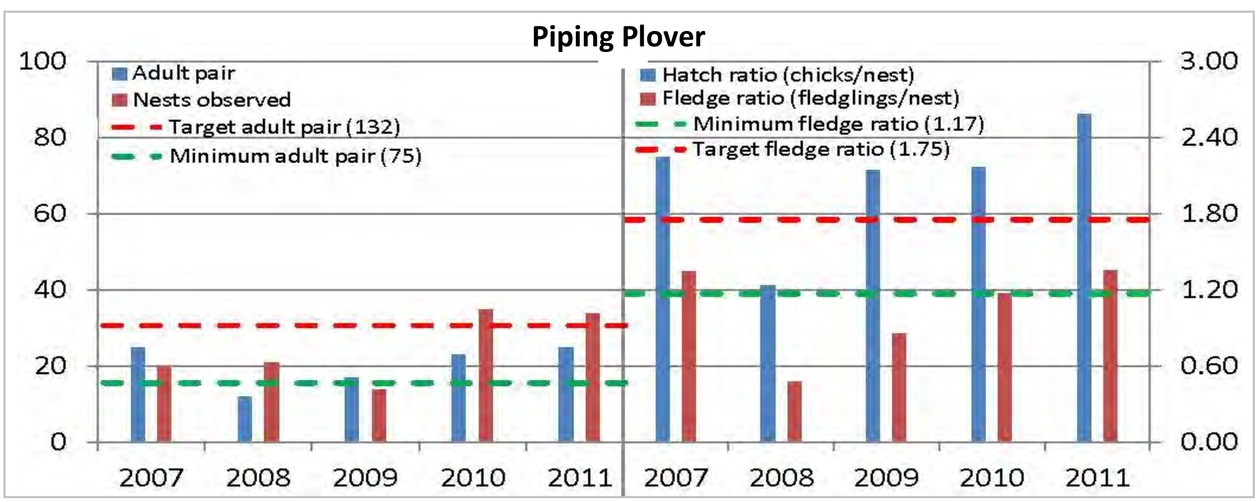


Figure 3. Numbers of piping plover pair and nests (left) and the hatch and fledge ratios (right) observed within Program Associated Habitats, 2007 – 2011. Dashed lines represent preliminary Minimum and Target Performance Benchmarks for plover pairs and fledge ratios. Final Performance Benchmarks will be established during 2012.

Habitat

- The amount of in-channel habitat meeting Program minimum habitat criteria has never met the Program's Minimum or Target Performance Benchmarks (Table 1). Season-long high-flow events the past 2 years have resulted in a near-total loss of suitable nesting habitat for terns and plovers (Figure 4).
- Management actions taken by the Program and its partners have resulted in a net increase in the availability of off-channel habitat within the Associated Habitat Area (Figure 4). The amount of off-channel habitat meeting Program minimum habitat criteria has exceeded the Program's Minimum and Target Performance Benchmarks since 2007 (Table 1).

Managed nesting habitat that was laterally eroded away by season-long high flow events during 2010 and 2011.

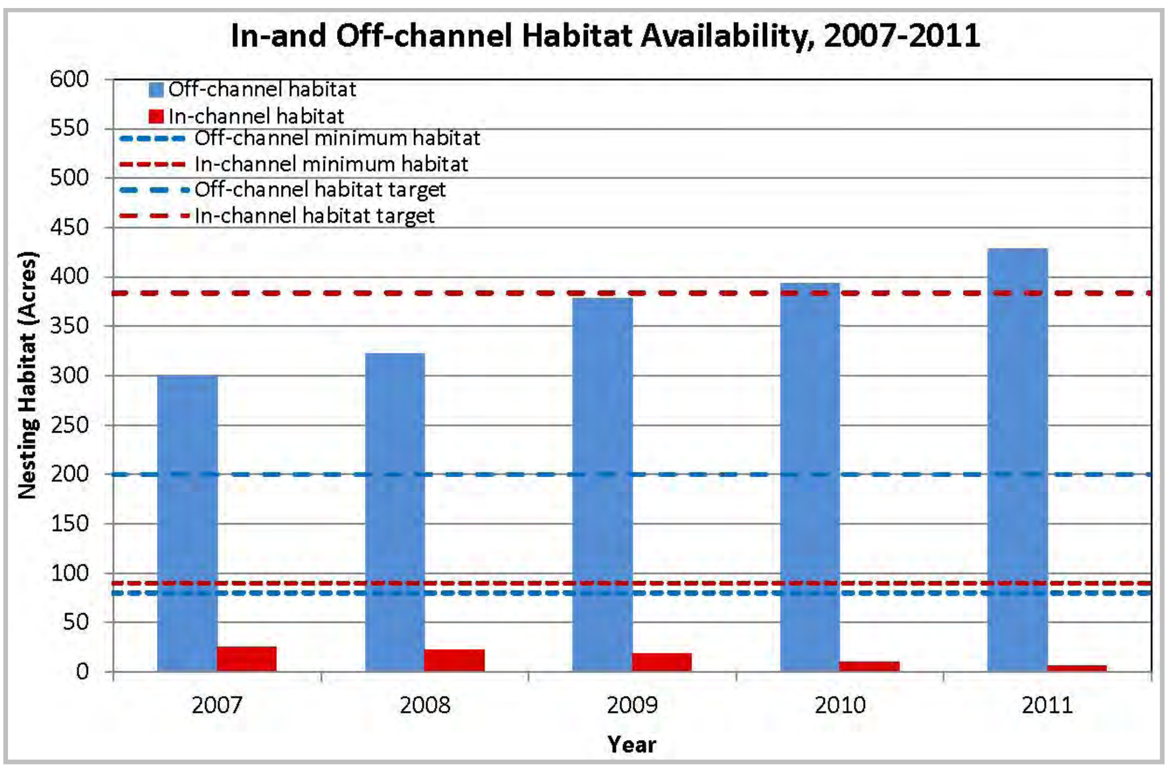


Figure 4. In- and off-channel habitat availability, 2007-2011. Dashed lines represent preliminary minimum and target performance benchmarks for in-and off-channel habitat availability. Final Performance Benchmarks for the Program will be established once habitat availability assessments are complete.

Tier 1 Hypotheses and Big Questions

- We observed a positive relationship between in- and off-channel habitat availability and numbers of least tern nests observed on each habitat type (Figure 5). In-channel habitat availability, however, has declined since 2007 and we observed no tern nests on river islands during 2010 or 2011.

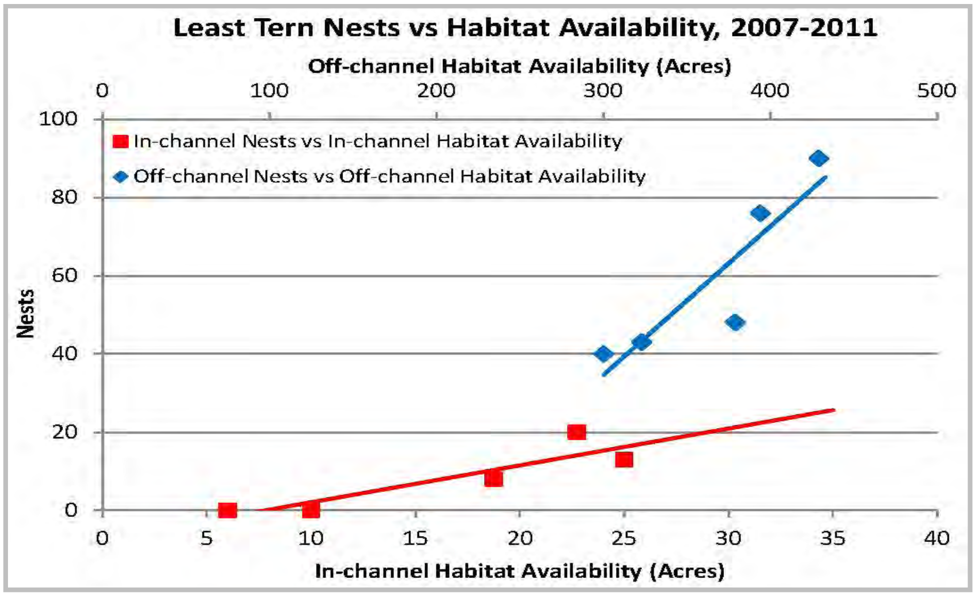


Figure 5. Relationship between availability of in- and off-channel habitat meeting Program minimum habitat criteria and number of least tern nests observed on each habitat type, 2007-2011.

- We observed a positive relationship between off-channel habitat availability and numbers of piping plover nests, 2007-2011(Figure 6).
- We observed a negative relationship between in-channel habitat availability and numbers of piping plover nests, 2007-2011 (Figure 6); however, the relationship was skewed by the loss of habitat following nest initiation during 2010. Removing the 2010 data from the trend analysis resulted in a positive relationship as described by Program hypothesis P1 (Figure 1).
- In-channel habitat availability has declined since 2007 and we observed no piping plover nests on river islands during 2011.

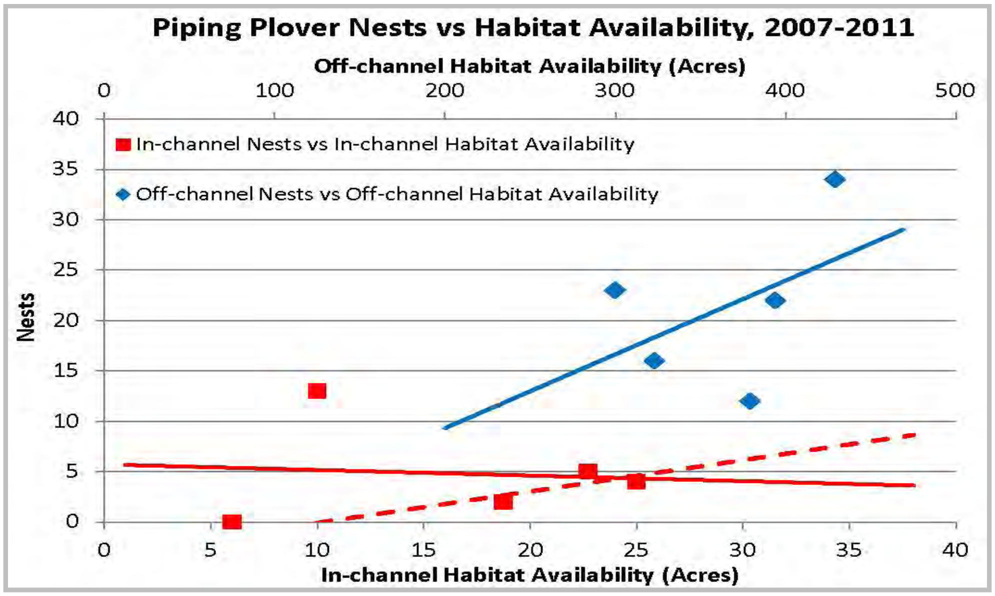


Figure 6. Relationship between availability of in- and off-channel habitat meeting Program minimum habitat criteria and number of piping plover nests observed on each habitat type, 2007-2011. The red dashed line excludes 2010 data when habitat availability was high during May, but decreased rapidly when a natural high flow event inundated and laterally eroded away most suitable nesting habitat.

Conclusions

- What are general takeaway messages from 2011?
    - 2011 productivity remained high despite the season-long high-flow event that inundated most riverine habitat.
    - Habitat enhancement work at off-channel sites the past 2 years resulted in a better distribution of terns and plovers throughout the Program Associated Habitat Area.
- Any implications to management actions based on 2011 data?
    - Going into the 2012 nesting season, the Program should create as much sandbar habitat as possible to allow the Program to test the hypothesized relationships presented in Hypotheses T1 and P1. We estimate there were ≤10 acres of habitat meeting the Program's minimum habitat criteria available for nesting the past 2 years due to the prolonged natural high-flow events.
    - Management actions taken at off-channel sites the past few years have resulted in a net increase in habitat availability and have distributed nesting across a wider stretch of river.
- What do 2011 and 2007-2011 data say about Big Questions and Tier 1 hypotheses?
    - There appears to be a positive relationship between in- and off-channel habitat availability and tern and plover use; however, to test hypotheses T1 and P1 the Program needs to increase habitat availability to better establish the relationships between habitat availability and use.

Recommendations for 2012

- Adjustments to monitoring protocol and/or methodology
    - Conduct 1 inside grid-search survey/week/nesting-colony site and add additional targeted band & chick surveys. Continue to survey all nesting colonies twice/week from outside the nesting colony.

- Adjustments to data analysis
    - Following the 2012 nesting season, conduct a habitat selection analysis on data collected since 2007 to refine our understanding about the influence various factors have on nest-site selection.
    - Analyze independent double observer data to determine if there is a benefit or need to continue monitoring from inside and outside the nesting colony.
- Adjustments to relevant Tier 1 hypotheses and/or conceptual model
    - T1 and P1 Hypotheses – Habitat should be calculated based on Program Minimum Habitat Criteria and habitat exposed during mid-June rather than being based on flows of 1,200cfs.
    - T1 and P1 Hypotheses – Change the Y-axis to numbers of nests observed on in-channel and off-channel habitat. An increase in adults or pairs doesn't appear to relate well with habitat availability by type. For example, availability of riverine habitat has decreased since 2007 while adult counts tended to increase during this timeframe.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

Tern and Plover Minimum Habitat Criteria

In-channel Minimum Habitat Criteria

- 0.25 acres ≥18 inches above river stage @ 1,200cfs
- Within 0.25 mile reach of channel, ≥1.5 acres of bare sand with at least one 0.25-acre sandbar 18 inches above river stage @ 1,200cfs
- Channel width ≥400 feet
- ≥50-foot water barrier between shoreline and edge of bare sand
- Edge of bare sand ≥200 feet from mature trees (predator perch)

Off-channel Minimum Habitat Criteria

- Within 2 miles of a river channel
- Within a site, ≥1.5 acres of nesting substrate; contributing habitat must be ≥0.25 acres in size.
- Bare or sparsely vegetated (<25%) sand and/or gravel substrate that is dry during the nesting season. Nest furniture may be present.
- Water:sand ratio between 1:1 and 4:1
- Edge of bare sand ≥200 feet from mature trees (predator perch)

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2011 Whooping Crane Monitoring Results

Monitoring Protocol: PRRIP Whooping Crane Monitoring Protocol
Monitoring Entity: AIM and WEST
Dates of Field Activity: March 21-April 29 and October 9-November 10, 2011
Numbers of Years of Implementation: Five (2007-2011)
Analysis Entity: WEST

Big Questions

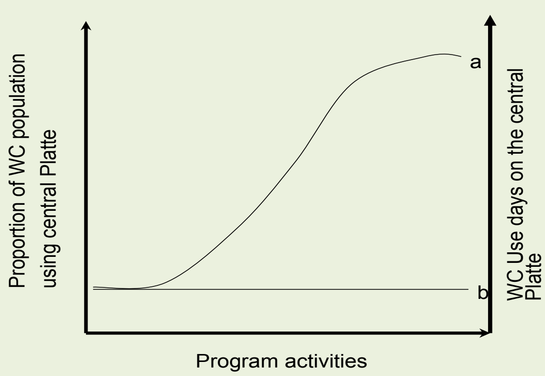
#1 – Do whooping cranes use Program habitat complexes and/or habitat meeting Program minimum criteria in proportions greater than their availability?

#3 – What is the relationship between availability of whooping crane roosting habitat meeting Program minimum criteria and whooping crane use?

Relevant Hypotheses from AMP

Two hypotheses from the AMP are directly tied to the whooping crane monitoring: WC 1 and WC 3. Below are the summary figures for these hypotheses.

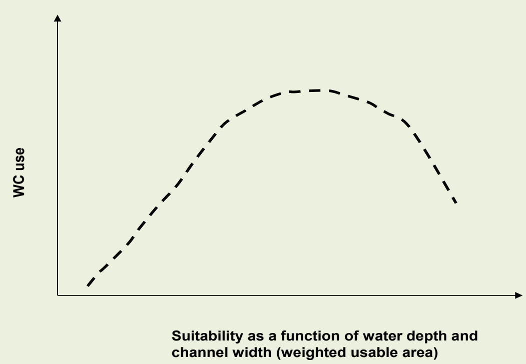
WC 1. Whooping Crane use will increase as function of Program land and management activities.



a. The amount of whooping crane use days will increase as Program activities increase.
b. Whooping crane use days will not increase with Program activities.

Analysis and consideration will be needed to investigate Program activities and non Program activities (e.g., Trust land management). Analysis could also be done on a bridge segment basis as well as a system basis.

WC 3. Whooping crane use is related to habitat suitability



The prediction of habitat suitability for whooping crane in channel habitat as a function of water depth and unobstructed channel width. FWS Instream flow recommendation for fall and spring whooping crane migration season is 2,400 cfs. Farmer et al. estimates that peak suitability is achieved at 1700 cfs.

Performance Measures and Benchmarks

The Executive Director's Office and Technical Advisory Committee began to specify performance measures and benchmarks for the Program related to whooping cranes. GIS habitat mapping will be done on existing aerial imagery starting in 2012. This information can then be used in various analyses to investigate changes to the system as they relate to flows and land management actions.

2011 Summary of Activities

- Aerial surveys were conducted along the 90-mile long study area during spring and fall migration as weather permitted.
- Whooping cranes were followed during daylight hours and habitat-use/activity was recorded.
- Use site profiles were measured at both riverine and palustrine wetland locations as conditions allowed.
- Aerial search efficiency trials were conducted by placing whooping crane decoys in the river channel at 20 randomly selected sites during both seasons combined.

2011 Survey Results

Aerial Survey and Index of Use

Spring- 100 (62%) out of 160 scheduled transects were flown. Eighteen whooping crane sightings were made for an index of use of 0.18 sightings per transect. About 4,500 survey miles were flown.

Fall- 112 (85%) out of 132 scheduled transects were flown. One whooping crane sighting was made for an index of use of 0.009 sightings per transect. About 5,040 survey miles were flown.

Number of Whooping Cranes

Spring - A record 36 (32 ad: 4 chicks) whooping cranes were recorded. This estimate represented a minimum number. Whooping cranes were present 23 (58%) of the 40-day survey period. An estimated 120 crane-use days were recorded.

Fall - Six (4 ad: 2 chicks) Whooping Cranes were recorded during 3 (9%) of the 33-day survey period. Twelve crane-use days occurred.

Habitat Use

Spring - Whooping Cranes were recorded at 29 locations within 12 sections during the day. Habitats used were: corn (23 locations), wetted channel (4 locations), and 1 each in alfalfa and palustrine wetland. One nocturnal roost location was palustrine wetland and 12 were wetted channel.

Fall - Wetted channel was the only habitat Whooping Cranes were observed using during the day. One of the nocturnal roosts was wetted channel and the other was a duck hunting pond excavated in the middle of the river channel.

Activity

Spring - A total of 107.2 hours of continuous and instantaneous use data was collected during 16 days of observation. Most of the diurnal activity recorded was in corn (79%), followed by wetted channel (12%), palustrine wetland (9%), and alfalfa (<1%). Feeding was the most frequently observed activity (Table 1).

Fall - About 0.5 hours of continuous and instantaneous use (time budget) data of Whooping Cranes was collected by ground personnel during 1 day of observation. Three data points of activity (time budget) were recorded in Wetted Channel. Resting was the only activity recorded.

Use Site Profiles

Spring - Twenty-five transects at 9 whooping crane roost sites were surveyed using a stadia and rod. Six sites were not surveyed due to high flows or they were lumped within a representative reach although visual obstruction data were collected at 3 of these. Distance to visual obstruction, unobstructed width, and roost depth are shown in Table 2.

Fall - Nine transects at 3 whooping crane use sites were surveyed using a Trimble GPS unit. Distance to visual obstruction, unobstructed width, and roost depth are shown in Table 3.

Table 1. Whooping crane activity by habitat type.

Habitat	Activity	n	Total	Percent
Ag-Corn	Alert	50	337	14
Ag-Corn	Courtship	1	337	<1
Ag-Corn	Feeding	257	337	77
Ag-Corn	Preening	9	337	3
Ag-Corn	Resting	20	337	6
Ag-Alfalfa	Alert	1	1	100
Palustrine Wetland	Alert	7	39	18
Palustrine Wetland	Feeding	16	39	41
Palustrine Wetland	Courtship	1	39	2
Palustrine Wetland	Resting	11	39	28
Palustrine Wetland	Preening	4	39	10
Wetted Channel	Alert	19	52	37
Wetted Channel	Defensive	1	52	2
Wetted Channel	Feeding	5	52	10
Wetted Channel	Courtship	1	52	2
Wetted Channel	Preening	1	52	2
Wetted Channel	Resting	25	52	48

Table 2. Visual obstruction (VO) distance (m), unobstructed width (m), and roost depth (in) at whooping crane use sites, spring 2011. Use Site 1 was a palustrine wetland.

Use Site ID	VO Upstream Distance	VO Right Distance	VO Downstream Distance	VO Left Distance	Unobstructed Width	Roost Depth
1	30	70	90	70	99	NA
2	98	47	52	64	107	-16.1
3	120	140	178	175	310	-15.7
4	110	71	137	207	276	-7.9
5	212	52	96	198	NA	NA
6	215	179	199	178	276	-8.7
7	NA	-	-	-	NA	NA
8	80	183	95	59	306	-17.3
8A	17	18	21	260	306	NA

Use Site ID	VO Upstream Distance	VO Right Distance	VO Downstream Distance	VO Left Distance	Unobstructed Width	Roost Depth
9	NA	-	-	-	NA	-
10	266	200	170	187	352	-16.5
11	119	147	132	81	168	-15.0
12	91	150	73	57	NA	NA
13	93	63	127	112	173	-9.8

Table 3. Visual obstruction (VO) distance (m), unobstructed view width (m), and roost depth (in) at whooping crane use sites, fall 2011.

Use Site ID	VO Upstream Distance	VO Right Distance	VO Downstream Distance	VO Left Distance	Unobstructed Width (ft)	Roost Depth (in)
1	185	148	200	78	724	+0.5
2	112	112	188	78	622	-8.0
3	59	28	36	28	177	-12.5

Searcher Efficiency Trials

Thirteen of 20 whooping crane decoys were detected by the aerial observers for an overall efficiency of 65%. Poor light conditions, decoys placed in the "blind spot" below the underbelly of the aircraft, and observer experience were factors influencing detection.

Comparative Results and Trends

Following are brief summaries of the various measurements taken by the Program during whooping crane monitoring from 2001-2011.

Aerial Survey and Index of Use

Spring - 1153 (72%) out of 1600 scheduled transects were flown. A total of 147 Whooping crane sightings were documented for an index of use of 0.13 sightings per transect.

Fall - 1122 (77%) out of 1452 scheduled transects were flown. A total of 60 whooping crane sightings were documented for an index of use of 0.05 sightings per transect.

In combination, 74% of transects were flown. The average index of use was 0.09 sightings per transect. Index of whooping crane use from 2001-2011 is reflected in Figure 1.

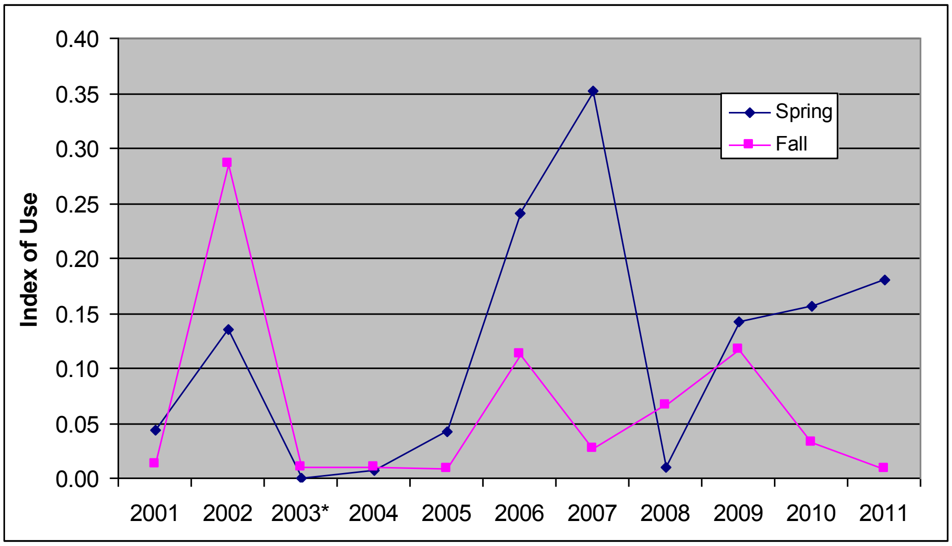


Figure 1. Index of whooping crane use of the study area. *Monitoring was not conducted during the spring 2003 migration.

Number of Whooping Cranes

Spring - 78 (60 ad: 18 chicks) whooping cranes were documented. An estimated 407 crane-use days were recorded.

Fall - 95 (79 ad: 16 chicks) whooping cranes were documented. An estimated 343 crane-use days were recorded.

There were 173 (139 ad: 34 chicks) whooping cranes documented to date and 750 crane-use days in the study area. The proportion of adults observed was greater in the fall (83%) than the spring (77%). The seasonal distribution of use is shown in Figures 2 and 3. The largest group was 11 individuals and the most seen during a migration season was 36. The dates of occurrence were March 21-April 19 in spring and October 23-November 7 in fall.

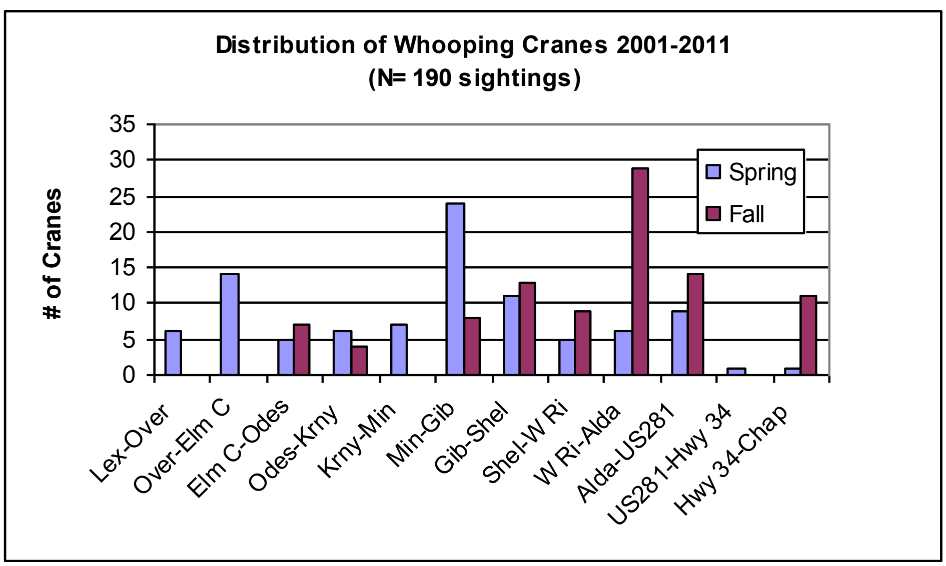


Figure 2. Seasonal distribution of Whooping Cranes by bridge segment (N= 173 individuals).

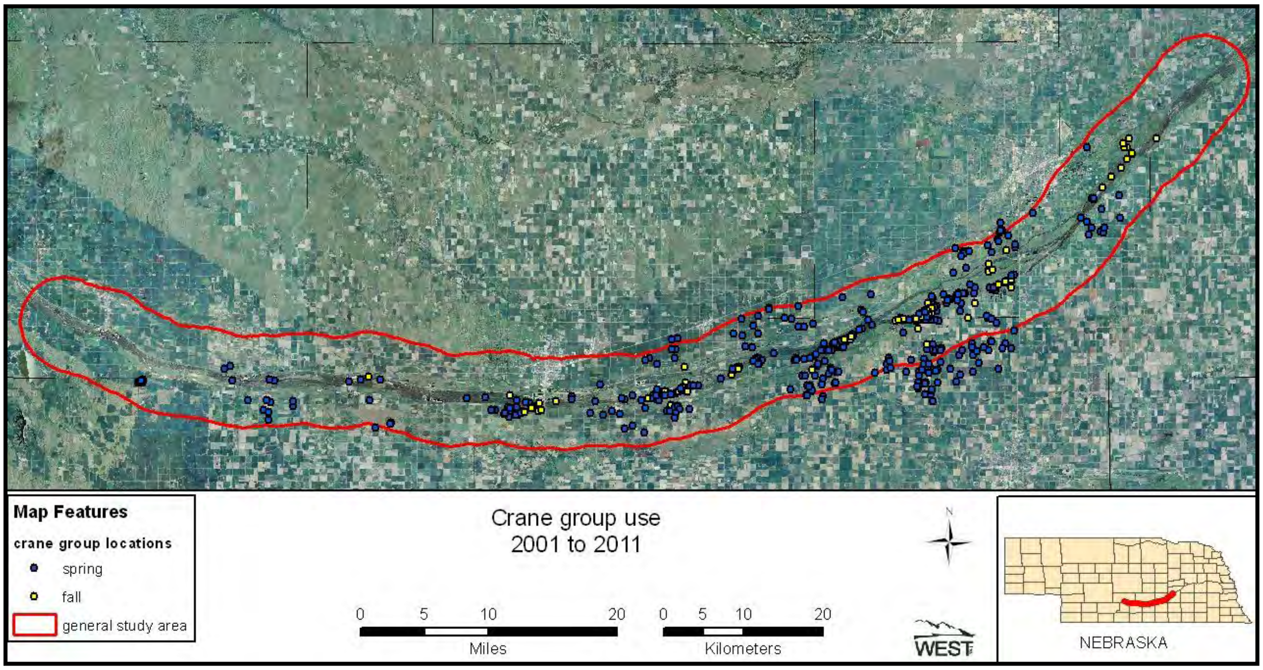


Figure 3. Seasonal whooping crane use locations.

We examined the number of crane-use days and percent of the population stopping along the Platte River by season (Table 4, Figure 4). Between 0.5% and 13% (mean= 4%) of the population stopped along the Platte River during migration. The length of stay varied from 2 to 26 days. More individual whooping cranes stopped in the fall (55%, N=173); however, more crane-use days occurred in the spring (54%, N=750 days).

Table 4. A comparison of the whooping crane population change and the percent of that population using on the Platte River.

	SPRING				FALL			
Year	WC Pop March	# Platte	Crane-Use Days	% Using Platte	WC Pop Dec	# Platte	Crane-Use Days	% Using Platte
2001	174	1	11	0.6	174	1	2	0.5
2002	174	1	26	0.6	185	19	121	9.8
2003	184	NA	NA	NA	194	1	2	0.5
2004	193	1	1	0.5	214	6	18	2.8
2005	214	4	13	1.9	216	2	2	0.9
2006	211	7	54	3.3	237	3	45	1.3
2007	237	9	71	3.8	266	10	23	3.8
2008	266	3	27	1.1	270	20	42	7.4
2009	247	6	42	2.4	264	12	44	4.6
2010	263	10	42	3.8	281	15	32	5.3
2011	269*	36	120	13.4	316*	6	12	1.9

*August population estimate

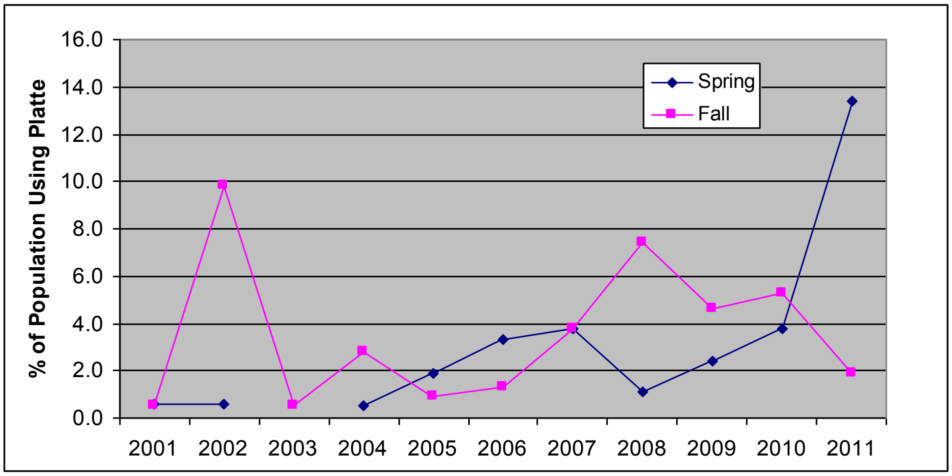


Figure 4. The percent of the whooping crane population observed on the Platte River.

Habitat Use

A total of 777 use locations, many of them used more than once, have been documented. Diurnal habitat use varied seasonally (Figure 5). Corn was used nearly 2.5 times more in the spring compared to fall while river was used 9 times more in the fall. Fall corn harvest was not believed to be a factor influencing use by whooping cranes because many, if not most, of the fields were harvested by the time the cranes arrived in late October. Whooping cranes were most frequently observed in corn (77% of the observations) in the spring while riverine habitat (57% of the observations) was most frequently used in the fall. We attribute that difference to the foraging activities during the summer months in Canada where wetlands are the only source of food for the cranes. The chicks have no experience foraging in agricultural fields prior to the fall migration and have not learned that behavior. Whooping cranes travelled from 0 to 7 miles from their nocturnal roosts to forage and occasionally travelled beyond the ~7-mile wide study area boundary (Figure 3).

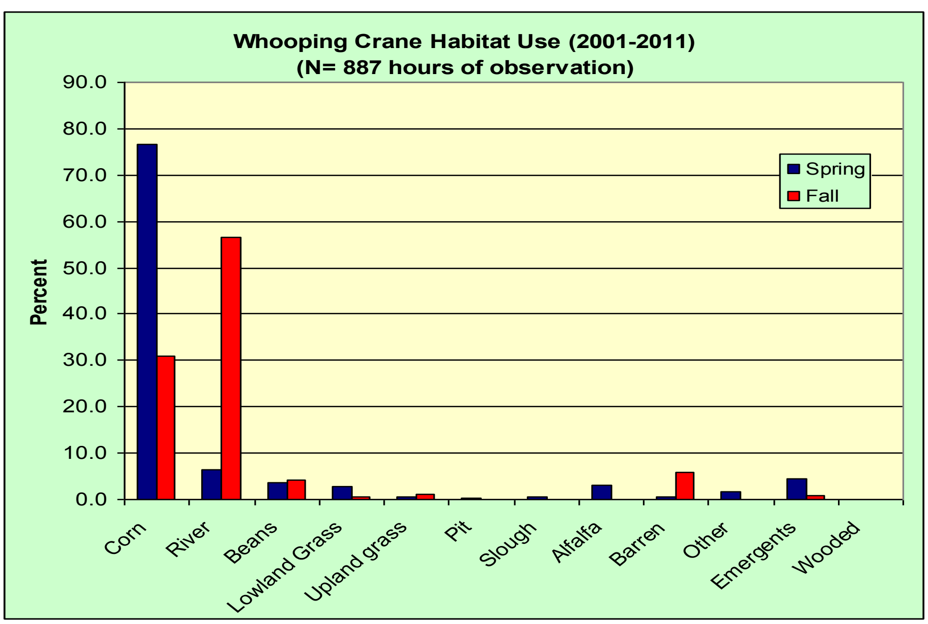


Figure 5. Diurnal habitat use in the spring and fall migration seasons.

Activity

A total of 619.2 hours of continuous and instantaneous use data was collected in spring and 131.5 hours in fall. Feeding was the most frequent activity observed (Figure 6).

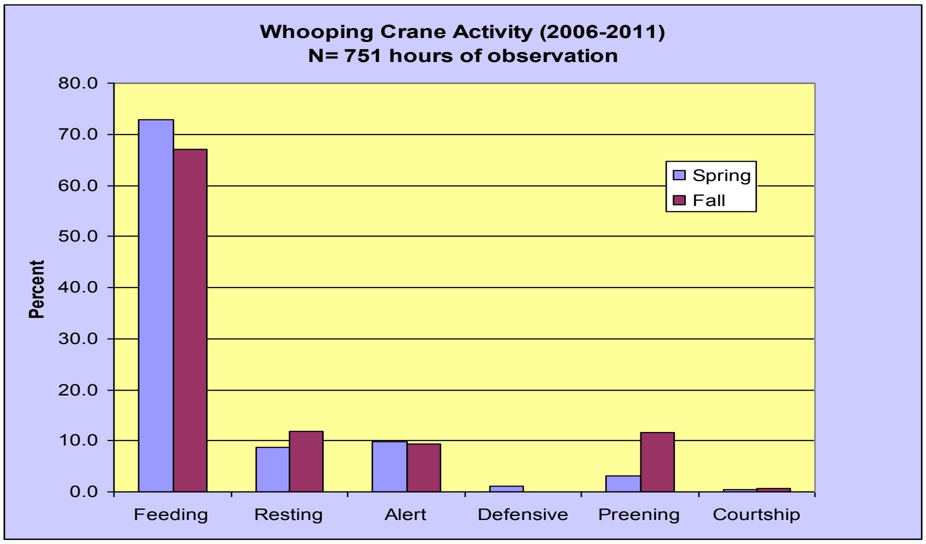


Figure 6. Seasonal whooping crane activity.

Use Site Profiles

Average distance to visual obstructions across the 21 migration seasons monitored from 2001 to 2011 averaged 495 feet (95% CI: 461, 530) from a sample of 249 use locations. Distance to nearest visual obstructions across the 21 migration seasons monitored from 2001 to 2011 averaged 260 feet (95% CI: 236, 284) from a sample of 249 use locations.

Roost depth across the 21 migration seasons monitored from 2001 to 2011 averaged 6.5 inches (95% CI: 5.9, 7.2) for the 201 roosts detected in water. Roost depth across the 21 migration seasons monitored from 2001 to 2011 averaged 2.9 inches (95% CI: 2.0, 3.8) for the 44 roosts detected on sand. Depths were measured after the whooping cranes migrated and are not necessarily the same as when the birds were present since flow conditions may have varied between the time of use and the time of measurement.

Unobstructed width across the 21 migration seasons monitored from 2011 to 2011 averaged 775 feet (95% CI: 724, 826) from a sample of 143 use locations.

Tier 1 Hypotheses and Big Questions

The two Big Questions related to whooping cranes are:

- Do whooping cranes use Program habitat complexes and/or habitat meeting Program minimum criteria in proportions greater than their availability?
- What is the relationship between availability of whooping crane roosting habitat meeting Program minimum criteria and whooping crane use?

The two Tier 1 Hypotheses are:

- Whooping crane use will increase as a function of Program land and management activities.
- Whooping crane use is related to habitat suitability.

The efforts to map minimum habitat criteria and planned resource selection function or similar analysis to investigate use vs. availability of habitat will be a key in addressing these Big Questions and Tier 1 Hypotheses. Habitat criteria mapping are just beginning and the initial information from this effort will be used as the available datasets in the analyses.

While a direct causal relationship to Program land or management actions is not possible with these data, the whooping crane population has increased since surveys started in 2001 as has the percentage of that population using the Platte River study area (Figure 7).

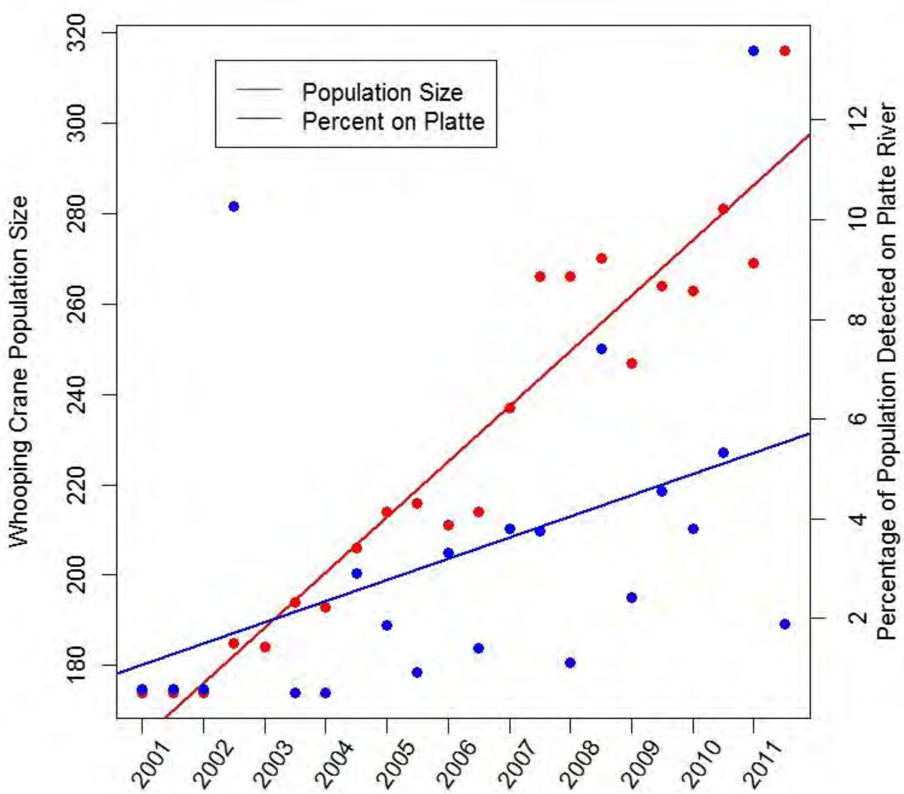


Figure 7. Whooping crane population size and percent of population observed on the Platte River, 2001-2011.

Conclusions

- What are general takeaway messages from 2011?
    - Surveys were successfully completed in both spring and fall migration efforts. We observed the most whooping cranes ever documented during the Cooperative Agreement or Program monitoring periods (2001-2011) during spring 2011
    - Whooping crane roosting was documented in river channel areas as in years past, but also within a palustrine wetland near the river and in a pond excavated for duck hunting along the river.
    - Whooping cranes continued to largely use channel habitats and corn while in the study area.

- Any implications to management actions based on 2011 data?
    - None specifically tied to monitoring activities. Changes to management actions may be indicated after implementation of detailed data analysis.

- What do 2011 and 2007-2011 data say about Big Questions and Tier 1 hypotheses?
    - Efforts are planned for detailed habitat assessments and use versus availability analyses to address Big Questions and Tier 1 Hypotheses for adaptive management.

Recommendations for 2012

- Adjustments to monitoring protocol and/or methodology
    - Evaluate alternatives to profile measurements for channel depth including GPS and laser levels.
- Adjustments to data analysis
    - Starting with the fall 2011 seasonal report and continuing forward there will be more summary data analysis included in the seasonal reports. This will help facilitate quick review of all data from past years regarding use site information, number of cranes observed, population levels, and other features measured by the Program.
    - Complete the process for data entry into the Program's online database.
    - Develop and implement QAQC procedures of all Program data.
- Adjustments to relevant Tier 1 hypotheses and/or conceptual model
    - No changes at this time are recommended. Changes may be warranted as the minimum habitat criteria are mapped and analyses are completed.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
Whooping Crane Minimum Habitat Criteria

Terminology for Quantifying Whooping Crane Habitat Availability

- Obstruction – Object ≥1.5 meters above ground level at a reference point or the waterline for wetted areas.
- Unobstructed Channel – Along a line perpendicular to the channel that extends from obstruction to obstruction and passes through a reference point, the unobstructed channel is the area that lies between the vegetation lines of the island or bank that contain the obstructions that lie on the line and on each side of the reference point.
- Disturbance Feature – Road, town, residence, out-building, etc. that may influence whooping crane use of an area. Bridges are an in-channel disturbance feature only.
- Benchmark Flows – To be determined by the Program's Technical Advisory Committee. Year-1 Assessment will be conducted @ 1,700cfs, 2,400cfs, and observed flows.

Whooping Crane In-channel Minimum Habitat Criteria

1. Channel Depth	**≤8 inches**
2. Suitable Channel Area	**≥40% of the channel ≤8 inches or bare sand**
3. Distance to Disturbance Feature	**≥160 feet and ≥1,320 feet (¼ mile) from a bridge**
4. Distance to Obstruction	**≥75 feet**
5. Unobstructed Channel Width	**≥280 feet**
6. Wetted Channel Width	**≥250 feet**
7. Unobstructed View Width	**≥330 feet**

Channel Depth

- *Definition* – Depth of channel from the surface of the water to the bed of the channel at benchmark and observed flows.
- *Criterion* – Channel areas ≤8 inches deep at benchmark and observed flows are habitat if the areas meet all additional in-channel minimum habitat criteria.

Suitable Channel Area

- *Definition* – Proportion of the channel ≤8 inches deep or bare sand.
- *Criterion* – Areas where ≥40% of the channel is ≤8 inches deep or bare sand at benchmark and observed flows are habitat if the areas meet all additional in-channel minimum habitat criteria.

Distance to Disturbance

- *Definition* – Distance from a point in any direction to the nearest disturbance feature.
- *Criterion* – Areas within individual channels that are ≥160 feet from all disturbance features and ≥1,320 feet (¼ mile) from a bridge are habitat if the areas meet all additional in-channel minimum habitat criteria.

Distance to Obstruction

- *Definition* – Distance from a point in any direction to the nearest obstruction (Figure 1).

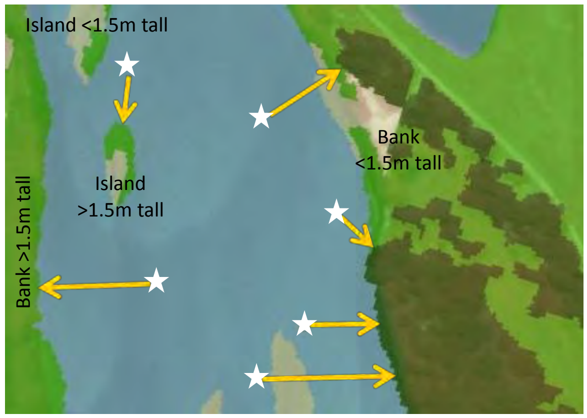


Figure 1. Distance to Obstruction

- *Criterion* – Area are ≥75 feet from an obstruction are habitat if the areas meet all additional in-channel minimum habitat criteria.

Unobstructed Channel Width

- *Definition* – Measured width of the unobstructed channel at benchmark or observed flows (Figure 2). Unobstructed channel width measurements start and end at the vegetated portion of islands or banks containing the obstruction in either direction from the reference point (i.e., unobstructed channel width does not extend beyond vegetated bank lines). Unobstructed channel width includes bare sand areas and vegetated sandbars that do not contain an obstruction that lies on a line running perpendicular to the channel.

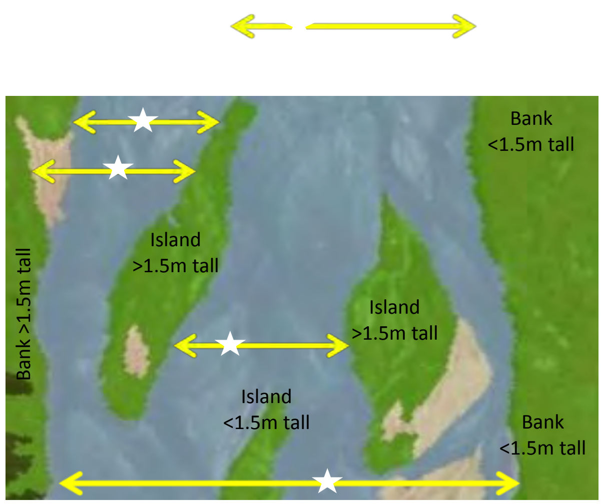


Figure 2. Unobstructed Channel Width

- *Criterion* – Areas with unobstructed channel widths ≥280 feet at benchmark or observed flows are habitat if the areas meet all additional in-channel minimum habitat criteria.

Wetted Channel Width

- *Definition* – Distance within the unobstructed channel that is covered by water at benchmark or observed flows (Figure 3). Wetted channel width measurements exclude bare sand and vegetated sandbar areas within the unobstructed channel.

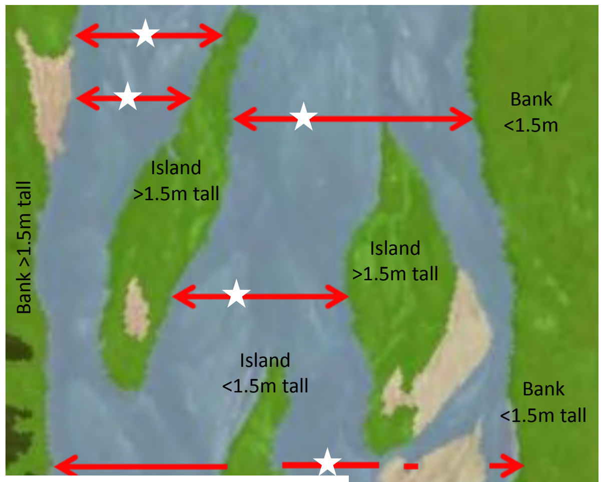


Figure 3. Wetted Channel Width

- *Criterion* – Areas with wetted channel widths ≥250 feet at benchmark or observed flows are habitat if the areas meet all additional in-channel minimum habitat criteria.

Unobstructed View Width

- *Definition* – Along a line perpendicular to the channel that extends from obstruction to obstruction and passes through a reference point, the unobstructed view width is the distance between the obstructions (Figure 4). Unobstructed view width includes all island/bare sand, vegetated sandbars, and banks between the first obstruction on either side of the reference point.

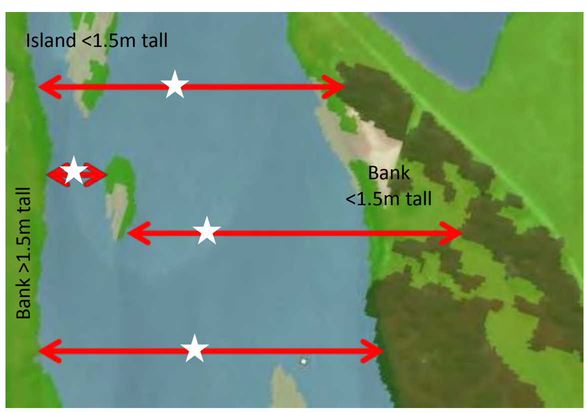


Figure 4. Unobstructed View Width

- *Criterion* – Areas with unobstructed view widths ≥330 feet at benchmark or observed flows are habitat if the areas meet all additional in-channel minimum habitat criteria.

<u>Whooping Crane Off-channel Minimum Habitat Criteria</u>

1. **Area ≤3.5 miles of main channel or ≤2 miles of side channel**
2. **Landcover Type and Structure**
   a. **Corn, soybean, alfalfa, wheat, grassland, wet meadow, and palustrine wetland**
      1. Suitable grassland acres determined by visiting a sample of sites
      2. Suitable cropland acres determined by reports of percent of crop fields harvested prior to the migration season

   b. **Wet Meadow Criteria**
      1. Wet Meadow Working Group (WMWG) identified potential wet meadow areas
      2. Habitat availability assessment contractor classify all grassland types as grassland
         i. Identified grasslands that conform to the Program's Wet Meadow Habitat Guidelines (Appendix 1) and meet all Program WC Minimum Habitat Criteria will be classified as whooping crane wet meadow habitat by the habitat availability assessment contractor; however, the WMWG will make the final determination of whooping crane wet meadow areas on a site-by-site basis.

   c. **Palustrine Wetland Criteria (Roost Habitat)**
      - ≥5 acres of water area ≤18 inches deep
      - ≥25% of the water area ≤12 inches deep
      - at least 1 water area that is 500 feet × 500 feet
3. **Distance to Obstruction ≥75 feet**
4. **Unobstructed View Width ≥330 feet**
5. **Distance to Disturbance Feature ≥285 feet**

<u>Area</u>

- *<u>Definition</u>* – Program Associated Habitat Area
- *<u>Criterion</u>* – Areas ≤3.5 miles of the main channel or ≤2 miles of side channel or the Platte River are habitat if the areas meet all additional minimum habitat criteria.

<u>Landcover Type and Structure</u>

- *<u>Definition</u>* – Landcover types suitable for whooping crane use
- *<u>Criterion</u>* – Areas of corn, soybean, alfalfa, wheat, grassland, wet meadow, and palustrine wetland are habitat if the areas meet all additional off-channel minimum habitat criteria.
  - *<u>Cropland</u>* – Suitable acres of cropland will be determined by reducing the total acres by the proportion of each crop type reported to have been harvested prior to 1 November each year.
  - *<u>Grasslands</u>* – Suitable acres of grassland will be determined by visiting a sample of grassland sites and reducing the total acres by the proportion of the sample that were of unsuitable structure for whooping crane use.
  - *<u>Wet Meadow</u>* – Wet Meadow areas will be delineated by the Program's Wet Meadow Working Group. Once an area is classified wet meadow habitat, it will remain wet meadow until management activities change the landcover type.
  - *<u>Palustrine Wetland</u>* – ≥5 acres of water area ≤18 inches deep with ≥25% of the water area ≤12 inches deep and at least 1 water area that is 500 feet × 500 feet.

Distance to Obstruction

- *Definition* – Distance from a point in any direction to the nearest obstruction (Figure 5).

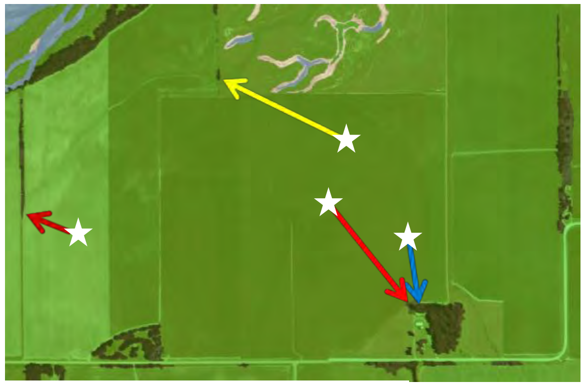


Figure 5. Distance to Obstruction

- *Criterion* – Areas that are ≥75 feet from an obstruction are habitat if the areas meet all additional off-channel minimum habitat criteria.

Unobstructed View Width

- *Definition* – Along a line passing through a reference point in any direction, unobstructed view width is the distance between obstructions (Figure 6). Unobstructed view width includes the area between the first obstruction on each side of the reference point.

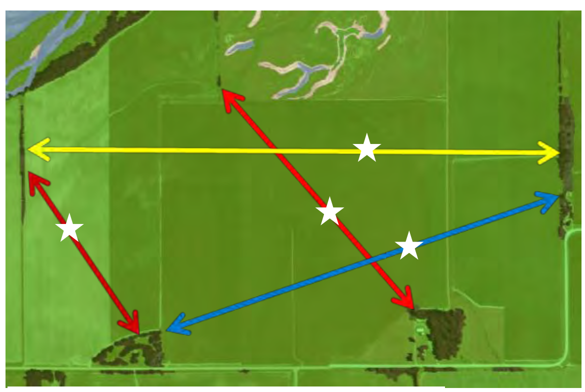


Figure 6. Unobstructed View Width

- *Criterion* – Areas with unobstructed view widths ≥330 feet are habitat if the areas meet all additional off-channel minimum habitat criteria.

<u>Distance to Disturbance Feature</u>

- *<u>Definition</u>* – Distance from a point in any direction to the nearest human disturbance feature (Figure 7).

Figure 7. Distance to Disturbance Feature

- *<u>Criterion</u>* – Areas that are ≥285 feet from a disturbance feature are habitat if the areas meet all additional off-channel minimum habitat criteria.

Appendix 1. Initial guidelines for classifying Program Wet Meadow Habitat (Revised by the WMWG 2-15-12)

Wet Meadow Habitat	Characteristics	When to measure
Location	Within 3.5 miles of main channel or 2 miles of a side channel of the Platte River	During land review process
'Gold Standard' acreage	≥40 acres not less than 0.25-mile from potential disturbance or appropriately screened from roads, railroads, occupied dwellings, bridges, etc.	During land review process
Distance from disturbance	Wet meadow habitat areas for whooping cranes will be ≥285 feet from a potential disturbance feature and will conform to the Gold Standard acreage requirements; sites evaluated by WMWG on a case-by-case basis	During land review process
Vegetation composition	Manage for native prairie grasses and herbaceous vegetation; mosaic of wetland (hydrophytic) and upland (non-hydrophytic) plants	Survey after acquisition, after application of management, and annually thereafter
Hydrology	Continuously saturated soils during the WC migration season 2 out of 3 years if possible	Survey after application of management and annually thereafter
Water management	Between February and April, mean monthly groundwater levels are at or above the ground surface in swales 25% to 75% of the time	Survey after application of management and annually thereafter
Topography and soils	Level or low undulating surface with swales and depressions; wetland soils with low salinity in swales and non-wetland soils in uplands	Survey after acquisition and after application of management
Flora and fauna	Supports characteristic aquatic, semi-aquatic, and terrestrial fauna and flora (especially aquatic invertebrates, beetles, insect larvae, and amphibians)	Survey after acquisition, after application of management, and annually thereafter
Whooping crane habitat requirements	Size – 640 contiguous acres or more when possible Unobstructed view area – As far as possible (330 feet = minimum habitat criteria) Low vegetative structure area – As much as possible Water area – As much as possible while maintaining wet meadow flora and fauna	During land review process then evaluate annually

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2011 Geomorphology & In-Channel Vegetation Monitoring Results



Monitoring Protocol:	PRRIP Channel Geomorphology and In-Channel Vegetation Monitoring Protocol
Monitoring Entity:	Ayres Associates and Olsson Associates
Dates of Field Activity:	July 2011 through August 2011
Number of Years of Implementation:	Three (2009-2011)
Analysis Entity:	Ayres Associates and Olsson Associates

Relevant Big Question(s)

1. How do short-duration high flows (SDHF), restoring sediment balance, and mechanical channel alterations contribute to the maintenance of channel width and creation of a braided river channel?
2. What is the relationship between SDHF, sediment balance, and tern (ILT) and plover (PP) riverine nesting habitat meeting Program minimum criteria?
3. What is the relationship between SDHF, sediment balance, and whooping crane (WC) habitat meeting Program minimum criteria?

Relevant Tier 1 Hypotheses from AMP

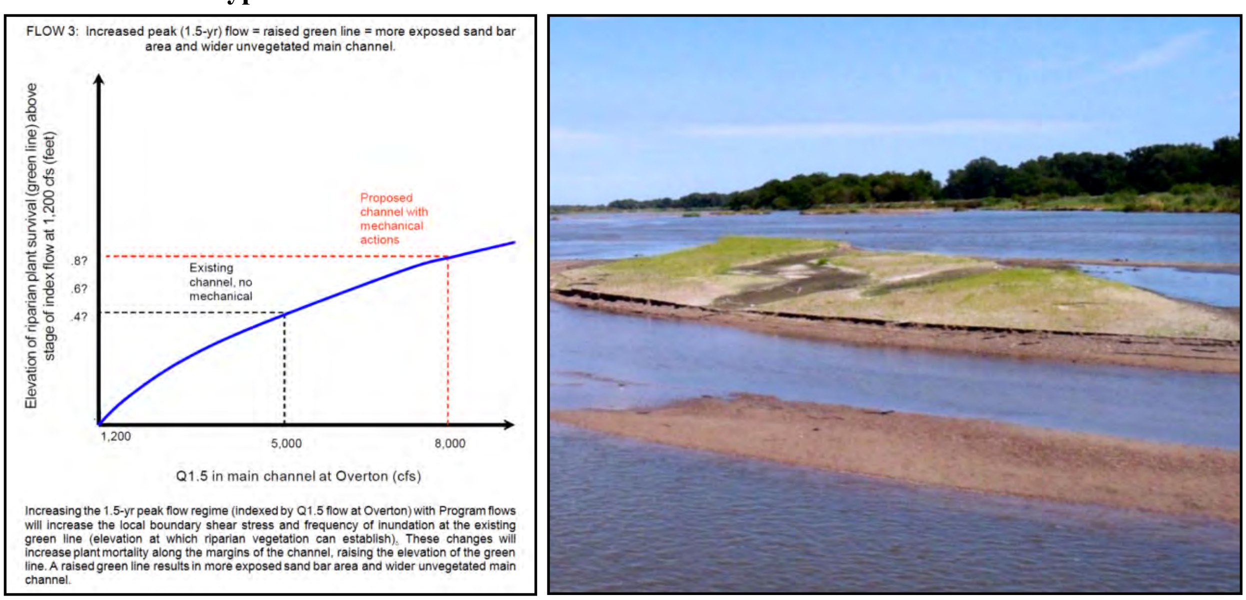


Figure 1. Flow #3 Hypothesis: increased peak (1.5-yr) flow will raise the green line and produce more exposed sand bar area and wider unvegetated main channel within the PRRIP reach of the Central Platte River.

Performance Measures and Benchmarks

Table 1. Program defined increased peak (1.5-yr) flow Performance Measures and Benchmarks. Benchmarks are based on various Program documents and will be finalized during 2012.

Performance Measure	Benchmarks	
	Minimum	Target
Elevation of green line above 1,200 cfs stage for flow event of 5,000 to 8,000 cfs (ILT and PP nesting)	>1.5’	N/A
Unvegetated channel width following flow event of 5,000 to 8,000 cfs (WC roosting)	750’	1,125’

2011 Summary of Activities

Surveys of the channel geomorphology and in-channel vegetation transects were conducted per Section III of the monitoring protocol. 2011 monitoring was completed for Pure Panel and Rotating Panel #3 (R3) anchor points. 2011 monitoring was completed between July 19 and August 4, and between August 16 and August 29, 2011. Flow at Overton was greater than 5,000 cfs for approximately 2.5 months May-July 2011 prior to 2011 monitoring (Figure 2), which made 2011 an ideal year for assessing the performance measures in the table above.

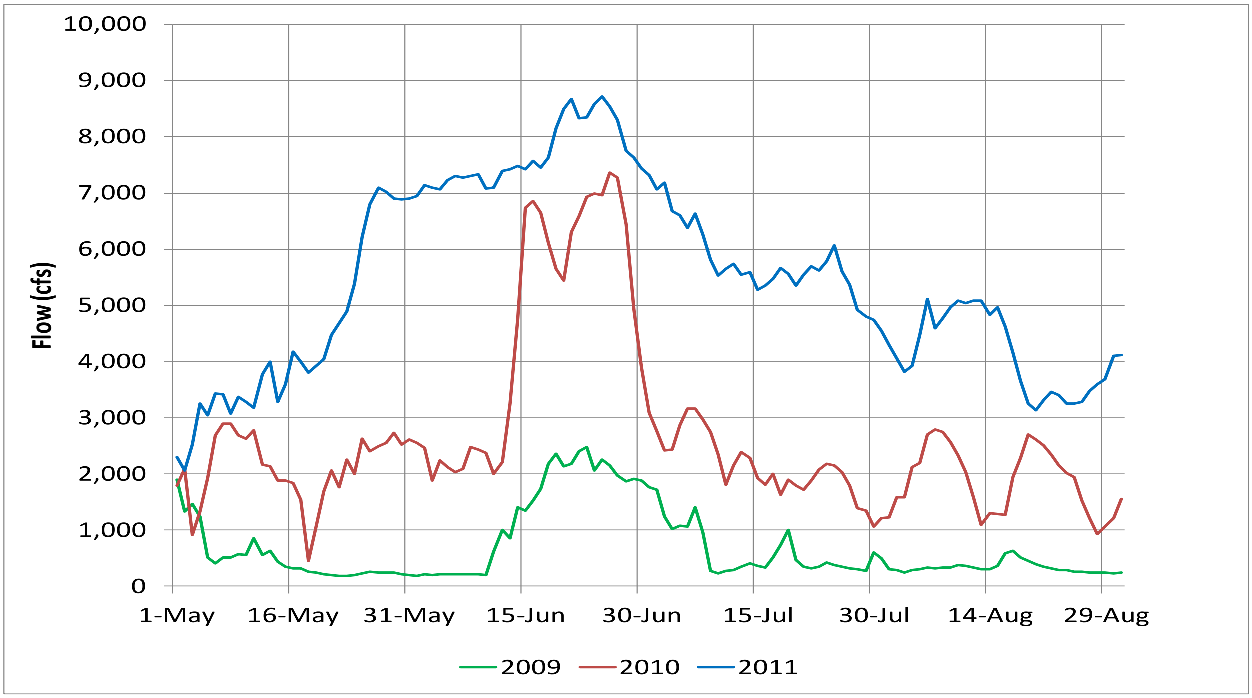


Figure 2. Flow hydrographs for the Overton Gage for 2009 to 2011.

Geomorphology Monitoring

Monuments for the R3 geomorphology transects were set on the historic high bank at or behind the tree line. Topographic data was collected for the top and toe of bank, grade breaks, green lines, water's edge, and the channel thalweg.

Vegetation Monitoring

Vegetation data was based on observations from meter square quadrats spaced at 10 meter intervals along the vegetation transects. Vegetation data included green line elevation (GLE) for banks and bars, and percent cover and frequency of occurrence for each species of interest.

Bed and Bar Material Sampling

In general, 10 bed material samples and one bar material sample were at each of the 25 surveyed anchor points, with single bed material samples collected in split flow channels. A total of 243 bed and 26 bar material samples were collected at all Year 3 (2011) anchor points.

Depth-Integrated Suspended Sediment and Bedload Sampling, Total Load Calculations

Bedload and suspended sediment load were monitored throughout the year at gaged bridge crossings near Lexington, Overton, Kearney, Shelton, and Grand Island. Flows never fell below 3,000 cfs during the sampling season so only the 2 suspended sediment and 2 bedload samples were collected under the 3,000-5,000 cfs flow increment and one suspended sediment sample was collected under the >5,000 cfs flow increment.

2011 Results

The long duration of flows greater than 5,000 cfs (i.e., 2.5 months of long-duration high flows) immediately prior to 2011 monitoring provided ideal conditions for assessing the performance measures relevant to geomorphology and vegetation (Figure 2). However, the high flows continued throughout the monitoring season, posing challenges to the survey personnel.

Evaluation of Flow #3 Benchmarks

- Green line elevation (GLE), defined as the minimum elevation with at least 25 percent vegetation cover, increased an average of more than 0.5 feet from 2010 to 2011 for all pure panel anchor points, and an average of over 1.5 feet from 2009 to 2011. Distribution of the change in GLE for all Pure Panel transects is shown in Figure 3.
- The relationship between GLE and 1,200 cfs stage will be determined for all APs and years of monitoring data when the data analysis plan is implemented (i.e., 2012, and annually thereafter). As an example, GLE relation to 1,200 cfs stage was calculated for 2009 to 2011 data for AP29 (Figure 4). The performance benchmark for Flow #3 (i.e., >1.5 feet above 1,200 cfs for flows between 5,000 and 8,000 cfs) was met at AP29 in 2011, with a GLE of about 1.6 feet above 1,200 cfs stage following the 2011 peak flow of approximately 8,700 cfs. However, GLE approximately was only approximately 1 foot above the 1,200 cfs stage following 2010 high flow of approximately 7,400 cfs. Although this is only two data points that may be affected by factors other than flow (e.g., vegetation spraying/clearing), it is interesting to compare the observed response of the GL at this AP to the hypothesized graph of response.
- Unvegetated channel width, calculated as the greatest width between green line data points at a given transect, increased at all pure panel anchor points from 2009 to 2010 and again from 2010 to 2011 (Figure 5). Average pure panel unvegetated width was about 260 feet, 330 feet, and 440 feet, for 2009, 2010, and 2011, respectively. It is unclear how much of the increase is attributable to high flows in 2010 and 2011, versus recent vegetation treatment on the Platte River. Although unvegetated width met the minimum performance benchmark of 750 feet at two anchor points in 2011 (AP-15 and Ap-33), the minimum benchmark was not met for the majority of the anchor points in 2011.

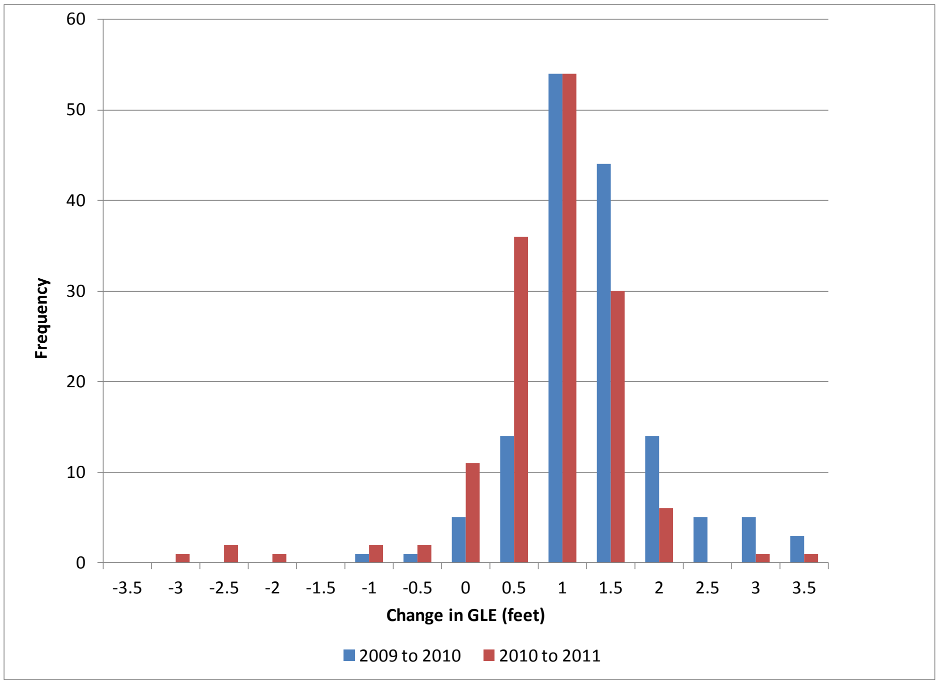


Figure 3. Histogram showing distribution of the change in GLE for all Pure Panel transects

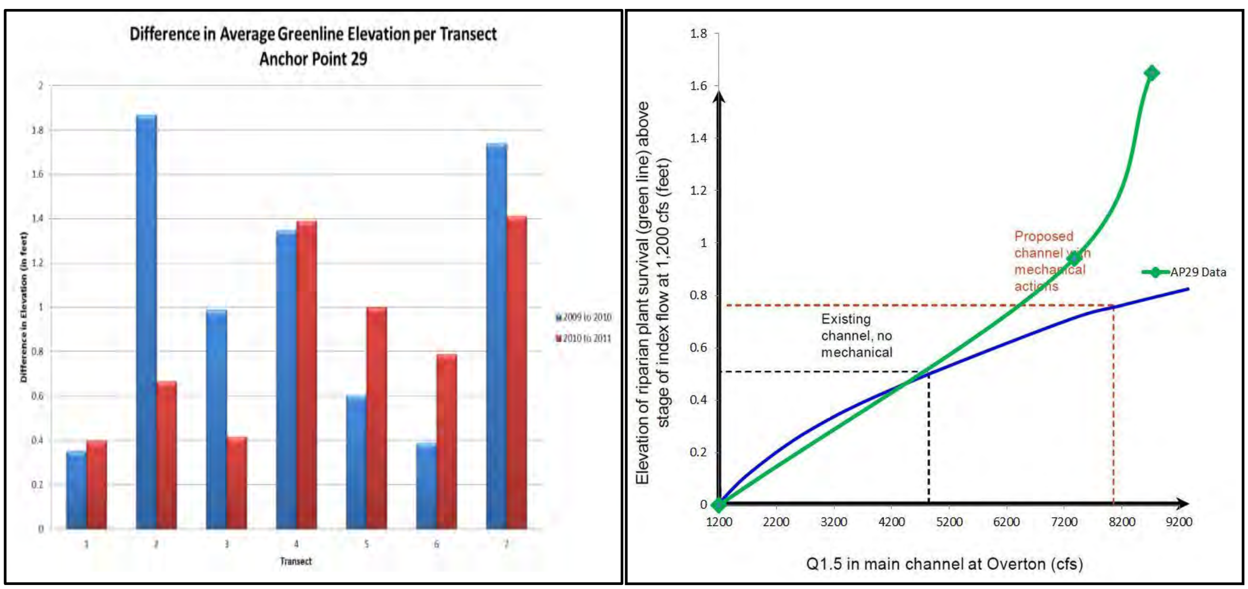


Figure 4. Change in GLE per transect at AP 29 (left) and (right) observed change in average GL elevation at AP29 relative to the elevation of the Program flow of 1,200 cfs following SDHF flows per Hypothesis Flow #3.

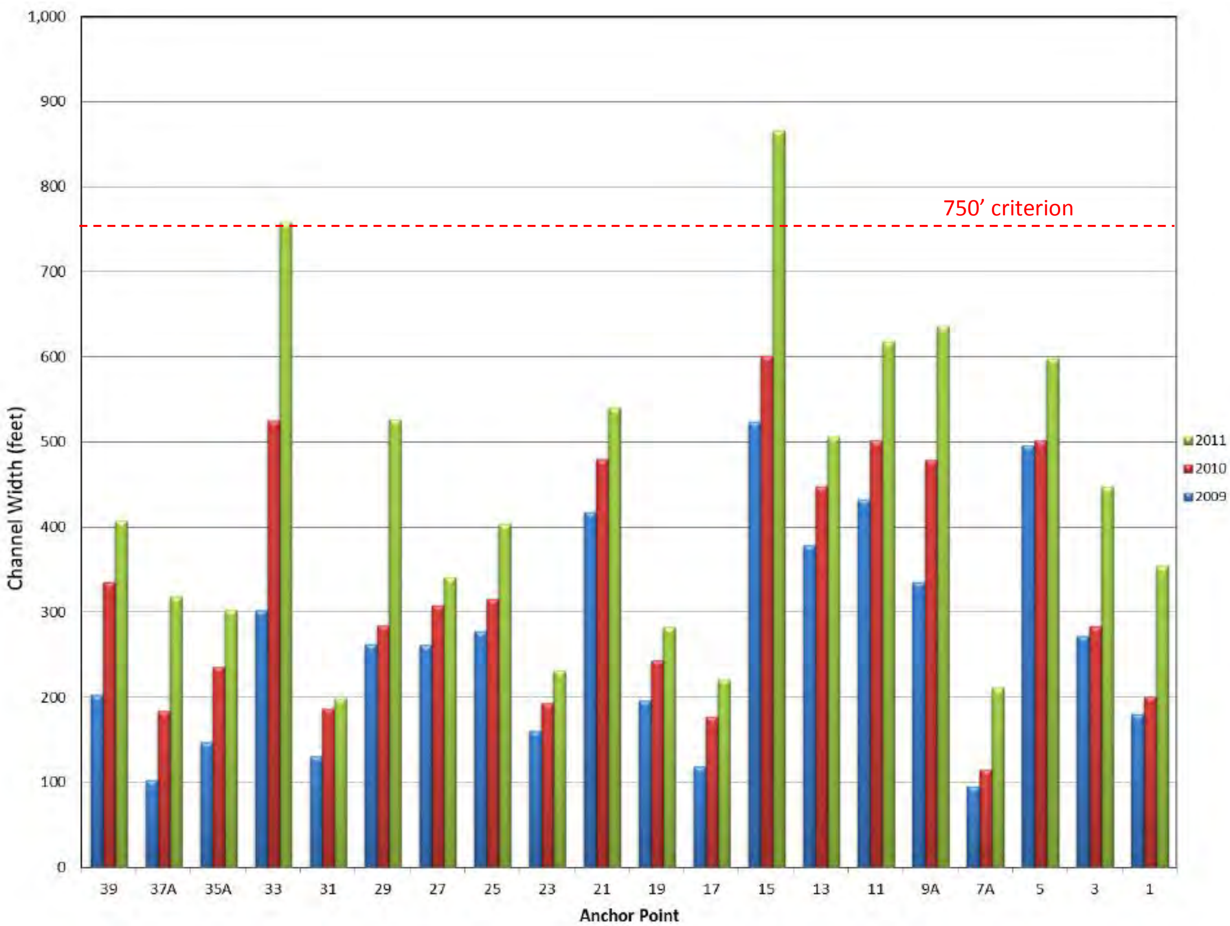


Figure 5. Unvegetated channel width for pure panel anchor points

<u>Other Relevant Results</u>

Geomorphology Monitoring

A preliminary examination of the 2009 and 2010 survey data reveals that the channel morphology has changed on many of the transects. Because of the long duration, high flow this summer as well as last summer, many of the low bars have been rearranged, the channel has deepened and the thalweg has shifted in places, and in some areas significant bank retreat has occurred. Figure 6 provides an example showing some of the cross-sectional changes that have occurred over the last 3 years at Anchor Point (AP) 25 (about 1.5 miles upstream of Kearney Bridge). More detailed analyses of channel degradation/aggradation will be conducted starting in 2012.

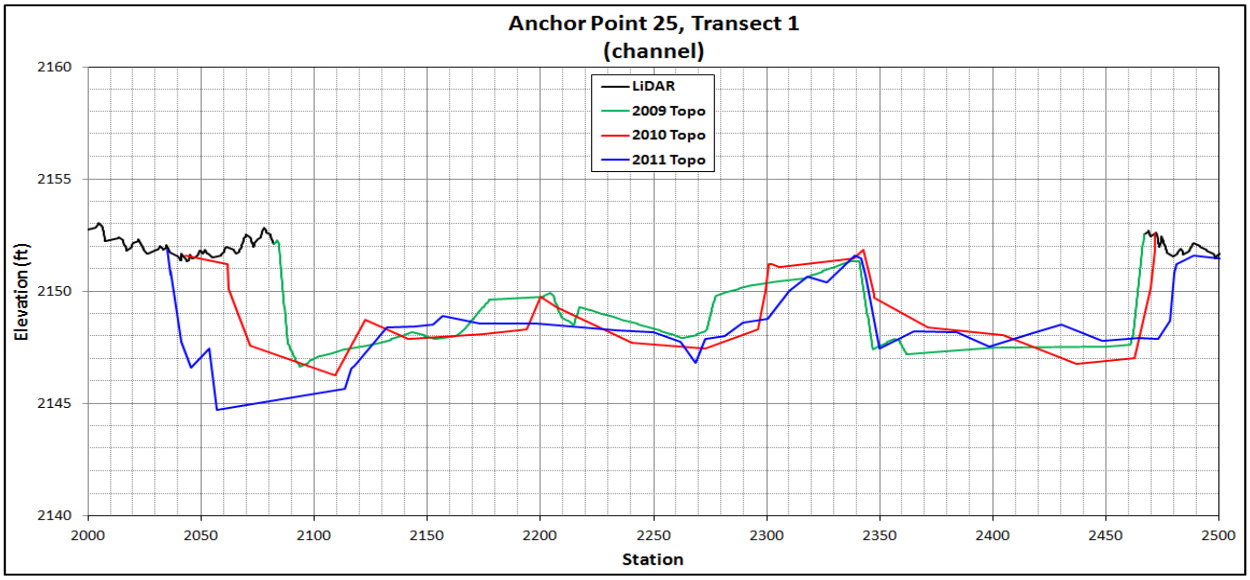


Figure 6. Transect 1 at Anchor Point 25 showing bed and bar changes and bank erosion between 2009 and 2011.

Vegetation Monitoring

- Canopy Cover, Frequency of Occurrence, and Acreage of Species of Interest
  - 2011 monitoring results indicate that high flows of 2011 in conjunction with herbicide application reduced vegetation within the channel for all species of interest. Canopy cover and frequency of occurrence decreased for the species of interest at pure panel APs from 2010 through 2011 (Figure 7).
  - During 2010 and 2011, as phragmites and purple loosestrife decreased in abundance, reed canarygrass and rice cutgrass became more noticeable components of the plant community. Particularly on sandbars, the colonizing vegetation often consisted of rice cutgrass and nutsedges. As a result of this observation, reed canarygrass and rice cutgrass were preliminarily analyzed in 2011.
- Total acreage of each species of interest generally decreased for species of interest at the pure panel anchor points (Figure 8).
- Average elevation for each species of interest increased at almost every pure panel anchor point in 2011 compared to 2010, and in 2010 compared to 2009. For example, Figure 9 depicts the average change in elevation for common reed and purple loosestrife across all pure panel anchor points that had these species present. Due to the higher river flows in 2011 compared to 2010, and in 2010 compared to 2009, this was anticipated to occur.

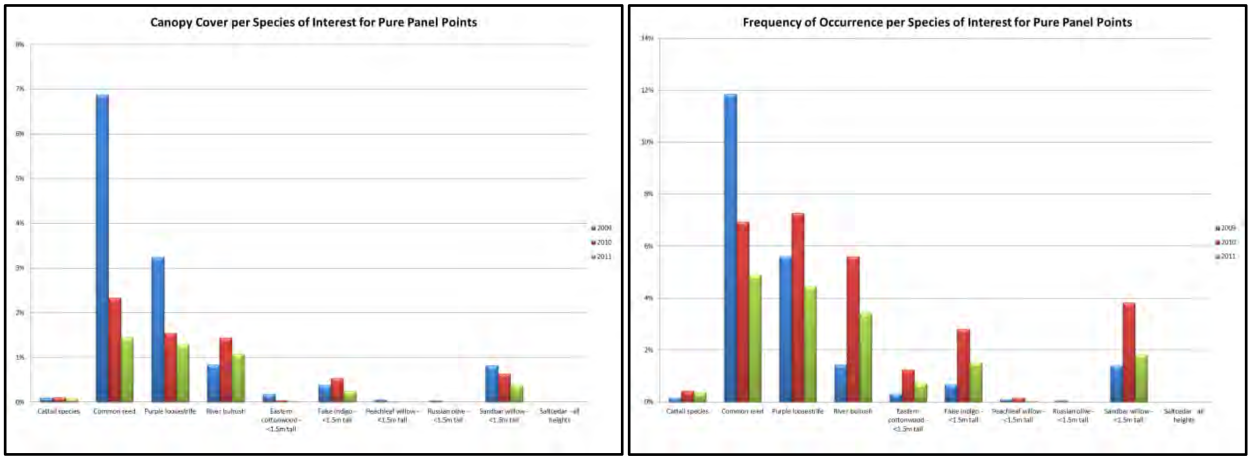


Figure 7. Percent canopy cover (left) and frequency of occurrence (right) for each species of interest. Blue bars are 2009 data; red bars are 2010 data; green bars are 2011 data.

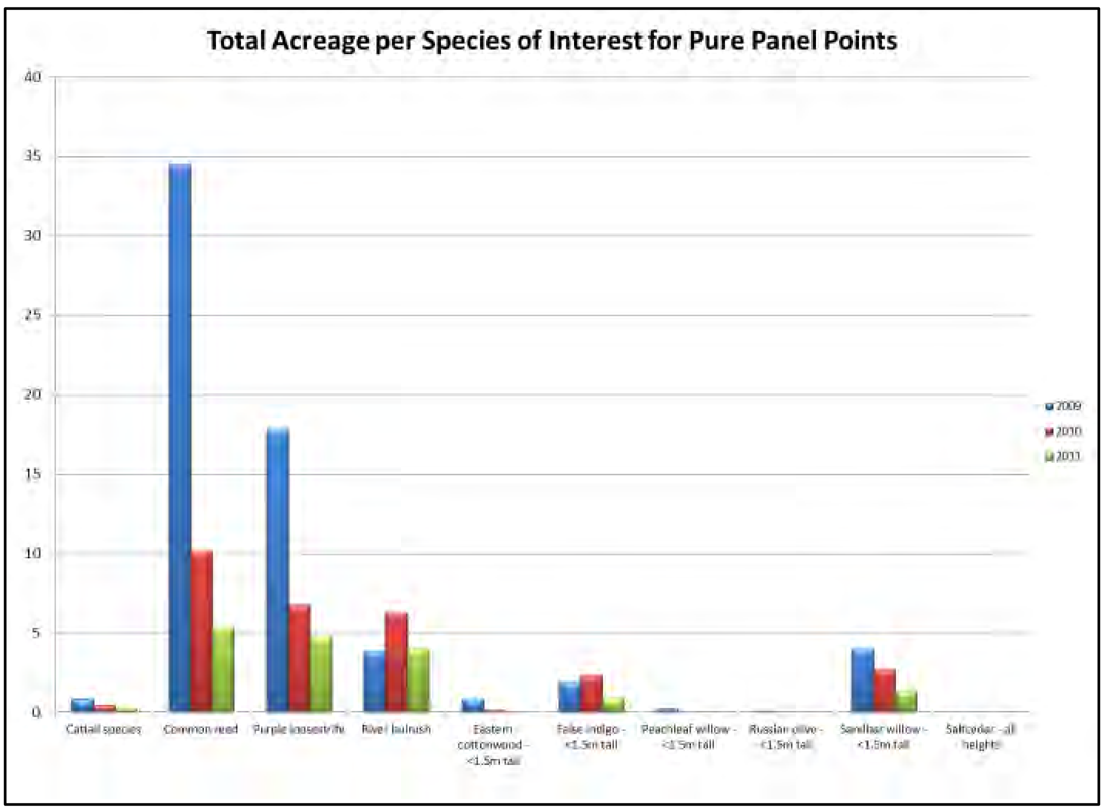


Figure 8. Estimated total acreage at pure panel anchor points.

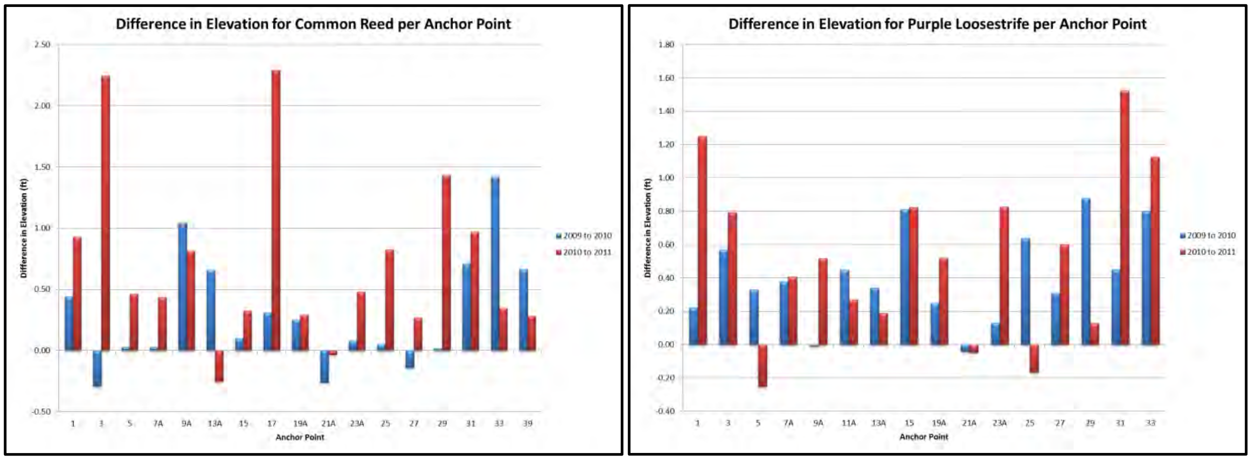


Figure 9. Average change in elevation for (left) common reed and (right) purple loosestrife across all pure panel APs.

Bed and Bar Material Sample Distributions

- Figure 10 provides a comparison of the 2011 bed material sample data to the 1989 USBR bed material sample data, which suggests a general overall coarsening of the Central Platte River since 1989.

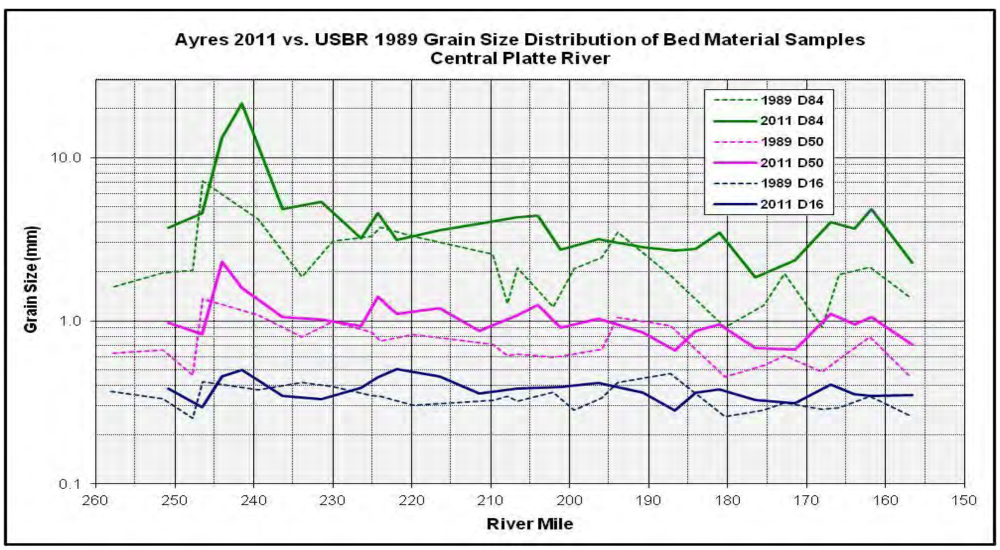


Figure 10. Comparison of the 2011 composited bed samples with the 1989 USBR bed samples by river mile.

- A comparison of the 2009, 2010, and 2011 composited bed material sample gradations for the project reach suggests that the bed material collected in 2011 is slightly finer than the 2010 bed material, which is slightly finer than the 2009 bed material, especially in the upper part of the reach. A comparison of the bar material sample data from 2009, 2010, and 2011 shows an overall coarsening in gradation from 2009 to 2011 along the project reach with a slight fining of the 2010 and 2011 bar material in the downstream direction.

Total Sediment Load Calculations

- The measured and Modified Einstein total load results are provided in Table 2. For most of the lower flows, there was not enough correlation between the bed material and suspended sediment gradations for the Modified Einstein calculations to work. There were no flows in the 1,000 - 3,000 cfs range (except at Darr) before the sampling was completed since flows didn't drop below 3,000 cfs until November.

Table 2. Total Sediment Load Results for 2011 Flow Events.

Bridge	Flow (cfs)	Measured Suspended Load (tons/day)	Measured Bedload (tons/day)	Measured Total Load (tons/day)	Modified Einstein Total Load (tons/day)
Darr	1,902	2,713	555	3,268	3,348
Overton	3,825	5,881	569	6,450	---
Overton	4,200	6,391	328	6,719	---
Overton	6,890	8,529	---	---	---
Kearney	3,790	4,455	1,028	5,483	4,704
Kearney	7,305	6,878	---	---	8,396
Shelton	3,529	4,622	1,643	6,265	4,950
Shelton	3,181	5,049	1,301	6,350	7,299
Gibbon	5,765	7,271	---	---	---
Grand Island	4,040	4,504	1,200	5,704	---
Grand Island	7,900	25,357	---	---	26,711

Comparative Results and Trends

- GLE has increased with higher flows (although this is based on only three years of data).
- Channel morphology has changed with high flows of 2010 and 2011 (e.g., bar migration and channel deepening).
- Vegetation has generally decreased over the three years of monitoring. However, it is difficult to parse out the factors affecting this reduction (e.g., herbicide spraying and high flows).
- Bed material appears to be fining slightly in the upper part of the reach.

Tier 1 Hypothesis and Big Questions

- GLE relation to 1,200 cfs stage will be determined in future years according to the analysis plan. Preliminary indications show that high flows of approximately 8,700 cfs in 2011 may have contributed to meeting the Flow #3 minimum performance benchmark of GLE >1.5 feet above 1,200 cfs stage. However, the influence of high flows and herbicide spraying are difficult to separate.
- The minimum performance benchmark for unvegetated channel width (750 feet) was only met for two of the 20 pure panel anchor points in 2011. The minimum performance benchmark for unvegetated channel width was not met for any pure panel anchor points in 2009 or 2010.

Conclusions

- What are general takeaway messages from 2011?
  - The high flows of 2011 were likely to have created more suitable nesting habitat for ILT/PP, if the flows had receded to typical rates during the nesting season. However, the slow recession of high flows effectively eliminated in-channel nesting habitat.
- Any implications to management actions based on 2011 data?
  - A brief examination of the survey data for several of the anchor points suggest that the channel has degraded since 2009 as a result of the long duration high flows of 2010 and 2011. It is possible that sediment augmentation under the FSM strategy, if it had been implemented, could

have offset some or all of the apparent degradation, at least at some of the anchor points between Overton and Kearney.
    - The reduction in the most common vegetation species from 2009 to 2011 has resulted in increased plant diversity; no one or two species dominated the vegetation, as phragmites and purple loosestrife had in 2009. In addition, more plant species were identified in 2011 than in either of the previous years. This may have implications for vegetation control methods required in the future.
- What do 2011 and 2009-2011 data say about Big Questions and Tier 1 hypotheses?
    - The high flows in the early summer of 2010 and 2011 were comparable to the SDHF flows, but the long duration of those high flows may make an accurate analysis of the 2010-2011 data problematic.
    - The high flows appear to have contributed to the increase in GLE. Further comparison of modeled flows and GLE at other APs could provide a refinement of the Flow 3 hypothesis relationship between SDHF and GLE, although the increased 2011 GLE may be an outlier due to the long duration of elevated flows.
    - Flow Hypothesis 1, that increasing river stage variation will create increased sand bar height, may not have been supported by 2010 or 2011 geomorphology data.

Recommendations for 2012

- Adjustments to monitoring protocol and/or methodology
    - Add reed canarygrass, and consider adding rice cutgrass and possibly nutsedges to the list of species of interest. The relatively large amount of reed canarygrass (Phalaris arundinacea) indicates that it should be added to the list of species of interest for 2011. For all identified plants, including reed canarygrass, the same data is being collected but currently no analyses of frequency of occurrence or canopy cover are being done for non-species of interest. Until these analyses are done, it is not as easy to identify trends for this species.
    - Remove Russian olive and saltcedar from the list of species of interest. Once again Russian olive and saltcedar did not appear as major factors for vegetation in the Platte River.
    - We also recommend returning to the 2009 vegetation height method, which averaged vegetation height at each quadrat. It takes no longer to measure or record than the height classes, and it provides more detailed information that can be useful to the Program.
    - It is suggested that both bedload and suspended load data are necessary and should be collected to estimate total load below 5,000 cfs. Above 5,000 cfs, only the suspended load needs to be measured as the total load can be estimated from the Modified Einstein method. Therefore, we recommend that samples be collected at each site 5 times during the year: two bedload and two suspended samples (concurrently) within the 1,000 to 3,000 cfs and 3,000 to 5,000 cfs flow increments each, and one suspended sediment sampling of a flow greater than 5,000 cfs.
- Adjustments to data analysis
    - Except for QA/QC purposes, there is no formal data analysis being conducted under this contract.
- Adjustments to relevant Tier 1 hypotheses and/or conceptual model
    - T1 Hypotheses – None

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2011 Elm Creek FSM "Proof of Concept"

Monitoring Protocol: Elm Creek FSM Proof-of-Concept Experiment
Monitoring Entity: ED Office lead; Tetra Tech
Dates of Field Activity: May 2011 through August 2011
Number of Years of Implementation: Three (2011-2013)
Analysis Entity: ED Office; Tetra Tech

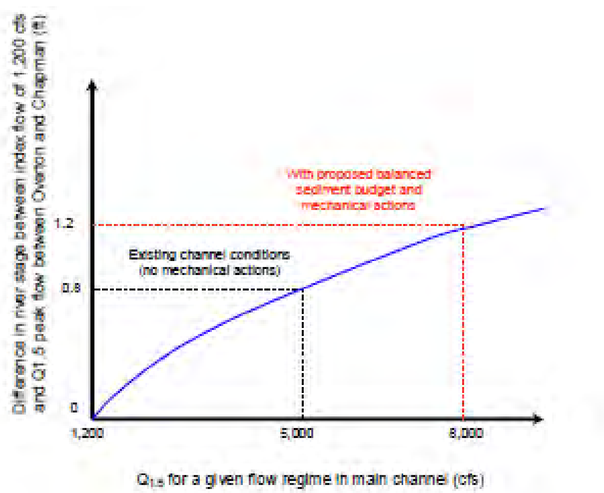
Relevant Program Big Questions and Hypotheses

Big Question #6 – How do short-duration high flows (SDHF), restoring sediment balance, and mechanical channel alterations contribute to the maintenance of channel width and creation of a braided river channel?

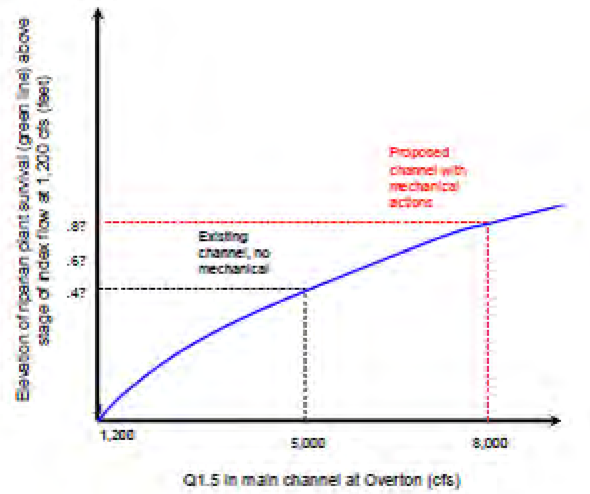
Big Question #7 – What is the relationship between SDHF, sediment balance, and tern and plover riverine nesting habitat meeting Program minimum criteria?

Big Question #8 – What is the relationship between SDHF, sediment balance, and whooping crane habitat meeting Program minimum criteria?

Flow #1: Increasing the variation between river stage at peak (indexed by the $Q_{1.5}$ @ Overton) and average flows (1,200-cfs index flow), by increasing the stage of the $Q_{1.5}$ through Program flows, will increase the height of sandbars between Overton and Chapman by 30 to 50 percent from existing conditions, assuming balanced sediment budget.



Flow #3: Increasing $Q_{1.5}$ with Program flows will increase local boundary shear stress and frequency of inundation at the existing green line (elevation at which riparian vegetation can establish). These changes will increase riparian plant mortality along margins of the channel, raising the elevation of the green line, providing more exposed sandbar area and a wider, unvegetated main channel.



Flow #5: Increasing the magnitude and duration of the $Q_{1.5}$ will increase riparian plant mortality along the margins of the river. There will be different relations for different species.

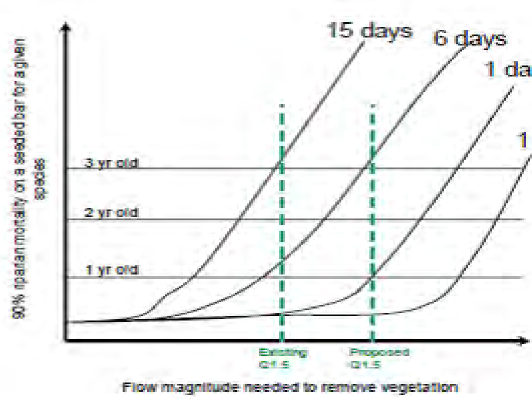


Table 1. Relevant performance measures and benchmarks.			
Hypothesis	**Performance Measure**	**Benchmarks**	
		Min	**Target**
Flow #1	Mean and maximum sand bar height relative to peak stage of formative flow event	-0.7	0.0
Flow #1	Mean and maximum sand bar height relative to 1,200 cfs stage for flow events of 5,000 to 8,000 cfs	1.5’	N/A
Flow #1	Unvegetated sand bar area exceeding height of 1.5’ above 1,200 cfs stage per ¼ mile of river channel	1.5 ac	N/A
Flow #3	Elevation of green line above 1,200 cfs stage for flow event of 5,000 to 8,000 cfs (ILT and PP nesting)	>1.5’	N/A
Flow #3	Unvegetated channel width following flow event of 5,000 to 8,000 cfs (WC roosting)	750’	1,125’
Flow #5	For flows of 5,000 to 8,000 cfs, is 90% of vegetation scoured in any inundated sand bar area 1.5’ above 1,200 cfs?	YES	N/A
Flow #5	For flows of 5,000 to 8,000 cfs, channel width at which 90% vegetation scour is achieved.	750’	1,125’
Flow #5	Can sustain releases necessary to inundate 750’ wide channel >0.25’ deep for period exceeding inundation mortality threshold?	YES	N/A

2011 Summary of Activities

- Monitoring surveys were conducted in early-May and late-August/early-September. The surveys included the following activities during each monitoring period:
    - Detailed topographic/bathymetric survey of 22 monumented transects.
    - Topographic surveys of all exposed bars in the reach (13 in May; 21 in late-August/early-September), including bar perimeter, cross-stream transects, and longitudinal transects used to define bar shape and topography.
    - Survey of green line around all bars and at transects, where present.
    - Discharge measurements at transects approximately mid-reach up- and downstream from the Kearney Diversion.
    - Installation and operation of pressure transducer stage recorders at each of the two discharge measurement points. Unfortunately, the downstream recorder was lost during the June high flows.
    - Collection of bed and bar material samples at every other transect (12 bed and 12 bar samples in May; 11 bed and 12 bar in late-August/early-September).
    - Vegetation sampling at a subset of 21 exposed bars using the Modified Whitaker sample plot layout (21 in May, 16 in August/September[1]).

- A two-dimensional (2-D) hydrodynamic and sediment transport model was developed, calibrated and applied to predict the response of the sand bars and vegetation in the reach to FSM management actions (e.g., short duration high flows, selective disking of bars, and potential increases in sediment supply associated with sediment augmentation).
- An experimental plan was developed to test the FSM management strategy. Flows considered for the FSM proof-of-concept experiment include short duration high flow releases. Sediment conditions are assumed to be controlled by flow at the Elm Creek Complex, and also as influenced by the upstream sediment augmentation study. Because flow and sediment conditions are not under direct control for the FSM proof-of-concept experiment, the experimental plan focuses on the FSM mechanical component (e.g., re-grading of islands and/or disking and spraying to remove vegetation). Based on the 2011 monitoring data and other available information, it was determined that existing islands provide a reasonable distribution of island height; thus, only disking/spraying of selected islands is included in the plan.

[1] Five of the plots sampled in May were under water during the August/September sampling period.

Monitoring photos


ADCP flow measurement (May 2011)


Modified Whittaker Vegetation Sample Plot (May 2011)


Bathymetric survey (September 2011)


Phragmites covered island (September 2011)

2011 Results

Field Monitoring Activities and Trends

- The discharges in the Central Platte River, and the Elm Creek Complex, were unusually high during 2011. Flows at the USGS Overton gage were in the range of the Program's short-duration high flows for 65 consecutive days from May 24 to July 27. Mean daily flows ranged from about 3,000 cfs (exclusive of the hydrocycling at the J-2 Return) during the early-May Baseline surveys to a maximum of 8,720 cfs on June 25, and then receded back to the 2,500 cfs to 3,000 cfs range in late-August/early-September when the post-runoff surveys were completed (**Figure 1**). For comparison, the flows are less than about 1,200 cfs in early-May in about 50 percent of the years, and the 2011 flows have historically been exceeded during this period in only about 1 in 5 years. Similarly, flows in late-August/early-September are less than 500 cfs in about 50 percent of the years, and the 2011 flows during this period have historically been exceeded in only about 1 in 10 years. The instantaneous peak discharge of 8,820 cfs that occurred on June 20 has a recurrence of about 1 in 5 years, based on the annual peak flow record from 1940 through 2011 at the USGS Overton Gage. For comparison, the 1.5- and 2-year flood peak at Overton for the post-Lake McConaughy period is about 4,000 and 5,200 cfs, respectively. The total runoff volume between April 1 and October 1, 2011 was about 1.8M ac-ft, which is the fourth highest in the 70-year period since 1942.

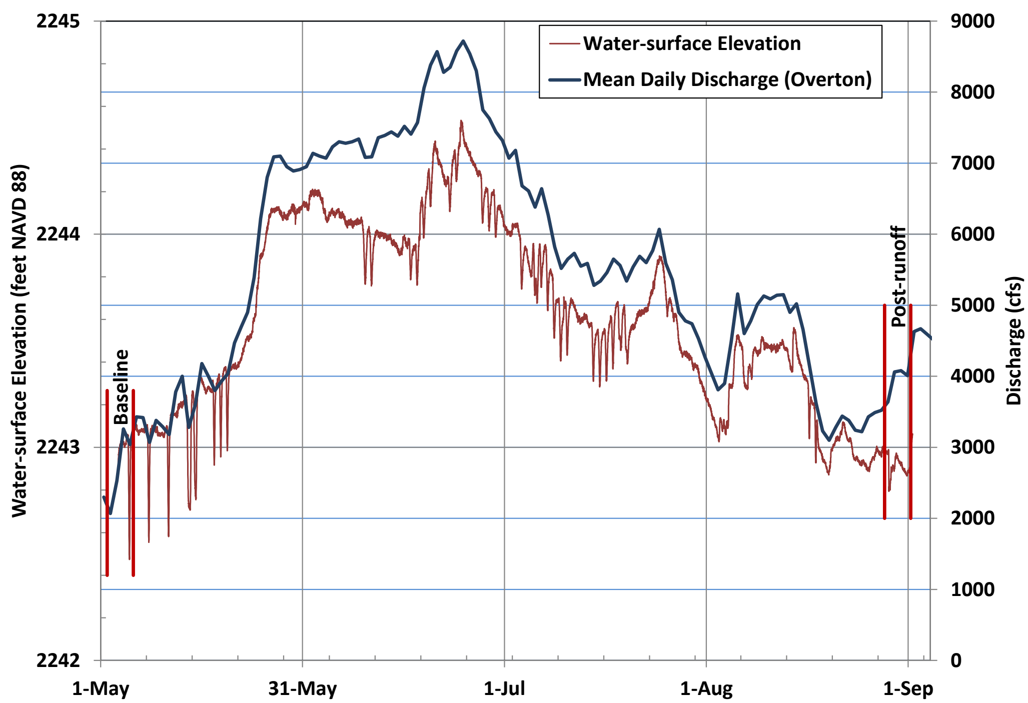


Figure 1. Mean daily discharge at Overton and recorded stages approximately mid-way between the Elm Creek Bridge and the Kearney Diversion Structure (KDS).

- Based on comparison of the May and August/September survey data, 11 of the 22 cross sections experienced net sediment accumulation (aggradation), 10 experienced net degradation, and one showed almost no net change (**Figure 2**). Based on average end-area calculations using the cross-section data, the portion of the reach between the Elm Creek Bridge and the Kearney Diversion Structure (KDS) experienced net loss of ~4.2 ac-ft (~9,100 tons) of sediment, and the portion of the reach downstream from the KDS had net loss of ~8.8 ac-ft (~19,100 tons) between the two surveys (**Figure 3**).

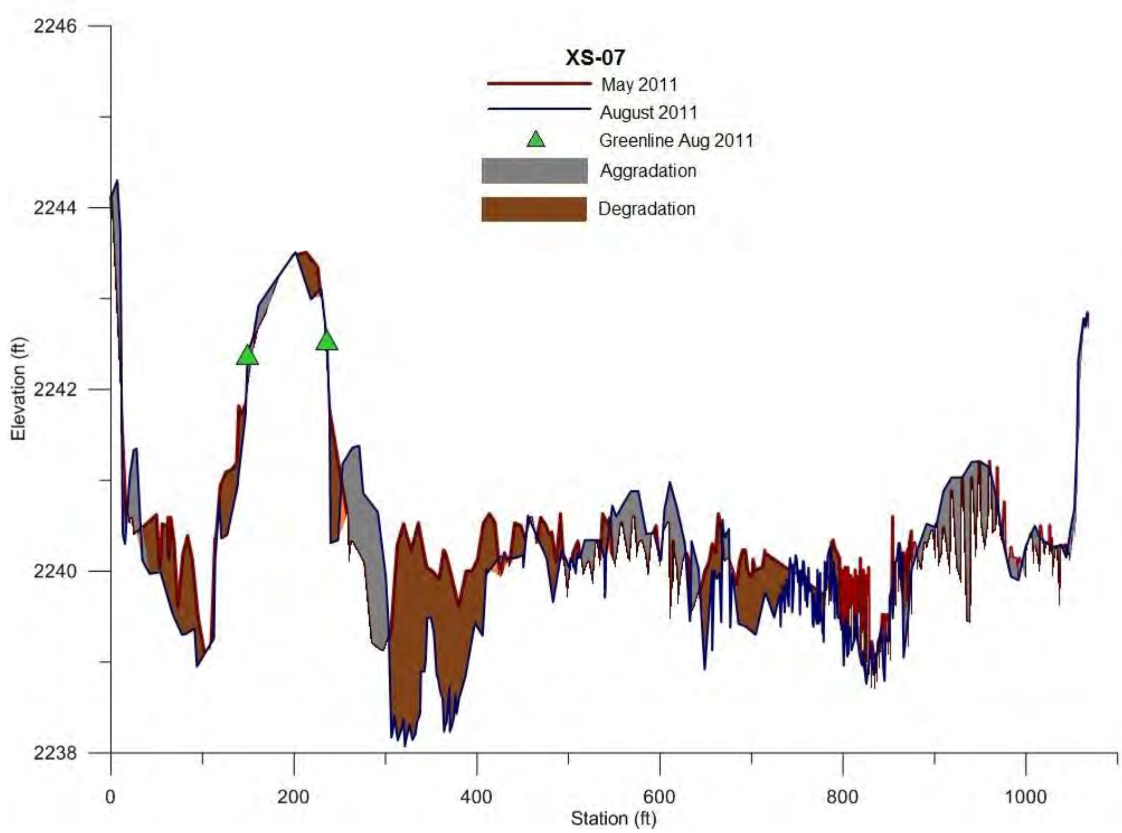


Figure 2. Typical profiles of Cross Section 7 (~0.9 miles downstream from the Elm Creek Bridge) from May and August, 2011 surveys and from the 2009 LiDAR. Also shown is the location of the Green Line that was identified on the bar along the left side of the channel. Similar plots are available for all 22 cross sections. Red line is from August/September survey.

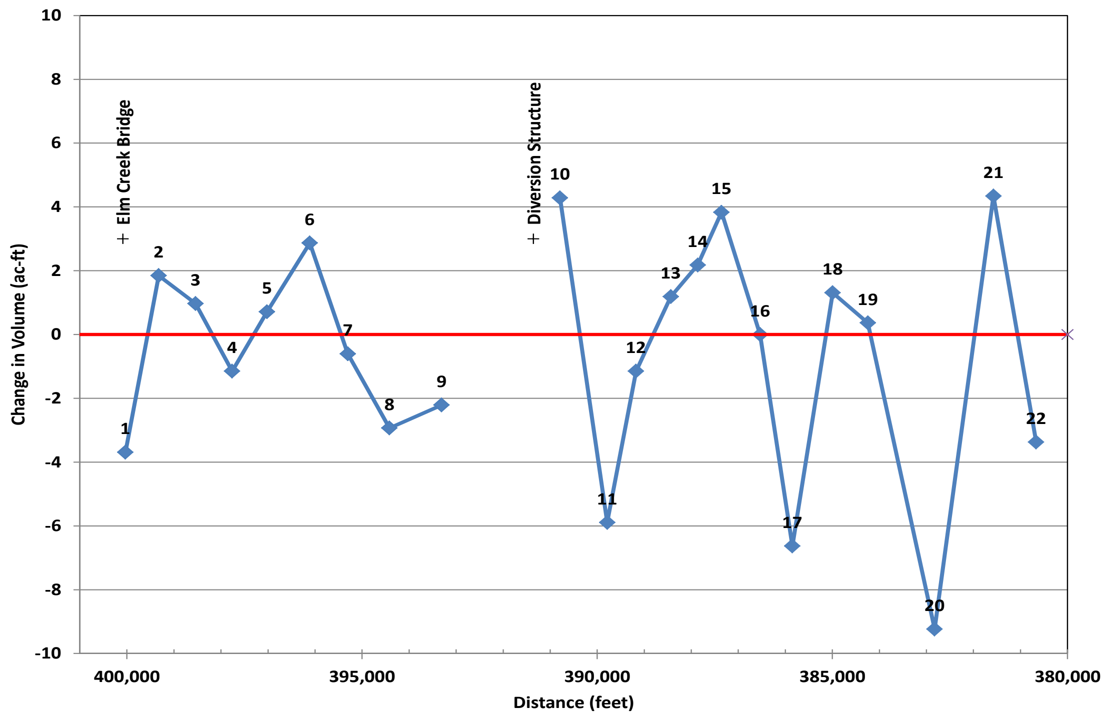


Figure 3. Approximate change in bed sediment volume between early-May and late-August/early-September 2011.

- Detailed topographic surveys were conducted on all exposed bars during each period (21 in early-May; only 15 in late-August/early-September due to the higher flows). Although the flows exceeded the 1,200-cfs baseline for defining the bars, sufficient bathymetry was collected at the primary and secondary bar cross sections to approximate the 1,200-cfs boundary. Two-dimensional topographic surfaces were developed for each of the bars based on survey data to facilitate evaluation of the bar topography with respect to the performance metrics for **Hypothesis Flow #1**.
  - To assess the bar height during the surveys relative to the 1,200 cfs and maximum water-surface elevations, two-dimensional topographic surfaces were developed for each of the bars based on survey data. The distribution of area above the 1,200-cfs level was computed (**Figure 4**). Two different metrics were used to quantify changes in bar height: (1) difference in the median elevation and (2) difference in the 90-percent elevation (elevation below which 90 percent of the bar falls, based on surface area). The percentage change in bar height between May and September was computed for each of these metrics (**Figure 5**). The changes in median elevation in the portion of the reach between the Elm Creek Bridge and Kearney Diversion ranged from a 16-percent decrease to a 55-percent increase, with an average increase of about 10 percent. In the portion of the reach downstream from the Kearney Diversion, the changes in median elevation ranged from a 64-percent decrease to a 67-percent increase, with an average decrease of about 8 percent. Changes in the 90-percent elevation were similar to the median elevation, except the average change in the downstream reach was much smaller (<~1 percent.)

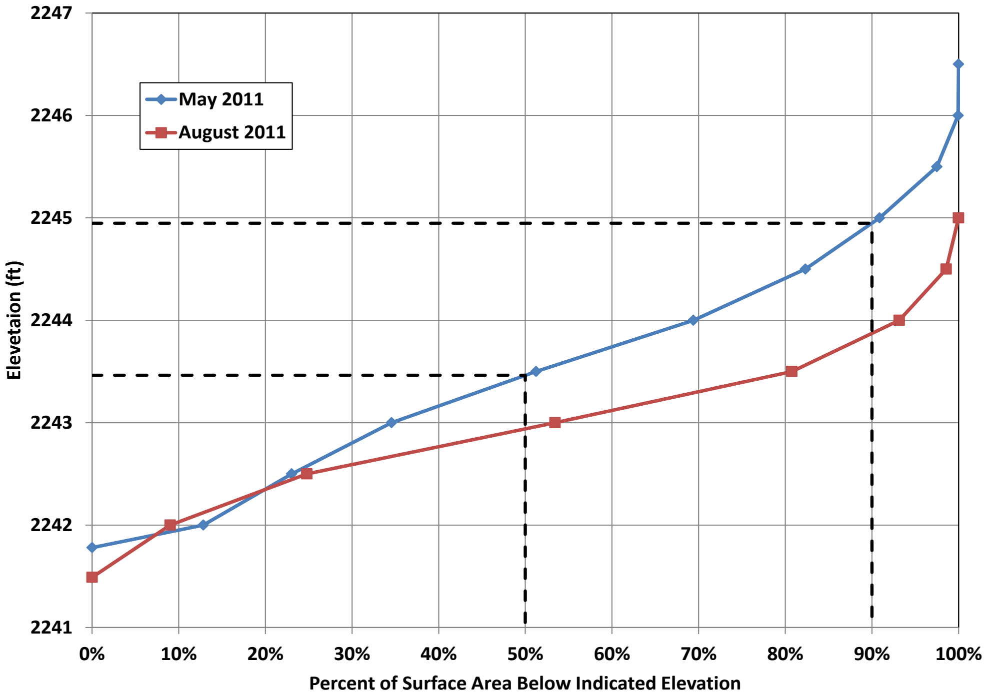


Figure 4. Typical topographic distribution on a surveyed sandbar (Plot is from May Bar #8/August Bar #9, located along the right side of the river about 0.8 miles downstream from the Elm Creek Bridge).

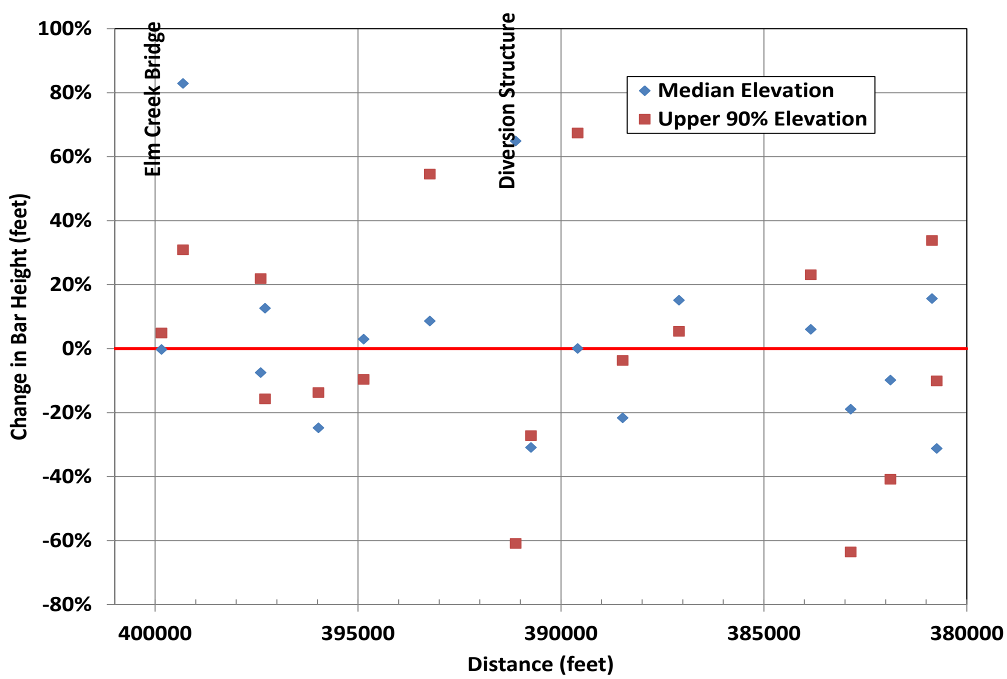


Figure 5. Percent change in median and 90-percent bar height above 1,200 cfs between the early-May and late-August/early-September surveys.

- The reduced survey data indicate that there is essentially no correlation between the changes in bar height and surface area (**Figure 6**).

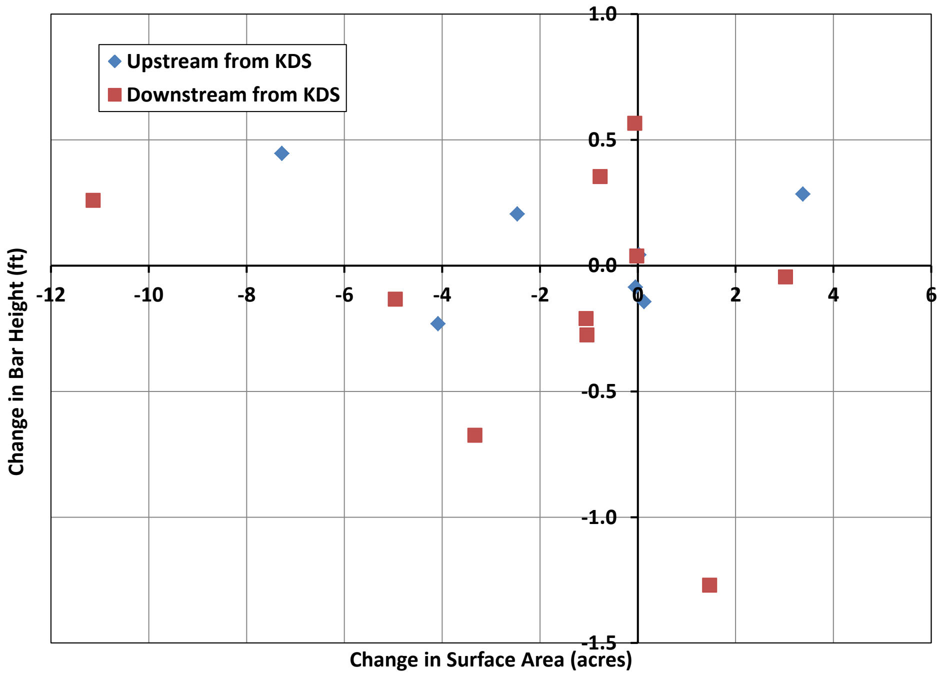


Figure 6. Change in surface area versus height of sandbars between the May and August/September 2011 surveys.

- Median and maximum sand bar heights from the two surveys relative to the maximum mean daily flows during the preceding runoff period (May: 7,370 cfs on June 26, 2010; August/September: 8,720 cfs on June 25, 2011)[2] were determined from the survey data and topographic surfaces (**Figures 7 and 8**).
- Only two of the surveyed bars had median elevations that are within the -0.7 foot benchmark height. Both of these bars are located upstream from the KDS, the downstream of which is the NPPID nesting island (**Figure 7**).
- The maximum elevation on four of the bars upstream from the KDS during both surveys is above the maximum water-surface elevation and one of the bars downstream from the KDS from the May survey was above the 2010 maximum water-surface elevation (**Figure 5**). With the exception of two of the August bars, all of these bars were vegetated. A high percentage of the unvegetated bars had maximum elevations below the -0.7-foot benchmark in both parts of the reach.
- The average difference between median and maximum elevations and the maximum water-surface elevations of the unvegetated bars upstream from the KDS increased between May and August, but the average elevations of the vegetated bars actually decreased (**Figure 9a**). There are two primary reasons for this unexpected results: (1) The 2011 maximum water surface was about 0.4 feet higher than in 2010; thus, this analysis would show that bars with no change in absolute elevation would be

[2] The maximum mean daily flow in 2010 was 7,370 cfs on June 26. Based on the steady-state HEC-RAS model results, the difference in water-surface elevation along the reach between the 2010 and 2011 maximum mean daily flows ranged from about 0.2 to 0.4 feet, and averaged about 0.3 feet. Direct comparison of the May bar elevations with the 2010 maximum water surface is tenuous because of the extensive disking that occurred during November 2010.

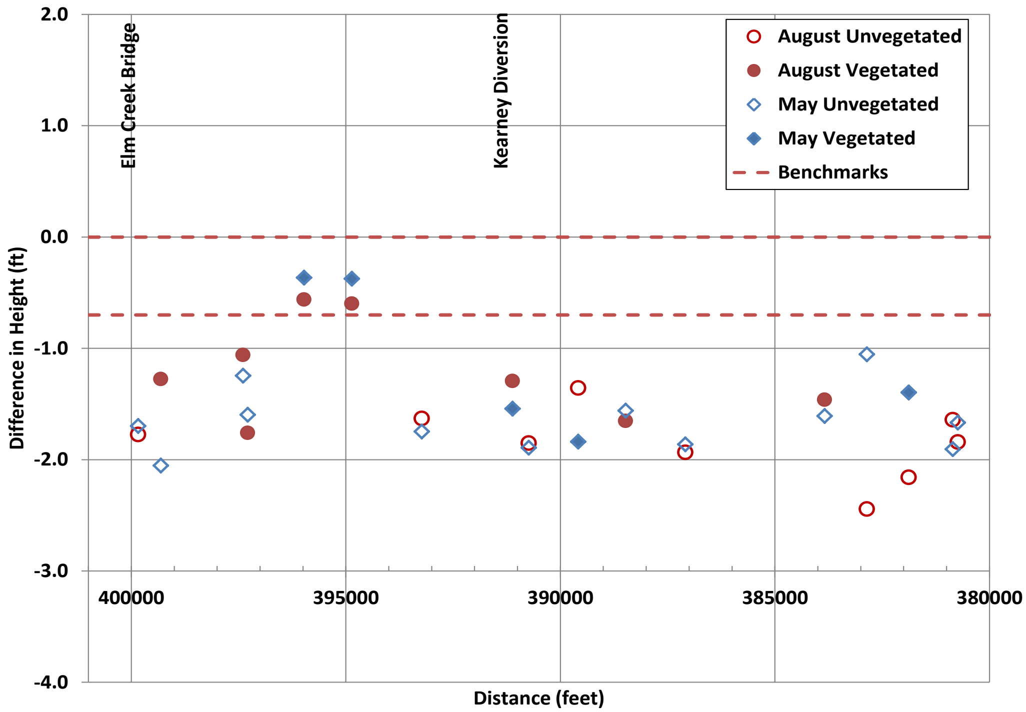


Figure 7. Difference between median bar elevation and maximum water-surface elevation during the preceding runoff period (May: 7,370 on June 26, 2010; August: 8,720 cfs on June 25, 2011).

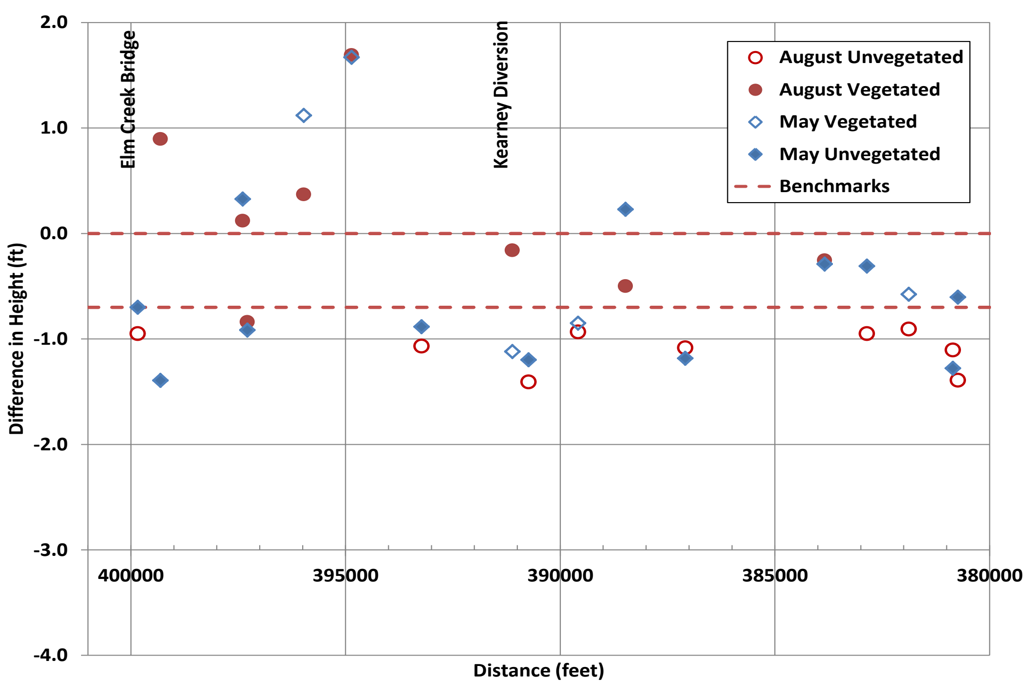


Figure 8. Difference between maximum elevation on the individual bars and maximum water-surface elevation during the preceding runoff period (May: 7,370 on June 26, 2010; August: 8,720 cfs on June 25, 2011).

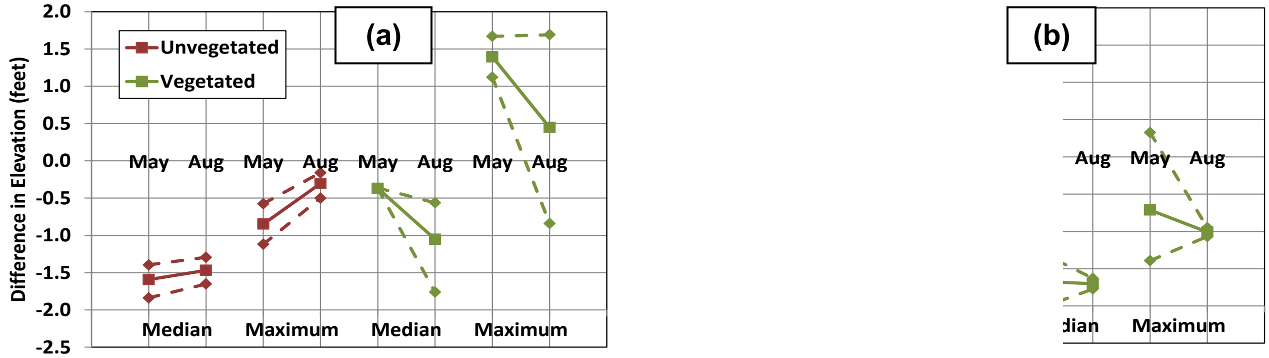


Figure 9. Average difference between maximum water-surface elevation and median and maximum bar elevations in the portion of the reach (a) upstream from the KDS and (b) downstream from the KDS. Note: Dashed lines represent minimum and maximum values.

lower with respect to the 2011 maximum water in the part of the reach downstream from the KDS, the difference between the maximum water-surface elevation and both the median and maximum bar elevations declined in both the vegetated and unvegetated categories (**Figure 9b**).

- During the May survey, only one bar upstream from the KDS and two bars downstream from the KDS (one vegetated and one unvegetated) had median heights exceeding the 1.5 foot benchmark height above the 1,200-cfs water surface (**Figure 10**). None of the bars during the August/September survey had median heights exceeding the 1.5-foot benchmark.
- The maximum height of all of the surveyed bars obviously exceeded the 1,200- cfs water surface (since 1,200 cfs is the base level for defining the bars) at heights ranging from about 1.5 feet to nearly 8 feet (**Figure 11**).
- The surface area of bars above the 1,200-cfs level in the portion of the reach upstream from the Kearney Diversion was about 36 acres in early-May, and this declined to about 33 acres in late-August/early-September (**Figure 12**). The surface area of the 1,200-cfs bars downstream from the Diversion declined even more dramatically over the period from about 44 acres to about 24 acres. About 70 percent of the bars in the upstream part of the reach were unvegetated[3] in May, and vegetation was present on all of the bars by August. In the downstream part of the reach, about 12 percent of the bars were unvegetated in May, this increased to only about 14 percent by August.
- Since the primary island habitat is typically 1.5 feet above the 1,200-cfs water surface, the surface areas at 1.5 feet above the 1,200-cfs level were also evaluated. About 12 acres of sand bar area meeting this criteria were present during both surveys in the upstream part of the reach, and this declined from about 18 acres to only about 8 acres in the downstream portion of the reach between the two surveys. About 53 percent of the area was unvegetated in the upstream part of the reach in May, and this declined to only about 11 percent in August. In the part of the reach downstream from the KDS, the unvegetated sand bar area greater than 1.5 feet above the 1,200-cfs water surface declined from about 74 percent in May to about 39 percent in August. The unvegetated bar areas in May represent about 0.9 acres per one-fourth mile of channel in the upstream part of the

[3] Based on greater than 75-percent bare ground at the vegetation sample plots.

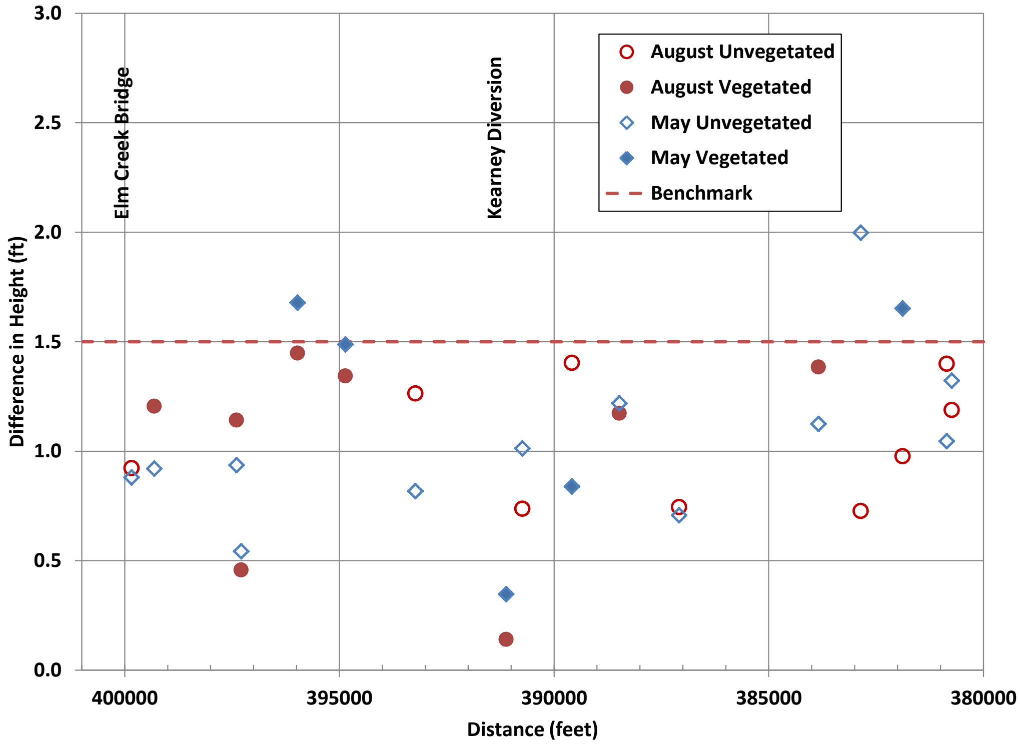


Figure 10. Median height of sand bars above the 1,200-cfs water surface during the May and August surveys.

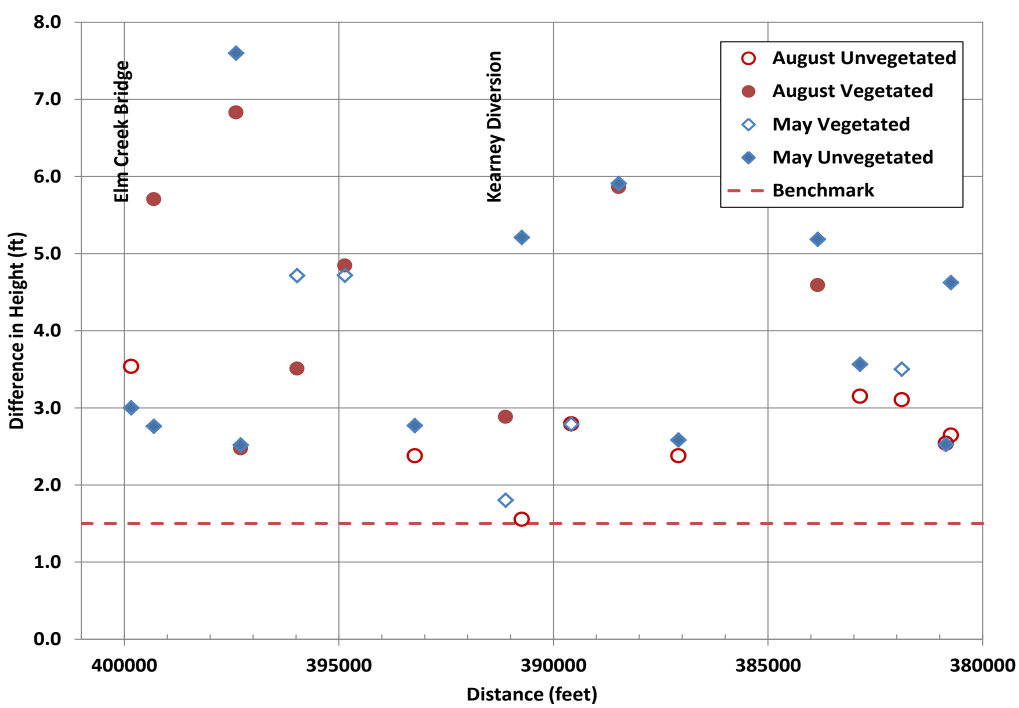


Figure 11. Maximum height of sand bars above the 1,200-cfs water surface during the May and August surveys.

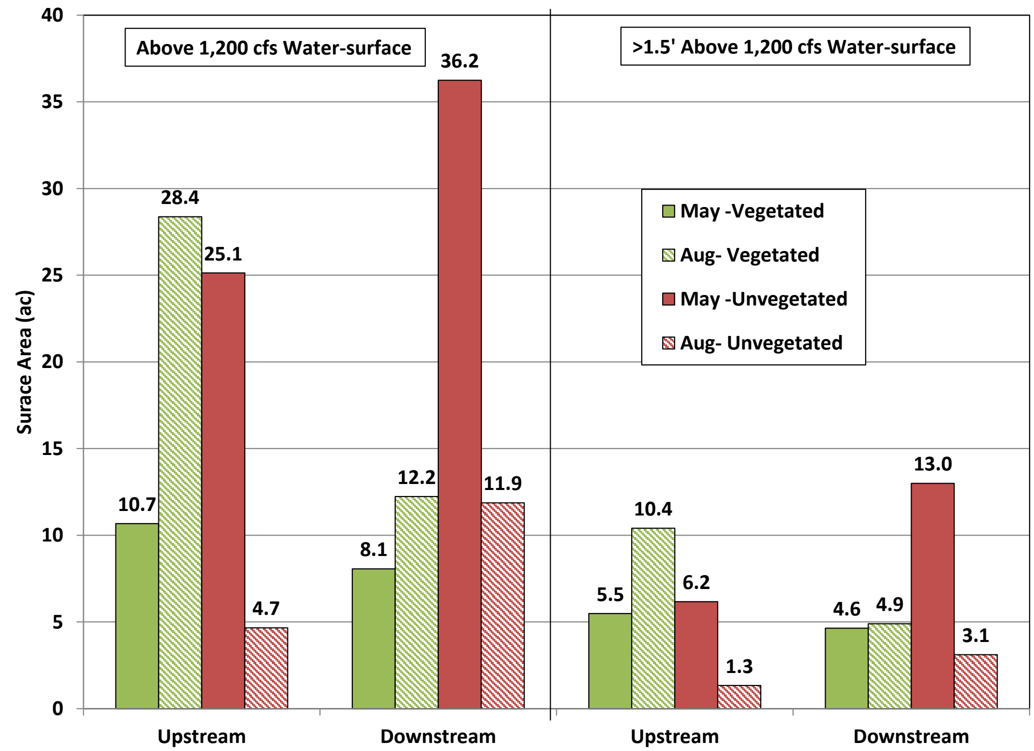


Figure 12. Surface area of bars above the 1,200-cfs water surface and 1.5 feet above the 1,200-cfs water surface during the early-May and late-August/early-September surveys.

reach and about 1.5 acres per one-fourth mile of channel in the downstream portion of the reach. These unit values declined to about 0.3 acres in the upstream part of the reach and 0.4 acres in the downstream part of the reach by the time of the August/September survey, substantially less than the 1.5-acre benchmark.

- The sediment data generally indicates that the surface of both the bed and bars coarsened between the two surveys (**Figure 13**).
- The green line was surveyed around the perimeter of all of the bars and at any locations where it could be identified on the cross sections. This resulted in nearly 340 individual points during the May survey and over 780 points during the late-August/early-September survey. Green line elevations were segregated by bar, averaged, and then compared between the two surveys to provide information to assess **Hypothesis Flow #3**.

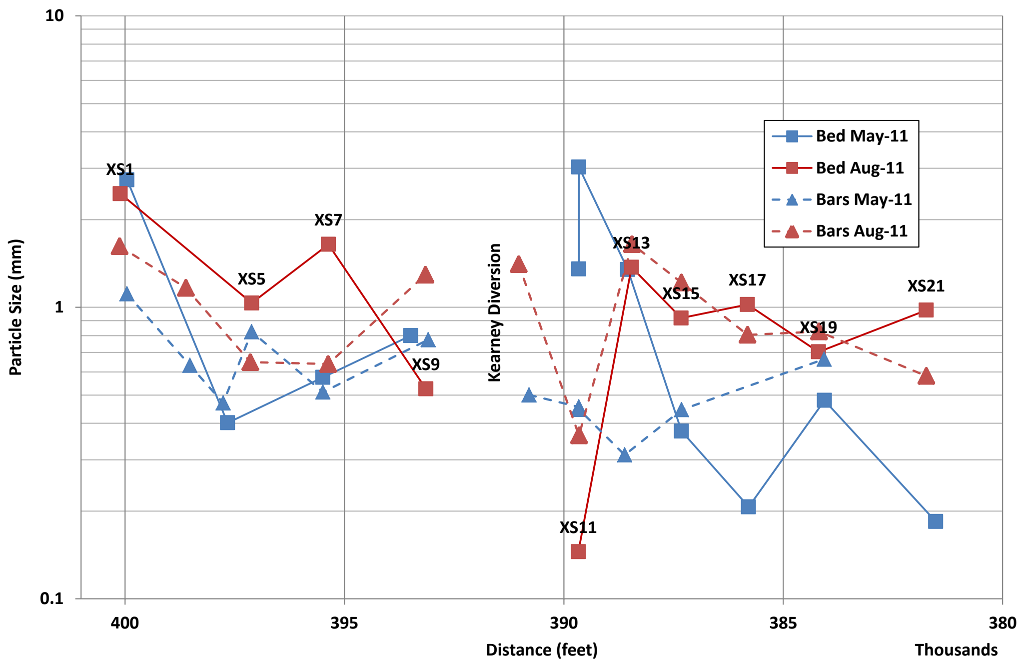


Figure 13. Median (D_{50}) size of the bed and bar-material samples collected during the early-May and late-August/early-September surveys.

- Based on bar-segregated data, the average discharge that would inundate the green line remained approximately the same in the part of the reach upstream from the KDS (~4,500 cfs in May, ~4,560 cfs in Aug/Sept), and increased from about 4,600 to 4,800 cfs in the downstream part of the reach (**Figure 14**).
- The average height of the green line above the 1,200-cfs water surface ranged from about 1.2 to about 2.2 feet, and averaged about 1.6 feet, in the upstream part of the reach during the May survey (**Figure 15**). In the downstream part of the reach, the average heights in May ranged from about 1.2 feet to 2.4 feet, and averaged about 1.7 feet. The range and average height were similar for the Aug/Sept survey, with a slight, but statistically insignificant increase in the upstream part of the reach, and a somewhat larger (1.7 feet in May to 1.8 feet in Aug/Sept), but still statistically insignificant increase in the downstream part of the reach.
- The maximum unvegetated width at each of the surveyed cross sections was also assessed based on the green line data. During the May survey, this width averaged about 710 feet in both the up- and downstream portions of the reach, and it declined significantly to about 590 feet in the upstream part of the reach and 625 feet in the downstream part of the reach by the August/September surveys (**Figure 16**).

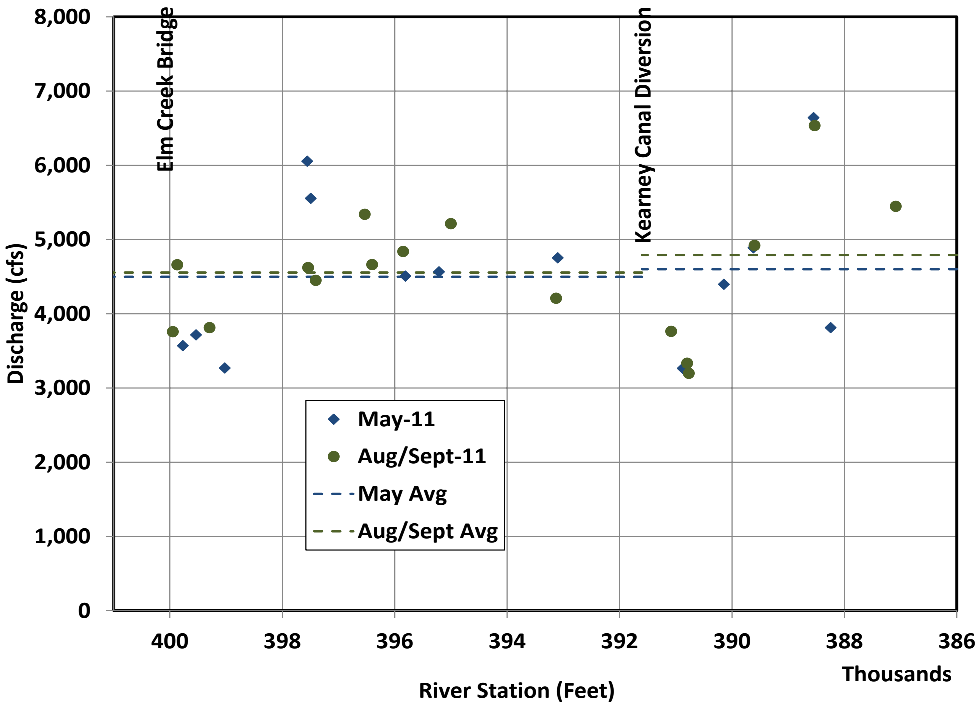


Figure 14. Discharge that inundates the average elevation of the green line points on individual sand bars surveyed during the May and August/September 2011 monitoring.

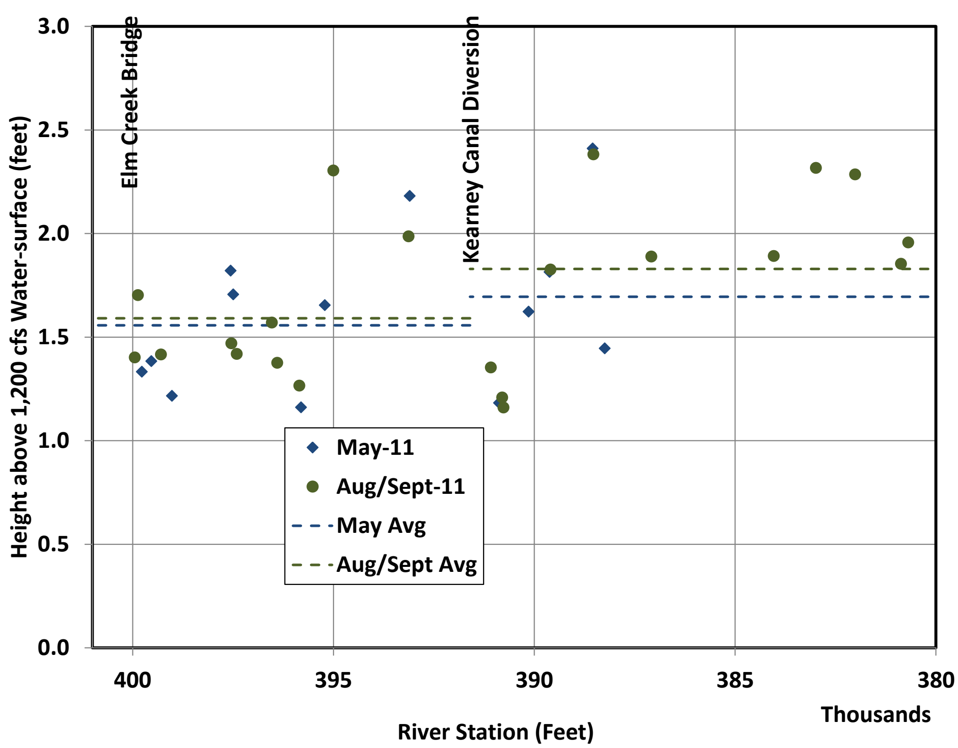


Figure 15. Average height of green line points above the 1,200-cfs water surface on individual bars during the May and August/September surveys.

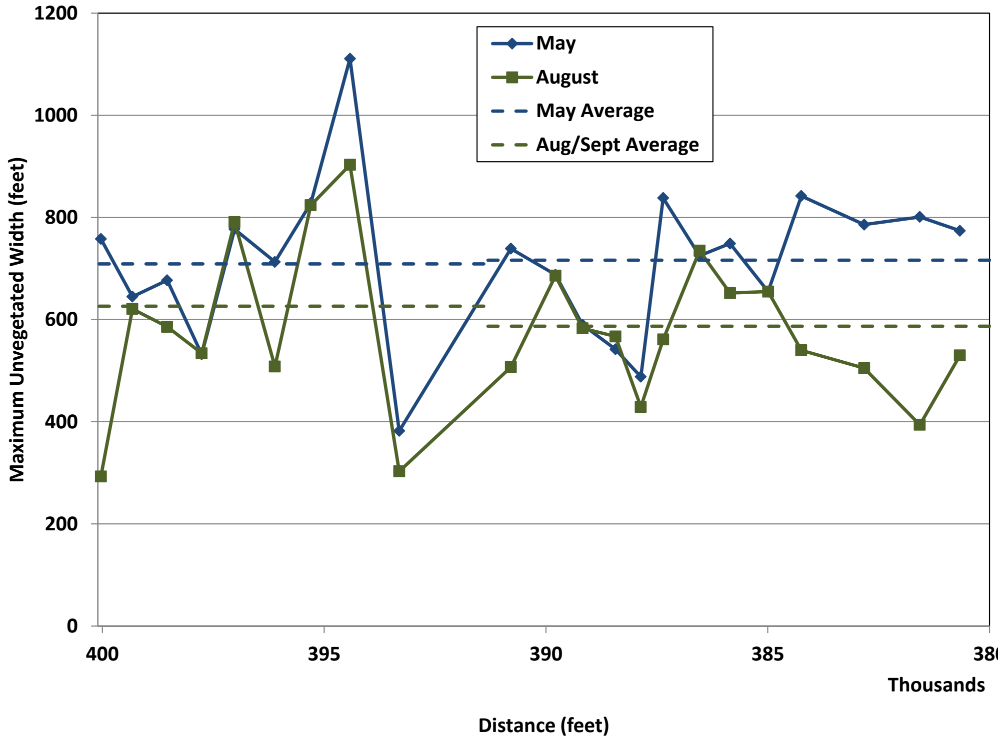


Figure 16. Maximum unvegetated channel widths at the surveyed transects, based on the green line data.

- Vegetation sampling was conducted at a series of modified Whittaker sample plots that were selected to represent a range of elevations corresponding to the water surface in increments of flow between 1,200 and 8,000 cfs. The elevation/flow zones are anticipated to produce distinct vegetation growth patterns that can be correlated with flow depths, velocities, and other factors. A total of 21 plots were sampled during the early-May surveys and 16 plots were sampled in late-August/early-September. The individual sample plots have areas of ~1,000 m^2, within which detailed sampling is conducted at 13 subplots ranging in size from 1 to 100 m^2 (**Figure 17**). Cumulatively, the sample plots occupy about 10 percent of the total sand bar area within the Complex. Vegetation sampling within each subplot included identification of all species present, percent cover of each species using Daubenmire cover classes, and height class for woody and herbaceous species using the categories from the system-wide vegetation sampling protocol.

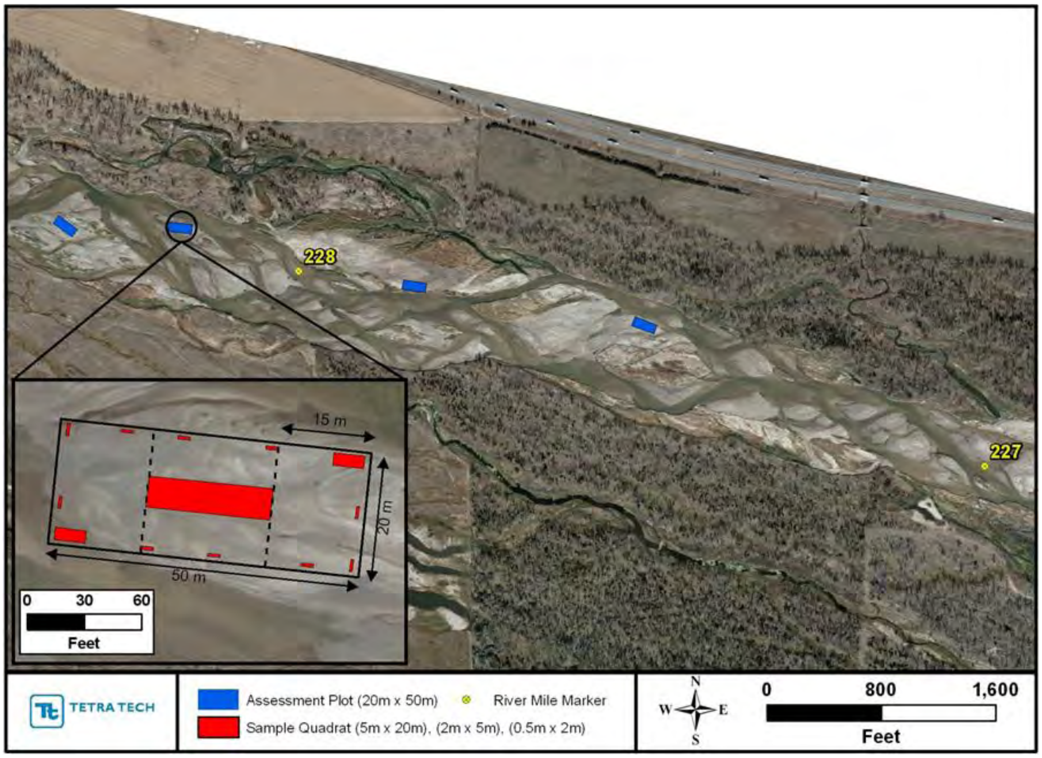


Figure 17. Example layout of modified Whittaker plots used for the vegetation sampling.

- A wide range of species were identified during the sampling (63 in May, and 86 in August) (**Figures 18 and 19**). The five most common species during the May survey were ragweed, rough cocklebur, red seedling, reed canary grass, and common reed (phragmites), and the five most common in August were flat sedge, rabbit's foot grass, barnyard grass, common reed (phragmites) and teal love grass. Because most of the sample sites were disked in November 2010, cover during the May sampling was quite low, and most of the vegetation during the late-August /early-September survey represented first-year growth.
- The frequency of occurrence and percent cover of the seven target species listed in the system-wide monitoring protocol were evaluated to assess changes between the survey periods. These species are:
    - *Amorpha fruticosa* (desert false indigo)
    - *Salix exigua* (sandbar willow)
    - *Populus deltoids* (plains cottonwood)
    - *Phalaris arundinacea* (reed canary grass)
    - *Phragmites australis* (common reed)
    - *Typha latifolia* (broadleaf cattail)
    - *Lythrum salicaria* (purple loosestrife)

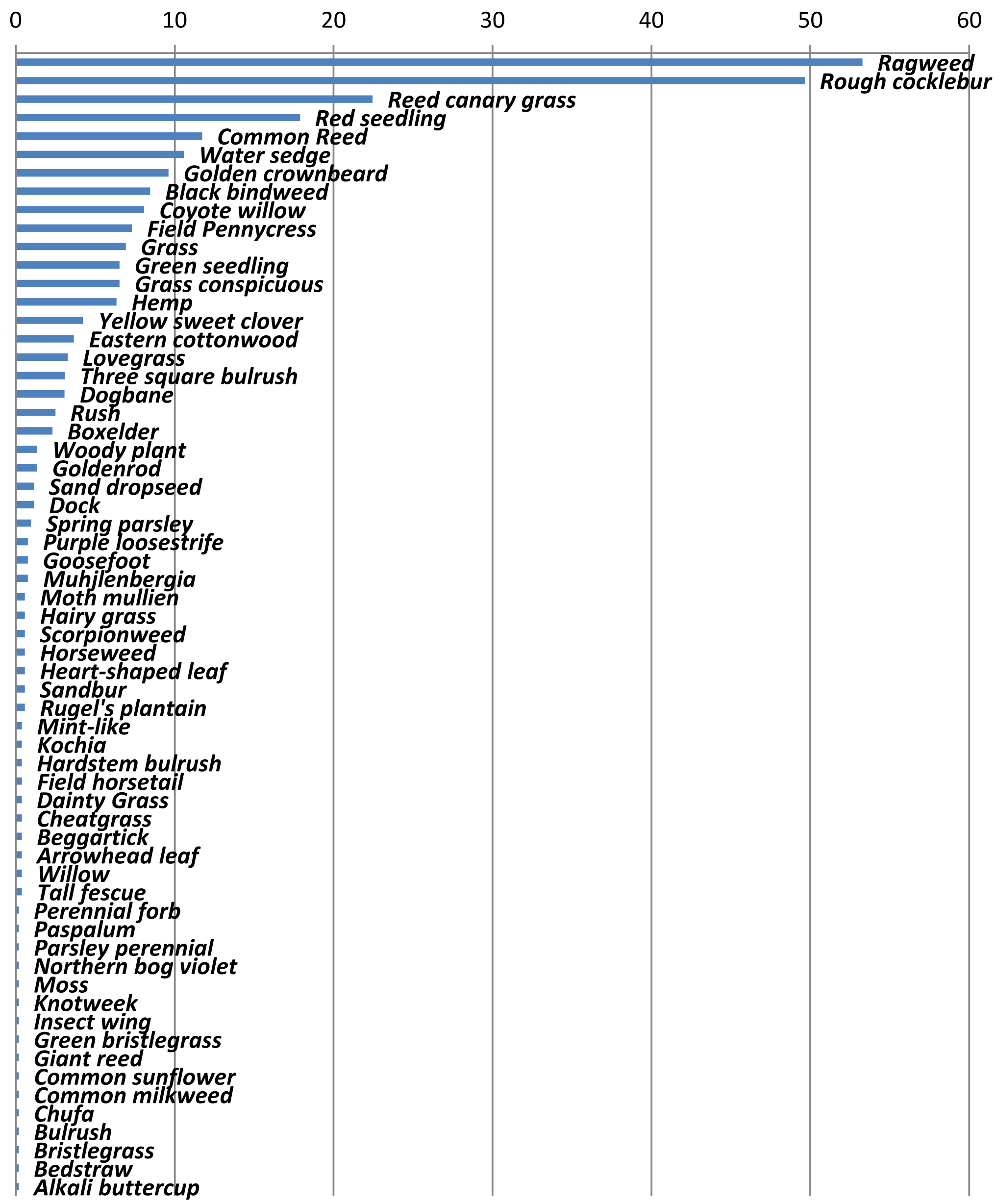


Figure 18. Percent cover for all species identified during the May survey.

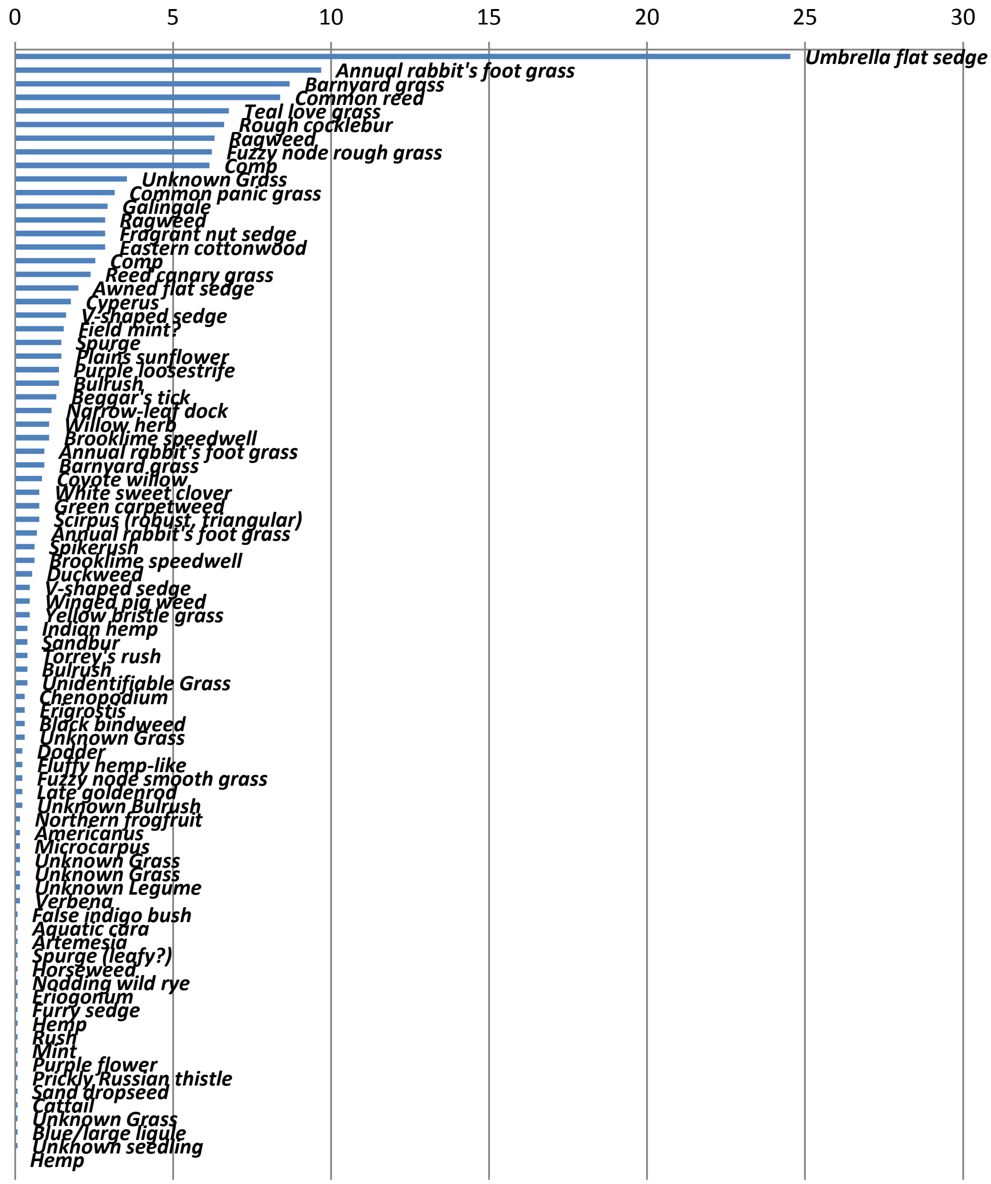


Figure 19. Percent cover for all species identified during the August survey.

240 • Based on the sampling data, very little false indigo or broadleaf cattail was encountered in the reach, the amount of sandbar willow and reed canary grass decreased, and the amount of cottonwood, phragmites and purple loosestrife increased between the two surveys (**Figures 20 and 21**).

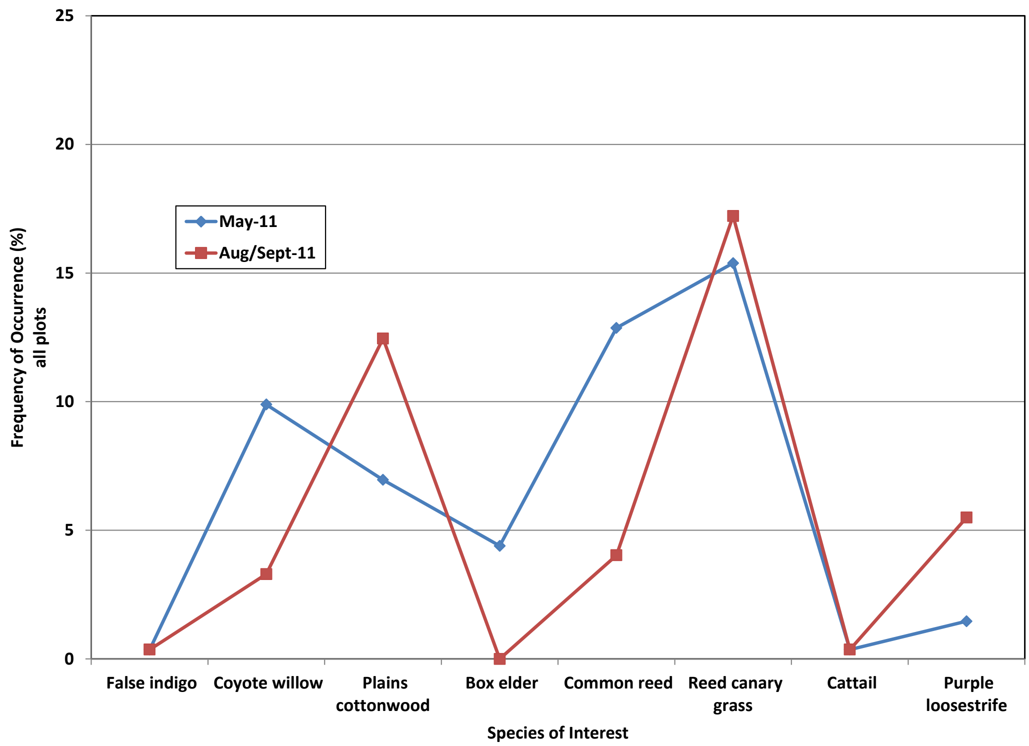


Figure 20. Frequency of occurrence of the target species during the May and August 2011 surveys.

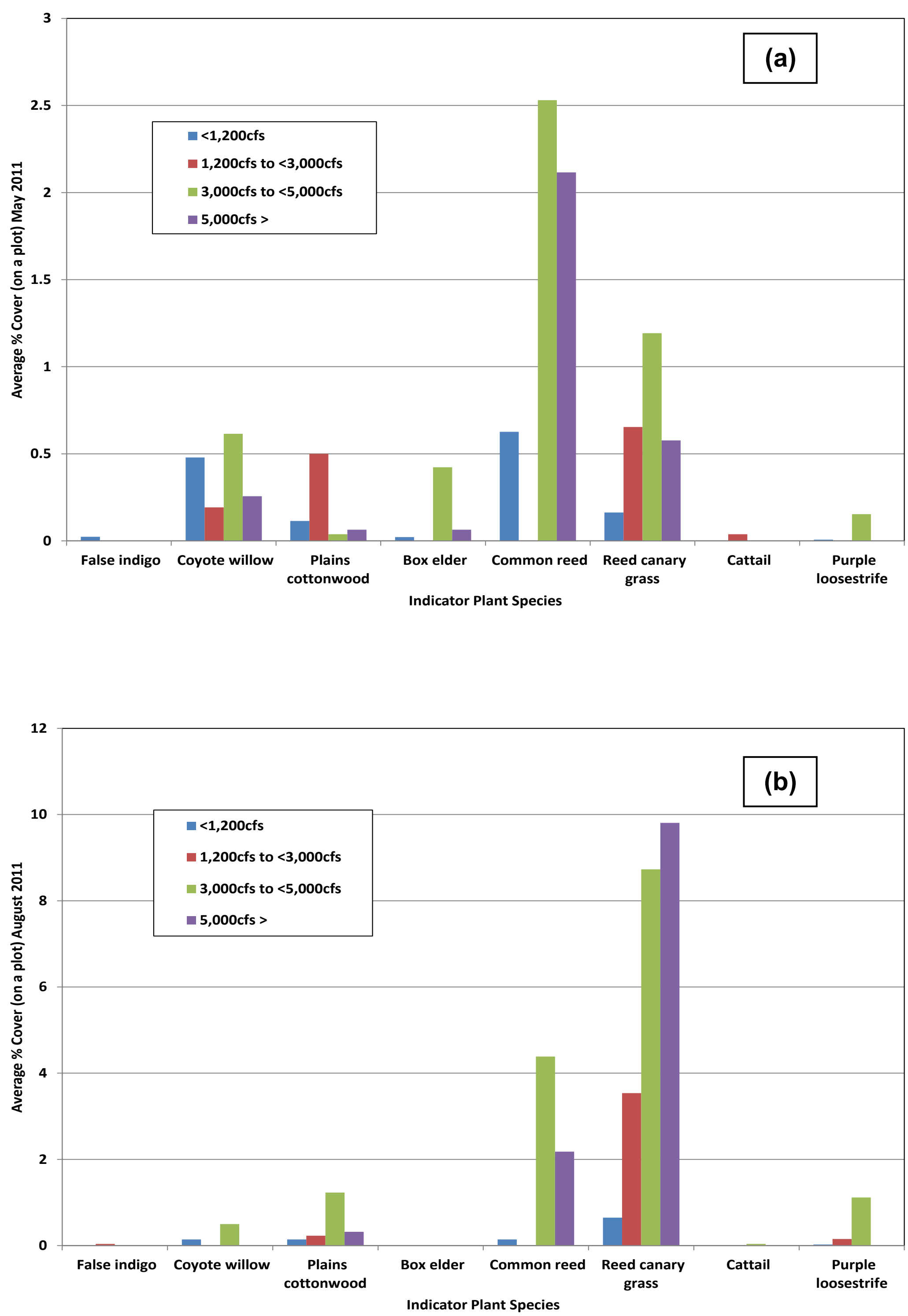


Figure 21. Average percent cover of the target species during the (a) May and (b) August/September 2011 surveys.

- The widest contiguous width of channel with depth greater than 0.25 feet at each of the surveyed transects over the range of flows up to 8,000 cfs (Flow #5 performance measure) was estimated based on the survey data and the HEC-RAS model results. The duration of inundation to cause mortality of the vegetation is not known at this time. For purposes of assessing this issue, the results were then used in conjunction with the Overton flow record to estimate the maximum width inundated at each transects for periods of 30, 60, 90, and the full 150-day period between the two surveys (**Figures 22 and 23**). Using the May transects, the widths at three of the transects in the upstream part of the reach and one of the transects in the downstream part of the reach exceeded the 750-foot benchmark for over 90 days during the period. Using the August data, three transects in each of the up- and downstream parts of the reach had widths exceeding the benchmark for over 30 days, and only one transect exceeded the benchmark for 90 days.

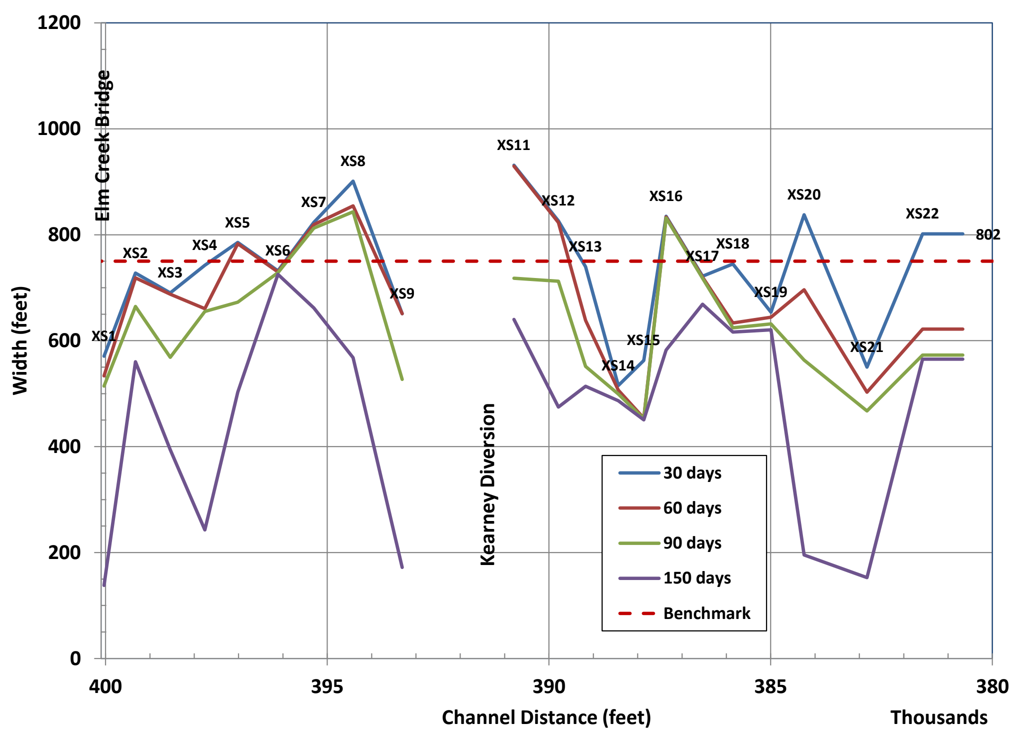
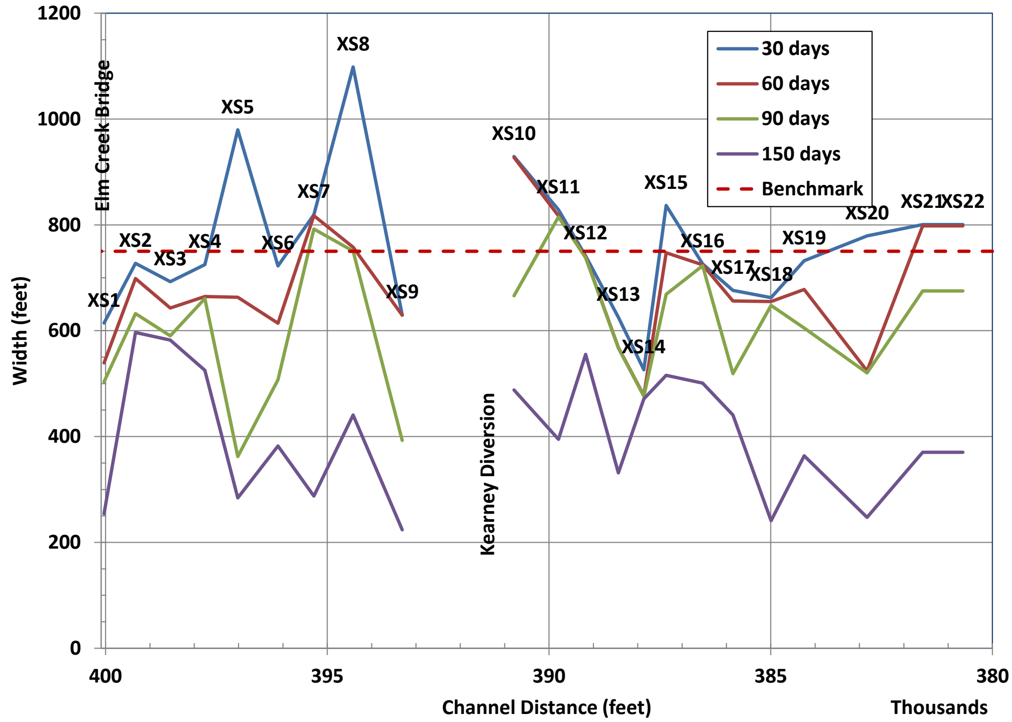


Figure 22. Width inundated to depths exceeding 0.25 feet for durations of 30, 60, 90 and the full 150 days between the May and August 2011 surveys, using the May transect data.



330 **Figure 23.** Width inundated to depths exceeding 0.25 feet for durations of 30, 60, 90 and the full 150 days between the May and August 2011 surveys, using the August transect data.

335 • The duration at which the vegetation sample plots were inundated during the period between the surveys was also estimated based on the mean plot elevation and the Overton flows, and the percentage bare ground within each plot was then compared with the resulting durations (**Figure 24**). Based on these data, there does not appear to be a strong relationship between the amount of unvegetated area and the duration of inundation.

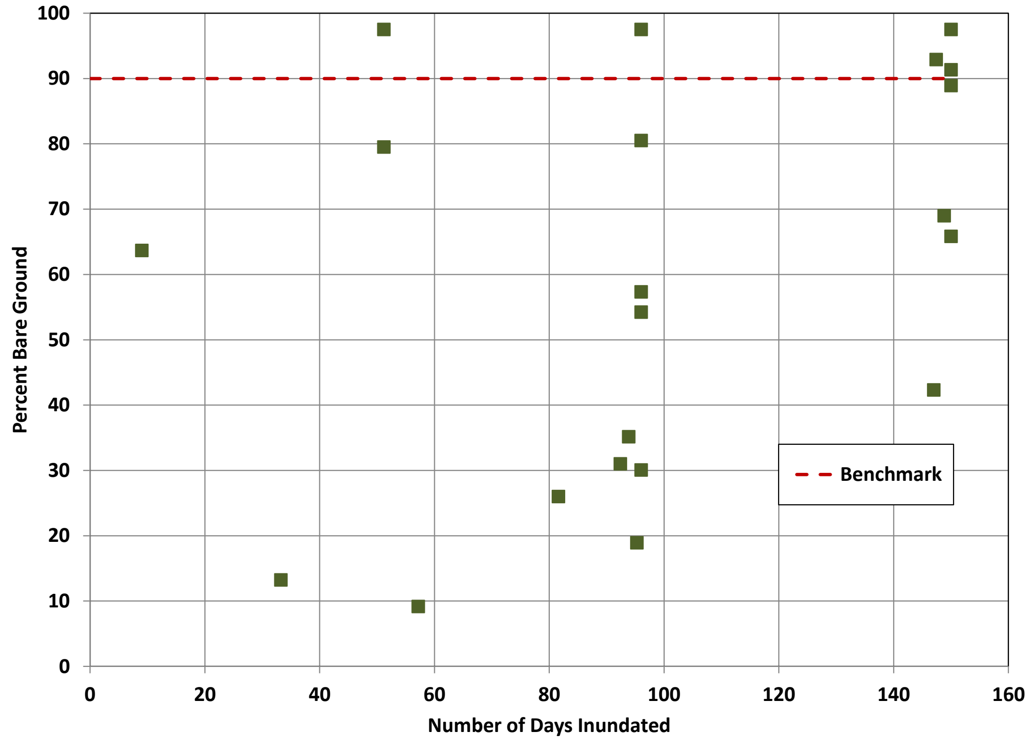


Figure 24. Percentage of bare ground at each of the vegetation sample plots during the August/September 2011 survey versus the number of days of inundation between the two surveys.

Experimental Plan

- The Elm Creek Flow-Sediment-Mechanical (FSM) Proof-of Concept Experiment is intended to provide the information to test FSM-related hypotheses and answer the three related "Big Questions" listed above.
- The flow and sediment aspects of the FSM management strategy may be controlled by Program actions separate from the Elm Creek proof-of-concept experiment (e.g., SDHF releases and sediment augmentation). These aspects are also largely controlled by the natural flow regime.
- Based on the above observations, only the **mechanical** element of the FSM strategy can be directly controlled as part of the Elm Creek Experimental Design. The general strategy for the experimental design for this element involves mechanically treating a representative subset of the existing bars by (1) grading to pre-determined elevations to assess whether or not they will build back to a suitable size and range of elevations, and (2) disking and/or spraying to inhibit vegetation growth on the islands. The existing bars within the Complex have heights that vary over a relatively broad range of inundation discharges; thus, it does not appear that physical manipulation of the bar topography would provide additional information for the analysis. The primary element of the experimental design, therefore, consists of disking and/or spraying a subset of the bars that have a representative range of elevations, while leaving the remainder untreated, and then performing appropriate statistical analyses to detect differences in the response between the treated and untreated bars, and to identify the key factors that drive responses that are detected.

- A total of 28 bars have been identified for sampling, including the original 21 that were sampled in May 2012 and an additional 7 bars to expand the data set. The experimental plan for disking and/or spraying different subsets of the bars in each of the years of the experiment is summarized in **Table 2**. Under this plan, 11 of the 21 previously sampled bars and all of the added bars that were not previously sampled will be disked and/or sprayed in 2012, and 8 of the total 28 bars will be disked/sprayed in 2013. Maps showing the locations of the bars are provided at the end in **Appendix A**.

Table 2. Vegetation clearing plan and summary of mean elevation and associated inundation discharge, sorted by discharge range and subsorted by location from upstream to downstream.

Sample Plot ID	Station	May 2011 Bar Number	August 2011 Bar Number	Year 1 (2011)	Year 2 (2012)	Year 3 (2013)	Sample Plot (August 2011 Survey)	
							Mean Elevation	Inundation Discharge (cfs)
10	394,396	13	Under Water	Cleared	Not Cleared	Not Cleared	2,239.2	1,200
17	386,048	27	Under Water	Not Cleared	Not Cleared	Not Cleared	2,226.4	1,500
18	385,198	Under Water	Under Water	Not Cleared	Not Cleared	Not Cleared	2,224.7	1,500
21 (May 2011)	382,243	32	Not There	Not Cleared	Not Cleared	Not Cleared	2,222.3	1,330
6	397,181	7	5	Cleared	Cleared	Not Cleared	2,242.6	2,800
14	389,599	19	15	Cleared	Cleared	Not Cleared	2,232.3	2,300
19	384,199	29	18	Cleared	Cleared	Cleared	2,224.1	3,000
22	381,320	33	Under Water	Not Sampled	Not Cleared	Not Cleared	2,220.9	3,000
28	380,854	34	22	Not Sampled	Cleared	Not Cleared	2,222.0	2,820
1	399,851	2	3	Cleared	Not Cleared	Not Cleared	2,247.4	4,150
23	399,786	1	1	Not Sampled	Cleared	Cleared	2,247.4	4,510
2	399,150	4	3	Cleared	Cleared	Cleared	2,246.4	4,030
3	399,026	5	Under Water	Cleared	Not Cleared	Not Cleared	2,243.9	4,000
24	398,058	Not There	4	Not Sampled	Cleared	Not Cleared	2,245.0	3,650
4	397,572	8	4	Cleared	Cleared	Not Cleared	2,244.7	4,600
5	397,486	6	5	Cleared	Cleared	Not Cleared	2,243.7	4,000
7	396,462	8	6	Cleared	Not Cleared	Not Cleared	2,243.2	4,090
11	393,112	15	11	Cleared	Cleared	Not Cleared	2,238.8	4,000
12	391,203	16	12	Cleared	Cleared	Not Cleared	2,234.9	4,000
26	390,481	Not There	14	Not Sampled	Cleared	Cleared	2,231.6	4,200
20	383,164	31	19	Not Cleared	Not Cleared	Not Cleared	2,223.8	4,000
8	395,952	9	8	Cleared	Not Cleared	Not Cleared	2,243.2	7,030
9	395,268	11	10	Cleared	Cleared	Cleared	2,242.8	8,000
25	392,511	Connected to bank	Not Sampled	Not Sampled	Cleared	Cleared	2,244.6	6,000
13	390,207	Not There	13	Cleared	Not Cleared	Not Cleared	2,231.9	5,800
15	388,481	21	16	Cleared	Cleared	Not Cleared	2,231.6	5,570
16	386,853	24	17	Cleared	Cleared	Cleared	2,227.8	5,800
27	384,418	30	27	Not Sampled	Cleared	Cleared	2,227.1	6,450
21 (Aug 2011)	381,926	Not There	20	Not Cleared	Not Cleared	Not Cleared	2,223.9	5,070

Conclusions Relevant to Big Questions and Tier 1 Hypotheses

Results are summarized in terms of the results observed between the May and August/September 2011 surveys for each of the Big Questions and Tier I hypotheses individually, and a summary evaluation of performance benchmarks is provided in **Table 3**.

Table 3. Summary of performance measure evaluation results.

Hypothesis	Performance Measure	Benchmark Met?	
		Upstream	Downstream
Flow #1	Mean and maximum sand bar height relative to peak stage of formative flow event	Partially	Partially
Flow #1	Mean and maximum sand bar height relative to 1,200 cfs stage for flow events of 5,000 to 8,000 cfs	No	No
Flow #1	Unvegetated sand bar area exceeding height of 1.5' above 1,200 cfs stage per ¼ mile of river channel	No	No
Flow #3	Elevation of green line above 1,200 cfs stage for flow event of 5,000 to 8,000 cfs (ILT and PP nesting)	Partially	Partially
Flow #3	Unvegetated channel width following flow event of 5,000 to 8,000 cfs (WC roosting)	Partially	Partially
Flow #5	For flows of 5,000 to 8,000 cfs, is 90% of vegetation scoured in any inundated sand bar area 1.5' above 1,200 cfs?	No	No
Flow #5	For flows of 5,000 to 8,000 cfs, channel width at which 90% vegetation scour is achieved.	No	No
Flow #5	Can sustain releases necessary to inundate 750' wide channel >0.25' deep for period exceeding inundation mortality threshold?	[1]	[1]

Notes:
[1] Not evaluated because the duration of inundation needed for plant mortality is not known.

Big Questions

- Flows in the Central Platte River and the Elm Creek reach were unusually high during 2011, both in terms of magnitude and duration. The peak flow of 8,820 cfs at Overton is equivalent to an approximately 5-year event, and the ~1.8M ac-ft of runoff volume between April 1 and October 1 was the fourth highest in the 70-year period since 1942.
- The Elm Creek reach responded to these high flows by generally degrading in both the portions of the reach between the Elm Creek Bridge and the Kearney Diversion (~9,100 net tons of sediment removed, based on the cross section data) and downstream from the Diversion (removal of ~19,100 net tons of sediment). In spite of the net loss, 4 of the 9 cross sections upstream from the diversion and 7 of the 13 downstream cross sections actually showed net aggradation.

Hypothesis Flow #1

- Only two bars (both vegetated and in the portion of the reach upstream from the KDS) met the Flow #1 benchmark of median elevation within 0.7 foot of the peak stage during the preceding high flows of 8,720 cfs in June 2011.
- The highest point on about half of the bars was within the -0.7-foot benchmark and several bars upstream from the KDS also have high points that are above the 0.0-foot benchmark

with respect to the peak stage for the preceding high flows. With two exception (both in the upstream part of the reach, one of which is the NPPID nesting island), the highest elevation bars are vegetated.

- None of the bars during the August/September survey had median heights exceeding the benchmark of 1.5-foot above 1,200-cfs stage.
- The surface area of unvegetated bars equaled about 1.5 acres per one-fourth mile of channel upstream from the KDS and about 0.9 acres per one-fourth mile in the downstream part of the reach during the May survey. This declined to about 0.3 and 0.4 acres, respectively, during the August survey. With the exception of the upstream May bars, none of these areas meet the 1.5-acre per one-fourth mile benchmark.

Hypothesis Flow #3

- The bar-segregated height of the surveyed green line above the 1,200-cfs water surface ranged from about 1.2 to 2.4 feet, and averaged about 1.6 feet , during the May survey. The range and average were very similar during the August survey. About half of the bars during May fell below the 1.5-foot benchmark with respect to the 1,200-cfs water surface, about 40 percent of the August bars fell below the benchmark.
- Based on the green line and transect surveys, the unvegetated channel width varied from about 380 feet to over 1,100 feet, and averaged about 710 feet, in the upstream part of the reach, and from about 490 to 840 feet, also averaging about 710, in the downstream part of reach during the May surveys. By August the upstream widths decreased to about 290 to 900 feet, averaging about 600 feet in the upstream part of the reach, and the downstream widths decreased to 400 to 740 feet, averaging 560 feet in the downstream part of the reach.

Hypothesis Flow #5

- Based on the vegetation data, little if any of the vegetation on surfaces more than 1.5 feet above the 1,200-cfs water surface was scoured.
- The 2011 vegetation monitoring data show very little correlation between the duration of inundation and the amount of unvegetated area on the bars.

Recommendations for 2012

- Implement the experimental plan as summarized above and described in the Experimental Plan Report, and continue the pre- and post-runoff monitoring activities to expand the topographic and vegetation change database under a broader range of hydrologic conditions.
- Continue to refine the 2-D sediment-transport model, and perform model runs for additional longer-term, high–flow hydrographs and variable sediment input to improve understanding of the likely response of the system over time.
- Support the ED Office in the development of a performance evaluation decision tree that will define potential action adjustments based on the potential range of experiment outcomes. This could then be used as a quantitative means for evaluating the performance of the management experiment.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
Sediment Augmentation Pilot-Scale Management Action

Sediment augmentation is part of the Program's Flow-Sediment-Mechanical (FSM) management strategy. As a management action, sediment augmentation will be implemented as one of a suite of actions to help address critical Program uncertainties including the following big questions:

- **Big Question #6 –** How do short-duration high flows (SDHF), restoring sediment balance, and mechanical channel alterations contribute to the maintenance of channel width and creation of a braided river channel?
- **Big Question #7 –** What is the relationship between SDHF, sediment balance, and tern and plover riverine nesting habitat meeting Program minimum criteria?
- **Big Question #8 –** What is the relationship between SDHF, sediment balance, and whooping crane habitat meeting Program minimum criteria?

To assess progress toward this objective and learn about the major whooping crane uncertainties, several finer-scale priority hypotheses were developed by Program participants. Those hypotheses were sequenced to develop a smaller set of Tier 1 hypotheses to receive focused attention in the First Increment. For sediment augmentation, the Tier 1 hypothesis is:

- **Sediment #1:** Average sediment augmentation near Overton of 185,000 tons/year under existing flow regime and 225,000 tons/year under Governance Committee proposed flow regime achieves a sediment balance to Kearney.

Feasibility Study

In November 2010, the *Sediment Augmentation Experiment Alternatives Screening Study Summary Report* (The Flatwater Group, Inc., et al., November 2010) (Screening Study) was prepared for the Program. The Screening Study identified, developed, and evaluated alternatives to test the Program's Tier 1 sediment augmentation hypothesis. This hypothesis is based on modeling performed by the Bureau of Reclamation (BOR). The Screening Study evaluated the sediment deficit reported by BOR as well as a number of potential sediment augmentation alternatives, and identified several areas of uncertainty that affect the design of a sediment augmentation program.

Modeling was conducted as part of the Screening Study to verify the results of the BOR model. Results from the Baseline Model simulation were evaluated to assess the magnitude, distribution, and characteristics of sediment loading along the project reach (between the Lexington and Odessa bridges) under existing conditions. The results confirmed a significant sediment imbalance along the project reach. In general, the results indicate that the overall sediment deficit in the project reach is approximately 150,000 tons/year. Several sediment augmentation alternatives were developed and evaluated in the Screening Study for their ability to reduce the 150,000 tons/year sediment deficit.

The Screening Study concluded that although a significant reduction in the sediment deficit could be realized, it is unlikely that any of the alternatives would be 100 percent effective in eliminating the sediment deficit at Cottonwood Ranch Complex (CWR). The modeling results also suggest that in addition to material size and volume of material, the augmentation technology and the location are significant factors in achieving sediment balance. Therefore, the Screening Study recommended implementing a 2-year pilot-scale management action to reduce these uncertainties. This pilot-scale management action will allow the Program to evaluate identified augmentation measures and compare physical actions with predicted model results (evaluated in the Monitoring Plan). In addition, implementing the pilot study and the associated monitoring protocol will provide data necessary to test the Tier 1 sediment hypothesis on a preliminary basis and evaluate learning related to the Big Questions noted above.

Objectives of Pilot Study

The objective of the Pilot Study is to collect data associated with the means and methods for sediment augmentation to provide an improved foundation for the design of the full-scale sediment augmentation project. Therefore, the Pilot Study has two primary components: first is the "Management Action" that comprises all of the activities required to introduce sediment to the river; second is the "Monitoring Plan" that comprises the activities associated with the collection and evaluation of the data from the implementation of the Management Action. It is anticipated that data and results from the Year 1 monitoring will inform Year 2 Pilot Study Management actions.

The following sediment augmentation uncertainties will be evaluated during the Pilot Study:

- Testing to determine the optimal particle size
- Technology to produce the optimal particle size
- Timing and duration of annual augmentation activities
- Optimal location of placed augmentation material for entrainment
- Enhanced understanding of potential for adverse downstream effects

Data will be collected as prescribed in the detailed Monitoring Plan to address the uncertainties. The Monitoring Plan will be implemented to accomplish two purposes. First, data will be collected and used to verify that the Pilot Study does not adversely affect adjacent property owners. Second, data will be collected to help determine whether the sediment placement technology is effective, whether the location chosen is appropriate, and whether the material used is sufficiently suitable for sediment augmentation purposes. The data will be evaluated to determine whether the physical response of the Platte River is substantially different from the response expected based on the sediment transport model and historical data. The monitoring activities will focus on stage and bed elevation change to identify trends that indicate how the river is responding, including whether the river responds in unexpected ways.

The Pilot Study and associated Monitoring Plan will also provide short-term data on sediment transport, dispersal, and any resulting influences on channel morphology and riverine processes. Implementing the Monitoring Plan will provide data necessary to test the Tier 1 sediment hypothesis on a preliminary basis.

In addition, the sediment transport model developed for the Screening Study will be updated based on the data collected during the Pilot Study. The results of the Pilot Study data collection and analysis combined with the results of the sediment transport modeling will be used to inform the final design for the full-scale sediment augmentation project.

Management Action

As stated, the objective of the Pilot Study is to collect data to help reduce the uncertainties concerning the means and methods for the full-scale sediment augmentation project by testing and evaluating the performance of sediment augmentation using both sand pump technology and mechanical placement. The Pilot Study will introduce sediment to the Platte River to offset a portion of the sediment deficit. In order to evaluate the effects of physical placement of material in the river, it was determined that a partial augmentation of material would be conducted. Partial augmentation will reduce the potential for the development of adverse flow conditions while still allowing the Program to evaluate augmentation methods identified in the Screening Study. It is estimated that augmenting a total mass of material equal to two-thirds of the predicted total sediment deficit of 150,000 tons/year in the project reach is adequate to inform the Program on full-scale sediment augmentation.

To accomplish the Pilot Study Management Action, half of the material (50,000 tons) will be mined from and placed into the river at the Cook Tract/Dyer Property using sand pumps (Figure 1). Existing sandpits on the property will be expanded to allow for a more rapid mobilization time. CWR was identified as a logical area to evaluate bulldozer options since the Program has been conducting bulldozer operations at the site for several years. The other half of the material (50,000 tons) will be dozed into the river at the CWR (Figure 2).

Figure 1. Typical Sand Pump Operation

Figure 2. Typical Mechanical placement using dozers.

Performance Measures

Performance indicators were established to evaluate the implementation of the Management Action as well as the eventual long term performance of the full-scale sediment augmentation project. The performance indicators are:

- Stage-discharge relationship
- Bed elevation
- Bed and bar gradation

To evaluate short- term effects, a threshold or "impact trigger" was established for each performance indicator for the implementation of the Pilot Study Management Action. The impact triggers were established to assist in identifying potential negative effects of the Management Action to adjacent property owners. These triggers will be used to help determine whether the Management Action implementation should continue or whether the Management Action should be stopped and/or modified. Long term effects will be evaluated using a performance benchmark for each performance indicator. The benchmark was established to evaluate the Management Action performance based on data collected throughout the entire Pilot Study. The collected information will be evaluated against historical or predicted natural river processes. The benchmarks were developed on a reach scale basis (extent of several miles). The benchmarks will aid in the evaluation of the full-scale sediment augmentation project.

As previously stated, a sediment transport model was developed as part of the screening study. This model will become the baseline for impact triggers and performance benchmarks. The sediment transport model results from the dry, normal, and wet simulations of the pilot augmentation will be used in conjunction with historical stage-discharge gage data as a basis for comparing measured changes in stage during the Pilot Study.

The following Stage-Change Classes were developed for this study and will be assigned to the observed Management Action stage-change data point as follows:

- Stage-Change Class I – The observed Management Action data point falls within the scatter of the measured gage data, indicating the Management Action has not had a significant effect on the stage.
- Stage-Change Class II – The observed stage-change data point falls outside of the scatter of the measured data but is less than the predicted maximum envelope, indicating the Management Action has significantly affected the stage but is within the levels predicted by the model.
- Stage-Change Class III – The observed stage-change data point is greater than the predicted maximum envelope, indicating the Management Action has significantly affected the stage beyond the levels predicted by the model.

Similar to the Stage-Change Classes, Mean Bed Elevation Classes were developed to assess the measured bed elevation versus the modeled and historical data for use in evaluating certain performance indicators:

- Mean Bed Elevation Class I – The observed Management Action data point falls within the scatter of the measured gage data, indicating the Management Action has not had a significant effect on the mean bed elevation.
- Mean Bed Elevation Class II – The observed mean bed elevation data point falls outside of the scatter of the measured data but is less than the modeled maximum increase in mean bed elevation, indicating the Management Action has significantly affected the mean bed elevation but is within the levels predicted by the model.
- Mean Bed Elevation Class III – The observed mean bed elevation data point is outside the scatter of the measured gage data and is greater than the modeled maximum increase in mean bed elevation change, indicating the Management Action has significantly affected the mean bed elevation change beyond the levels predicted by the model.

The impact triggers and performance benchmarks for each performance indicator, as well as the measurement method are described in Table 1.

Table 1 - Pilot Study Performance Indicators

Performance Indicator	Measurement Method	Impact Trigger	Performance Benchmark
Stage Discharge Relationship	Pressure Transducers and Gages	Stage-Change Class II or III	Stage-Change Class I
Bed Elevation	Topographic and Bathymetric Surveys	Mean Bed Elevation Class II or III	Mean Bed Elevation Class I
Bed Elevation	Photographic Documentation	Visual evidence of sediment accumulation: excessive, acceptable, none or negative (degrading) as compared to prior photos	Average reduction in degradation over reach
Bed and Bar Gradation	Bed-and-Bar Material Sampling	N/A	Median diameter within ± 0.2 mm of model results; and change in median diameter of -0.2 mm as compared to historical data

Monitoring Plan/Protocol

The monitoring program will follow the guidelines in the Program Project-scale Geomorphology and Vegetation Monitoring Protocol (Program, 2011) for collecting and analyzing specific data types:

- Stage and discharge data will be collected and reviewed daily from the available gages within the project reach. Stage data will be collected at three additional locations to supplement active stream gages.
- Topographic/bathymetric changes, including both the aggradation/degradation response of the river bed and lateral migration.
- Bed material samples will be collected at each survey cross section.

The monitoring locations are shown in Figure 3.

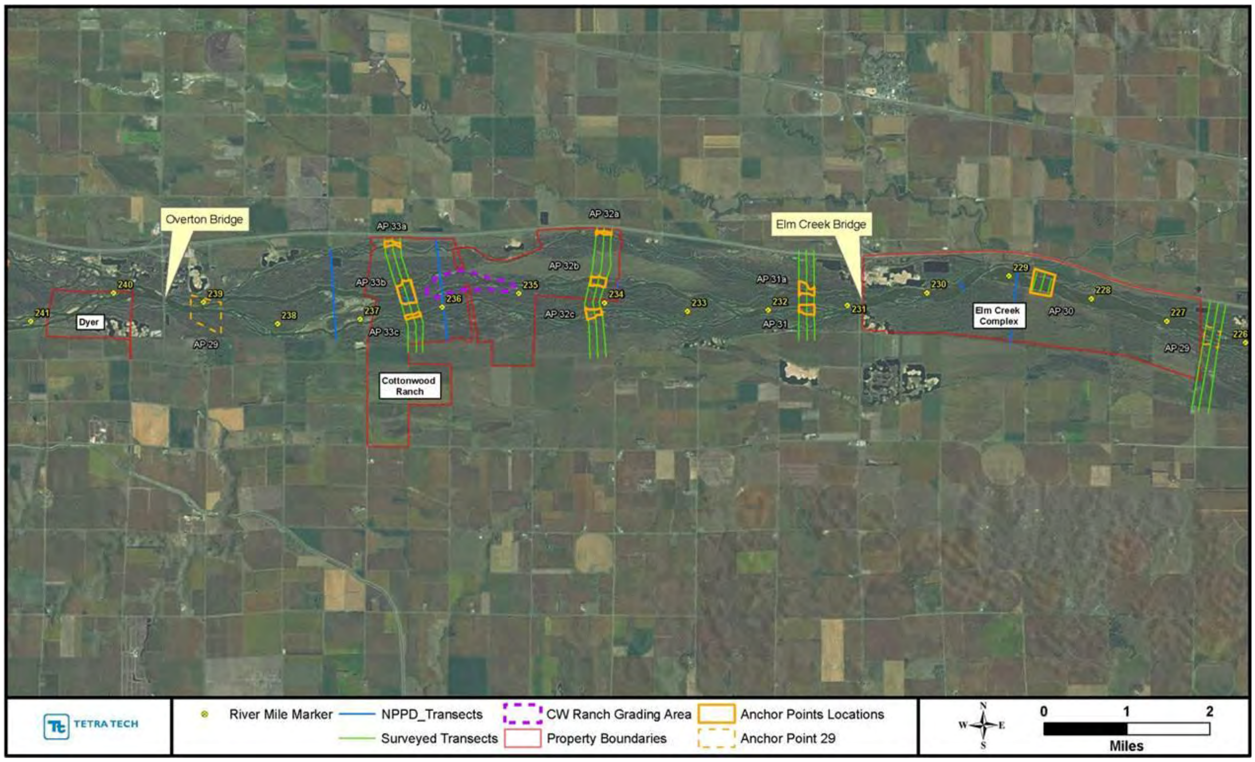


Figure 3. Monitoring Locations

Topographic and bathymetric data specifically collected for the Pilot Study will supplement data currently being collected by the Program. The supplemental data can be divided into two general types:

1. Near-outfall surveys to understand the rate of entrainment and downstream movement of augmented material, particularly near the pump site
2. Downstream river surveys to monitor the overall response of the river to the augmented sediment

All cross section surveys performed specifically for the Pilot Study will include sufficient points to define the bed and bank topography ensuring that the top-of-bank is clearly defined. The surveys will also include the location of the green line, as defined in Program (2010 and 2011).

In addition to the monitoring locations identified in Figure 3, monitoring will be conducted in specific localized areas identified where potential excessive aggradation from sediment augmentation activities could have adverse effects. Specific locations have been identified through correspondence with local property owners and the Natural Resources Districts.

Additional data from the System-wide and Kearney Diversion Water Quality (WQ) Monitoring Programs (Program, 2010 and 2011) will be used to the extent possible to monitor downstream bed and suspended sediment loads. These data include individual bed and suspended sediment loads at Overton and Kearney from the System-wide monitoring program. Continuous sampling will also be conducted at the Overton Bridge for turbidity, conductivity, and temperature data, as well as daily point suspended sediment samples. The data will be collected during the pumping period and for at least two weeks after cessation of pumping.

Decision Criteria

Impact triggers were based on a series of performance indicators related to water surface elevation, bed elevation, and sediment gradations in the river. Decision criteria were developed based on the specific triggers identified for the applicable performance trigger. The decision criteria will assist the Program in using gage data, pressure transducers, and monitoring data to determining whether the Management Action has adverse effects on adjacent property owners and to assess whether the physical response of the Platte River is significantly different than the response expected based on the sediment transport model and historical data. These decision criteria will help guide the Program during implementation of the Management Action and inform decision makers whether to proceed with the action, stop the action, or modify the action or whether additional information may be needed prior to making a decision. Adjustments to the frequency of monitoring data collection may also be warranted based on the decision logic. Table 2 lists the decision criteria and corresponding actions based on those criteria.

Table 2 - Decision Criteria

Decision Criteria	Action
Stage-Discharge Relationship	
Stage-Change Class II at a single monitoring location on one occasion	Increase monitoring frequency of topographic/bathymetric data to bi-weekly.
Stage-Change Class III at a single monitoring location on one occasion	Increase monitoring frequency of topographic/bathymetric data to weekly.
Stage-Change Class II at a single monitoring location on consecutive occasions	Increase monitoring frequency of topographic/bathymetric data to weekly.
Stage-Change Class III at a single monitoring location on consecutive occasions	Reduce rate of sediment introduction by 25-50 percent and increase frequency of data collection to weekly.
Stage-Change Class II and III at multiple monitoring locations on one occasion	Increase monitoring frequency of topographic/bathymetric data to weekly.
Stage-Change Class II at multiple monitoring locations for two consecutive occasions	Reduce rate of sediment introduction by 25 percent, and increase frequency of data collection to weekly.
Stage-Change Class III at multiple monitoring locations for two consecutive occasions	Reduce rate of sediment introduction by 50 percent, and increase frequency of data collection to weekly.
Stage-Change Class II and III at multiple monitoring locations for three consecutive occasions	Stop operations, and evaluate all available data. Determine need for corrective action.
Stage-Change Class I at multiple monitoring locations for three consecutive occasions	If stages are not increasing more than expected, reduce topographic data collection frequency by 50 percent.
Mean Bed Elevation	
Mean Bed Elevation Change Class I	Continue current monitoring frequency.
Mean Bed Elevation Change Class II	Evaluate corresponding Stage-Change Classification. If Stage-Change Classification II or III, incorporate Action of Stage-Change Class. If Stage-Change Class I, continue current monitoring frequency.

Decision Criteria	Action
Mean Bed Elevation Change Class III	Evaluate corresponding Stage-Change Classification. If Stage-Change Classification II or III, incorporate Action of Stage-Change Class. If Stage-Change Class I, increase monitoring to bi-weekly.

The discharge and mobilization of material will be monitored. Monitoring results will be reviewed, and if practical, Year 2 Pilot Study activities will commence in the fall of 2012. A flowchart or decision tree (Figure 4) describes the various actions based on the identified performance benchmarks.

Permitting Status

For compliance with Section 404 of the Clean Water Act, the U.S. Army Corps of Engineers (Corps) determined that an Individual Permit would be needed. A Section 404 permit application was submitted to the Corps on May 13, 2011. The Corps issued a public notice for the application on July 6, 2011. Comments on the public notice prompted the Program to coordinate with the Corps and selected parties who made comments to discuss concerns. The Nebraska Department of Environmental Quality (NDEQ), as the state agency responsible for Section 401 Water Quality Certification, indicated that it was concerned with the mining component of the project. After discussion with NDEQ, it was determined that a variance from Chapters 3 and 4 of Nebraska Title 117, Surface Water Quality Standards, would be needed. NDEQ issued the 401 Water Quality Certification with the condition that the variance be applied for. The Program is currently working on the variance application for submittal to NDEQ. The Corps has all the information it needs to develop its permit decision document, and a draft permit decision document has been reviewed by the Corp's Nebraska State Program Manager.

References

The Flatwater Group, HDR and Tetra Tech, Inc. November 2010. Platte River from the Lexington to Odessa Bridges: Sediment Augmentation Experiment Alternatives Screening Study Summary Report.

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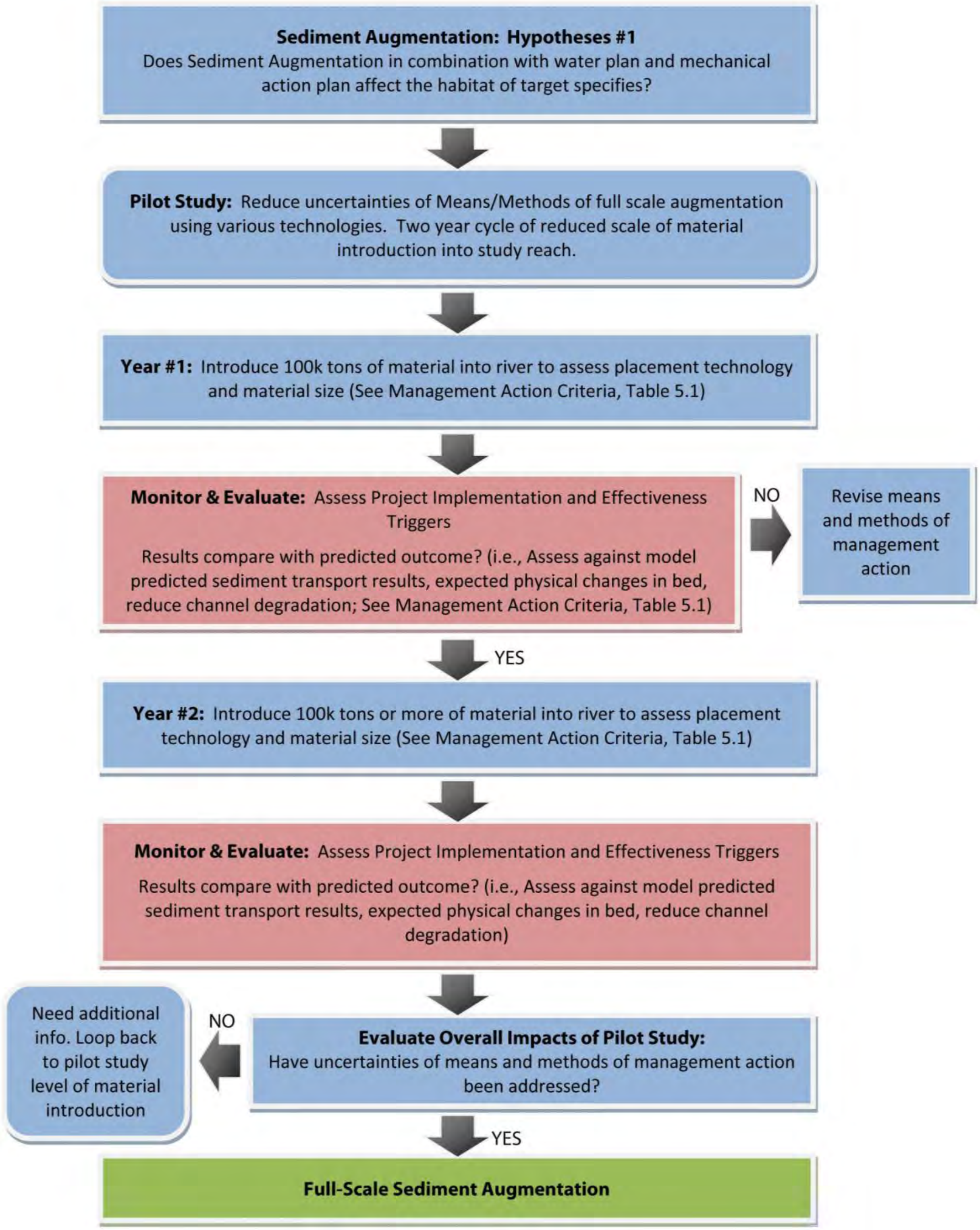
Platte River Recovery Implementation Program, 2010. Monitoring the Channel Geomorphology and In-Channel Vegetation of the Central Platte River, Final Protocol, April 23, 24 p.

Figure 4. Decision Tree for Performance Benchmarks



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PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
Cottonwood Ranch Flow Consolidation

Approaches to Flow Consolidationat Cottonwood Ranch

Figure 1: Main channel of the Platte

Relevant Tier 1 Hypotheses from the Adaptive Management Plan

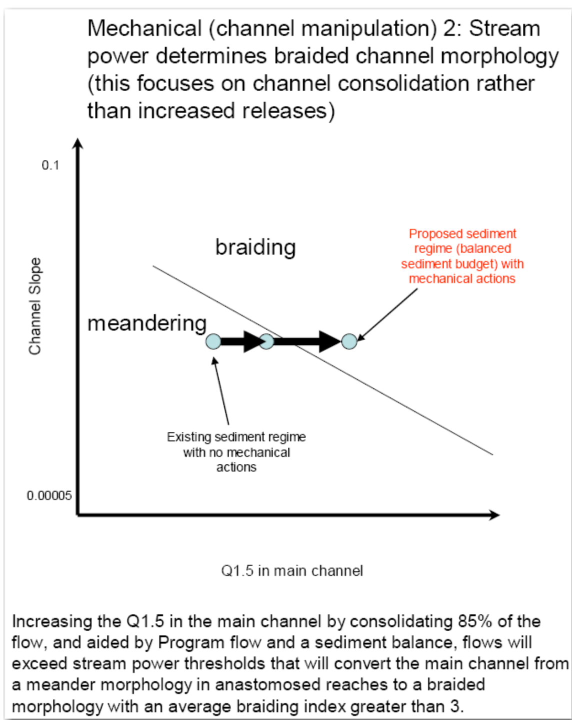


Figure 2: The South channel on the Cottonwood Ranch property

Background

- The Cottonwood Ranch (CTWR) habitat complex is located in the Overton to Elm Creek bridge segment, encompasses approximately four miles of river channel and includes lands owned by the Nebraska Public Power District and Platte River Recovery Implementation Program. The Platte River includes three distinct channels through the complex, the North, Main, and South channel.
- Currently flow is split among the 3 channels, with the North conveying 10%, the Main 66%, and the South 24% of the modeled 8,000 ft^3/s flow. Flow consolidation on the Platte River at the Cottonwood Ranch property endeavors to achieve a minimum of 85% of the volume at the 8,000 ft^3/s flow event in the Main channel, or 6,800 ft^3/s, utilizing only water from the South channel.

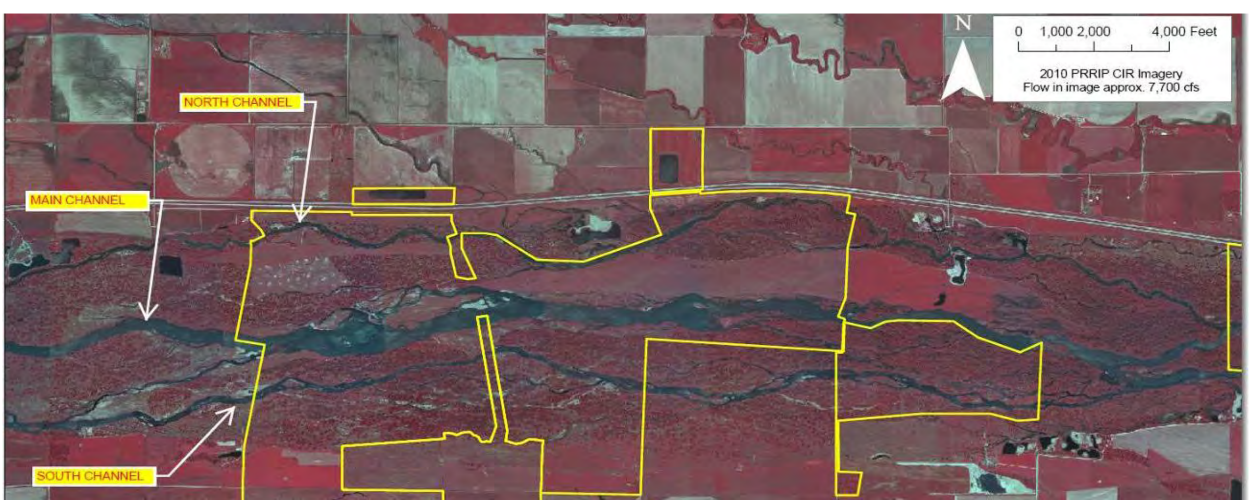


Figure 3: North, Main and South channels at Cottonwood Ranch

Analysis

- *Hydraulic Model:* A HEC RAS model developed for the program in 2009 was the primary tool to evaluate flow consolidation.
    - The HEC GEO RAS output of this model at the 8000 ft^3/s discharge was compared to aerial photos taken in 2010 at a similar flow event. Water inundation patterns did not differ significantly in planview between the two data sets
    - Differences were noted in the predicted water surface elevation when compared to the 3 USGS gages on site
- *Modeling Scenarios:*

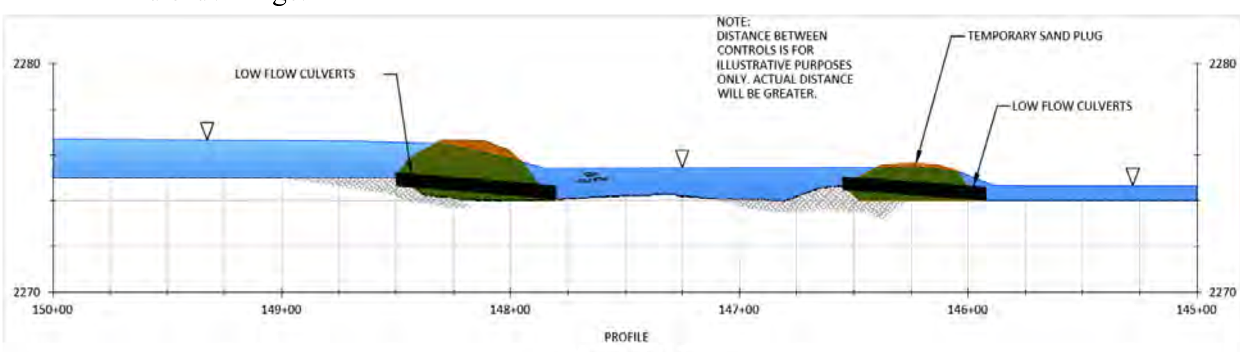
SCENARIO	DESCRIPTION
1- Upstream Overflow Channel	*Summary* - included simply modeling a constructed overflow channel, dug between the South and Main channels near the upstream end of CTWR *Results* – the head differential was not great enough to push water through the overflow channel into the Main channel. Flow reported in the model was 150 ft^3/s well below the minimum flow of 1200 ft^3/s
2- Upstream Overflow Channel + Roughness	*Summary* – building on scenario 1, the roughness co-efficient was increased throughout the length of the South channel to simulate the addition of logs or large sand bedforms in an attempt to increase head and drive more water to the Main channel *Results* – the head differential was increased and the model reflected additional flow, 880 ft3/s, in the overflow channel, though still below the minimum flow of 1200 ft3/s
3- Upstream Overflow Channel + Hydraulic Control	*Summary* – building on scenario 2, the additional roughness elements were removed and instead an “inline structure” meant to simulate a hydraulic control was placed just downstream of the overflow channel in the South channel. *Results* – the more substantial structure created the head necessary to increase flow into the overflow channel. The model predicted 1340 ft3/s, which exceeded the minimum flow criteria of 1200 ft3/s.
4- Upstream Overflow Channel + Multiple Hydraulic Controls	*Summary* – though scenario 3 met the criteria for flow consolidation, the lowered water surface elevation downstream of the obstruction in the South channel caused concern for significant inflow back into the South channel. As a result, four hydraulic controls were added in the model (manifest as either a log jam or a sand plug) to maintain head and create a series of ponds. *Results* – the multiple hydraulic control structures maintained periodic pools interspersed with flow at lower volumes and lower

	elevations. The model indicated flow criteria for consolidation were still met.
5- Downstream Overflow Channel + Hydraulic Control	*Summary* – Moving the overflow channel further downstream along the South channel may provide several advantages. The overflow channel was moved downstream in the model and a single "inline structure" placed below to move water from the South into the Main channel. *Results* – The model predicted identical results to Scenario 3, indicating little difference in the predicted impact of locating the overflow channel in its original upstream location or in more downstream locale. Modeled flow in the overflow channel was 1300 ft3/s, which met the minimum flow criteria of 1200 ft3/s. Of note however, this scenario does increase flood elevations on the hay field along the left bank of the Main channel. The validity of this result should be considered with respect to the resolution with which the model can predict such elevations accurately.

Types of Hydraulic Controls

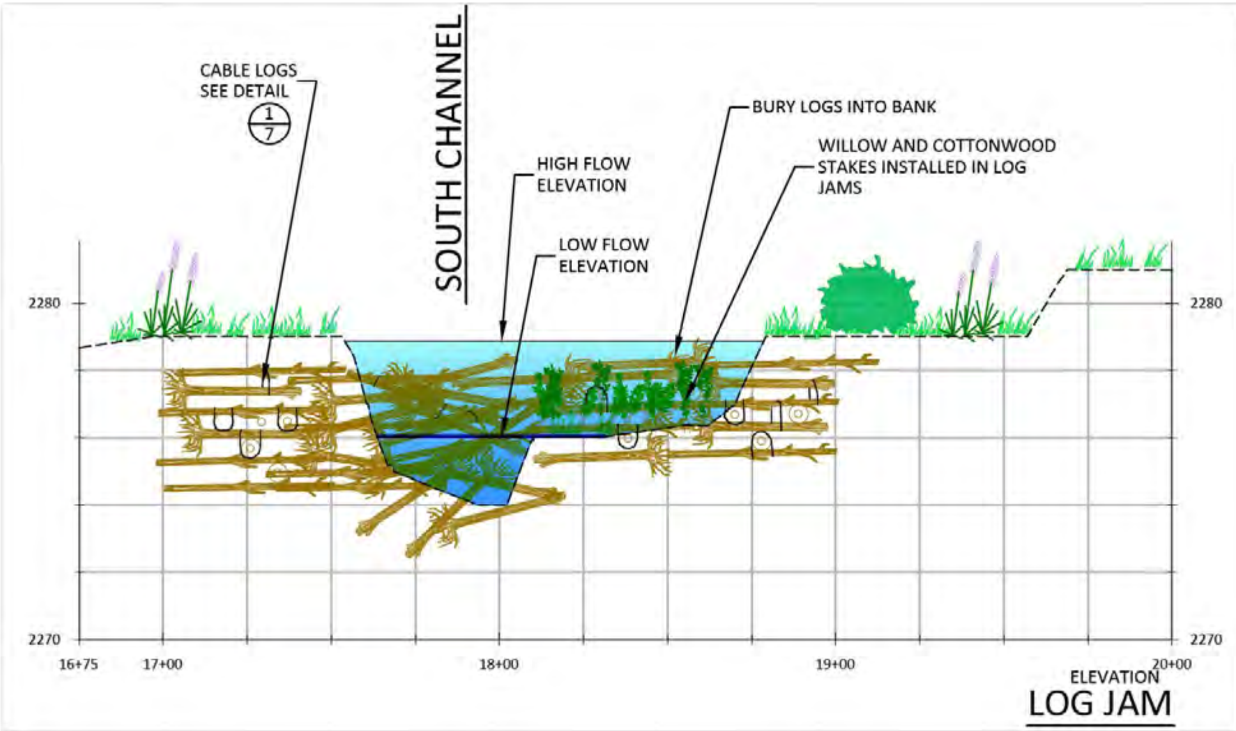
- Two types of hydraulic controls may be effective on the site; large channel spanning log jams and channel spanning sand plugs. These controls will vary in scale (major and minor controls) with the volume of water they are intended to intercept.

    - Sand plugs have the advantage of lower cost to construct as well as a track record of acceptable practice and application within the Platte. They fail when overtopped, a disadvantage.



SAND PLUG
(Temporary Control)

    - Log jams have the advantage of longevity in the Platte, particularly if Cottonwood logs or other cuttings can regenerate to create a living jam. They are more expensive to construct and are not considered common practice for water control on the Platte.



Construction Costs

- Construction costs were assumed based on simple unit costs noted in the table below. The range for constructing sand plug controls among scenarios 3-5 was $12,600-$25,200. For log controls $42,000-$142,000. These are concept level estimates.

	Sand Control	**Log Jam Control**
Construct 1 Major Control	0.5 days	5 days
Excavate Overflow Channel	2 days	2 days
Construct 1 Minor Control	0.25 days	1.5 days
Equipment and Operators	$3000 / day	
Engineer Oversight	$1200 / day	
TOTAL LABOR	**$4200 / day**	
Assumptions: • Each Major Log Jam is comprised of 50 trees • Each Minor Log Jam is comprised of 30 trees • Trees can be harvested on site at a rate of 10 /day • Engineer oversight assumes a 10 hour day • Material costs are negligible (cable, vegetation stock and seed)		

Summary

- The analysis indicates that Flow Consolidation using hydraulic controls on the South channel of the Cottonwood Ranch complex can be achieved
- Based on USGS gage data on the site, it appears consolidation goals may be closer to being met than predicted in the HEC RAS model
- The effect of Sediment Augmentation and SDHF was not considered in this analysis but may play a key role in the consolidation of flow on the property

2012 Effort

- A more detailed analysis of Flow Consolidation at the property will commence with a "Proof of Concept" investigation
- Options for consolidation will be more thoroughly vetted and the preferred approach will be designed to an approximate 30% level, with associated construction drawings
- The 30% design will be used to describe the project to a variety of stakeholders before the decision to develop final construction documents is made.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2011 Water Quality Monitoring Results

Monitoring Protocol:	PRRIP Water Monitoring Protocol
Monitoring Entity:	EA Engineering, Science, and Technology, Inc.
Dates of Field Activity:	March 2011 through November 2011
Numbers of Years of Implementation:	Three (2009-2011)
Analysis Entity:	EA Engineering, Science, and Technology, Inc.

Relevant Big Question(s)

Have Program water-related activities avoided adverse impacts to pallid sturgeon in the lower Platte River?

Relevant Tier 1 Hypotheses from AMP

There are no relevant Tier 1 Hypotheses from the AMP for water quality.

Performance Measures and Benchmarks

Table 1. Literature Referenced Water Quality Ranges

Water Quality Measure	Range	Source
Dissolved Oxygen, mg/L	5.0[a]	U.S. Environmental Protection Agency 1986
	4.87 to 18.41	Peters and Parham 2008
Temperature, °C	**Acipenseridae** Optimal Range for Growth 15.0 to 25.0 Minimum for Growth 10.0	Blevins 2011
	Juvenile Pallid Sturgeon 28.0 Optimal Growth 30.0 to 33.0 Stressful >33.0 Lethal	Chipps, et al, 2010
Turbidity, NTU	12 to 6,400[b]	Blevins 2011, Tews 1994
Specific Conductance, mS/cm	[c]	Blevins 2011, Pillsbury 1981

[a] U.S. Environmental Protection Agency (USEPA) standard for warm-water fish.
[b] An optimal range of turbidity has not been determined. Studies conducted on the Missouri and Yellowstone Rivers show that turbidity within suitable habitat for pallid sturgeon was within this range.
[c] Studies show pallid sturgeon appear to tolerate specific conductance greater than occurs in the Missouri River, which has similar turbidity as the Platte River.

2011 Summary of Activities

- The central and lower Platte River water quality was monitored from March 22, 2011 through November 23, 2011. This concludes a three year baseline water quality monitoring program (2009-2001).
- Monitoring locations included: Lexington, Overton, Odessa, Kearney, Shelton, Grand Island, Duncan, and Louisville.
- Continuous water quality monitoring included installation of water quality sondes capable of collecting temperature, specific conductance, pH, turbidity, dissolved oxygen. A data point for each parameter was taken every 30 minutes.
- Discharge data was collected from existing gaging stations on the Platte River operated continuously by the USGS and NDNR. A data point was collected every 15 minutes at USGS gaging stations: Louisville, Duncan, Grand Island, Kearney, and Overton. The NDNR gaging stations at Shelton, Odessa, and Lexington collected a data point every 30 minutes.
- Discrete water quality monitoring included metals and bacteria. Samples for metals were collected in April, June, August, and October and analyzed for dissolved copper, dissolved lead, dissolved nickel, and total selenium. Bacteria samples were collected during the peak period of waterfowl migration (March) and the non-peak period of migration (July, August, and September) at Grand Island, Kearney, and Lexington.

2011 Summary of Results and Trends

- Results are illustrated in Figures 1 through 8, and summarized in Table 2.
- The water quality of the Platte River at the Louisville monitoring location differs from other monitoring locations specifically for turbidity and conductivity. This is likely due to the Loup and Elkhorn rivers contributing to the Platte River flow.
- A trend in temporal variation was limited to temperature, dissolved oxygen, and discharge. Temperature increased during the summer months while dissolved oxygen decreased. A temporal trend in discharge was associated with rain events in the spring and early summer.
- Discharge had little impact on temperature, specific conductance, and dissolved oxygen, but generally had an inverse relationship on pH. As discharge spiked due to storm events, pH dropped. A direct relationship between turbidity and discharge was evident at all monitoring locations. However, turbidity response time and peak duration to a discharge peak varied between the monitoring locations.
- Discharge, pH, and turbidity were the only parameters with substantial spatial variation. Discharge at the monitoring locations in the central Platte was very similar with a much higher discharge at Louisville in the lower Platte. Turbidity and pH were also higher at Louisville compared to monitoring locations in the central Platte.
- Results of the metals analysis were all below the laboratory reporting limit.
- Bacteria generally showed an increasing trend from Lexington to Grand Island for coliform and *E. coli* bacteria. Colonies of coliform bacteria were lower during the peak flow period at all locations. Colonies of *E. coli* bacteria were generally lower during the peak flow period at Lexington and were higher at Kearney and Grand Island during the peak flow period.

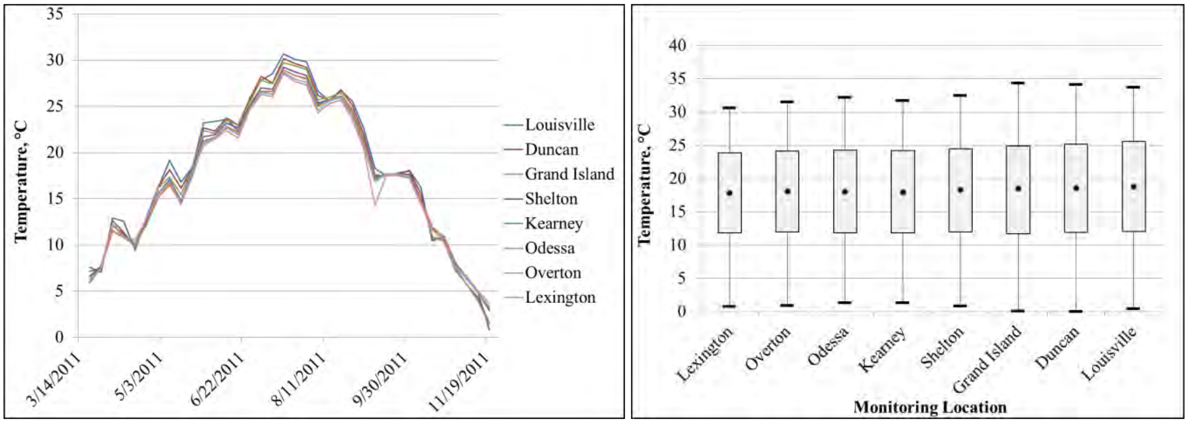


Figure 1. Temperature graph and box plot, Platte River, NE, 2011.

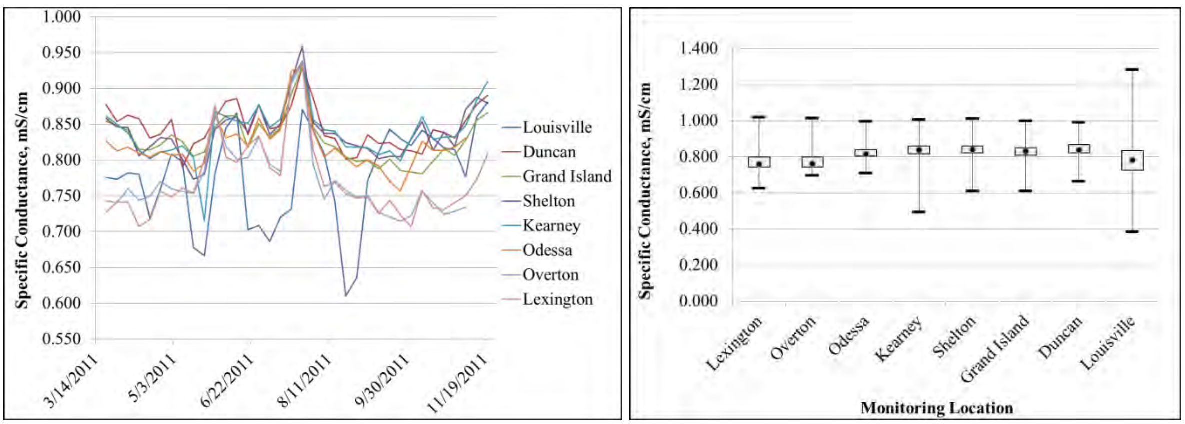


Figure 2. Specific conductance graph and box plot, Platte River, NE, 2011.

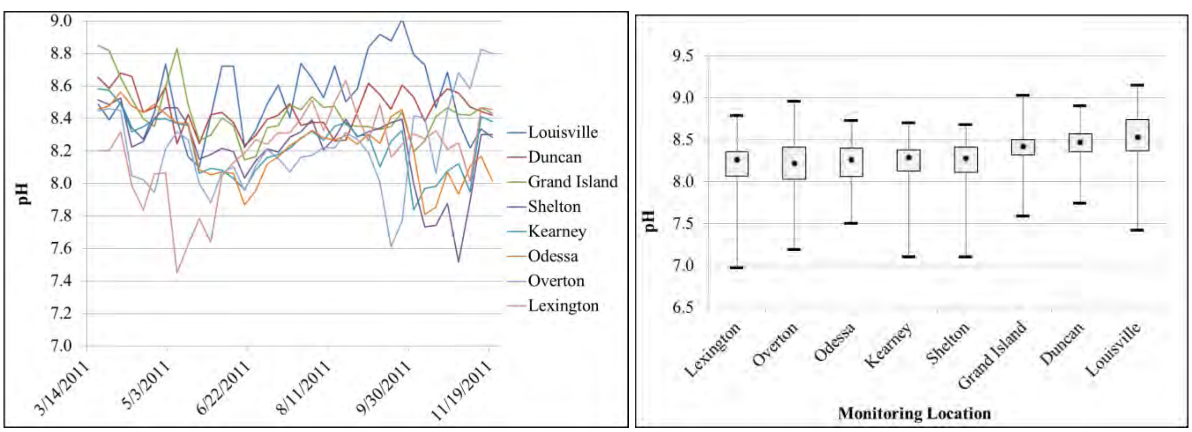


Figure 3. pH graph and box plot, Platte River, NE, 2011.

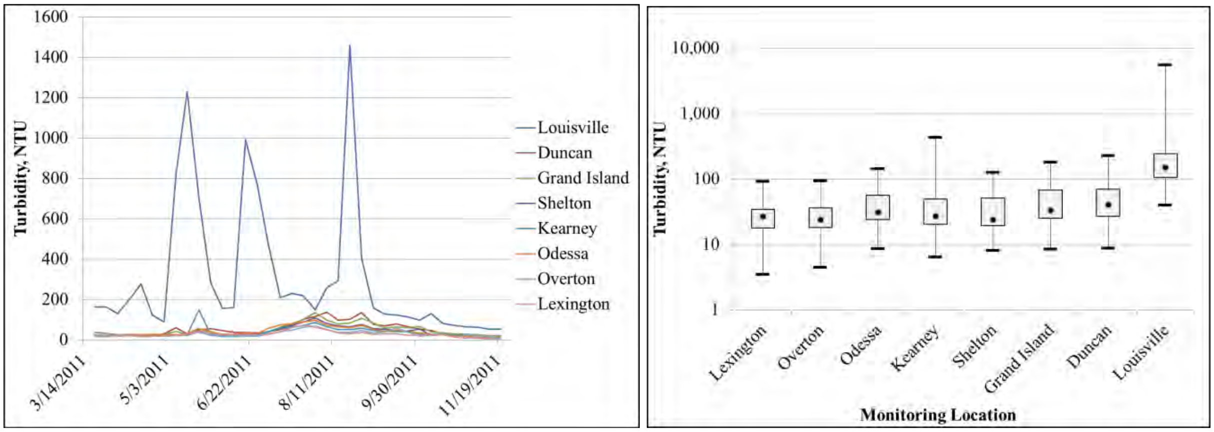


Figure 4. Turbidity graph and box plot, Platte River, NE, 2011.

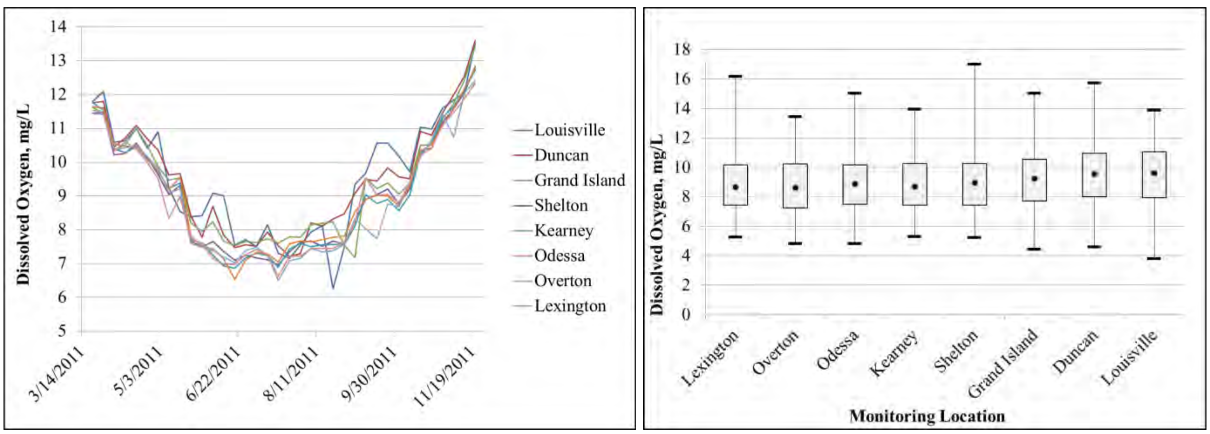


Figure 5. Dissolved oxygen graph and box plot, Platte River, NE, 2012.

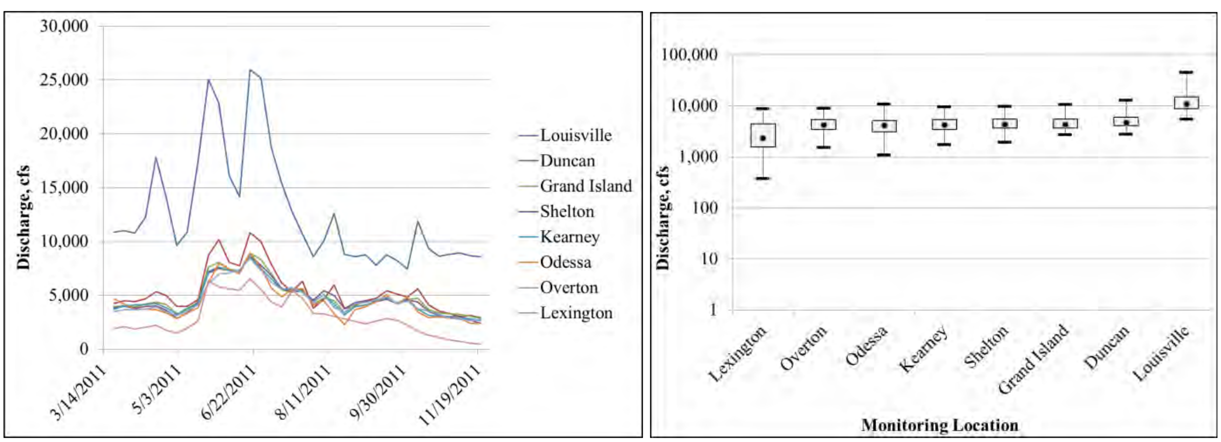


Figure 6. Discharge graph and box plot, Platte River, NE, 2011.

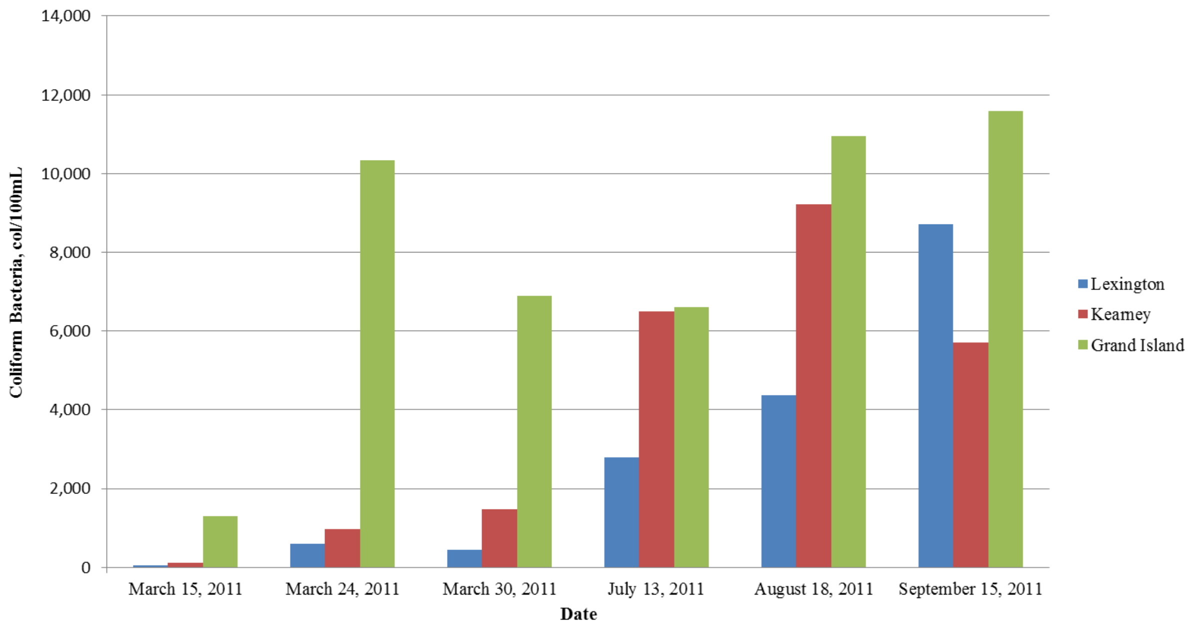


Figure 7. Coliform Bacteria, Platte River, NE, 2011.

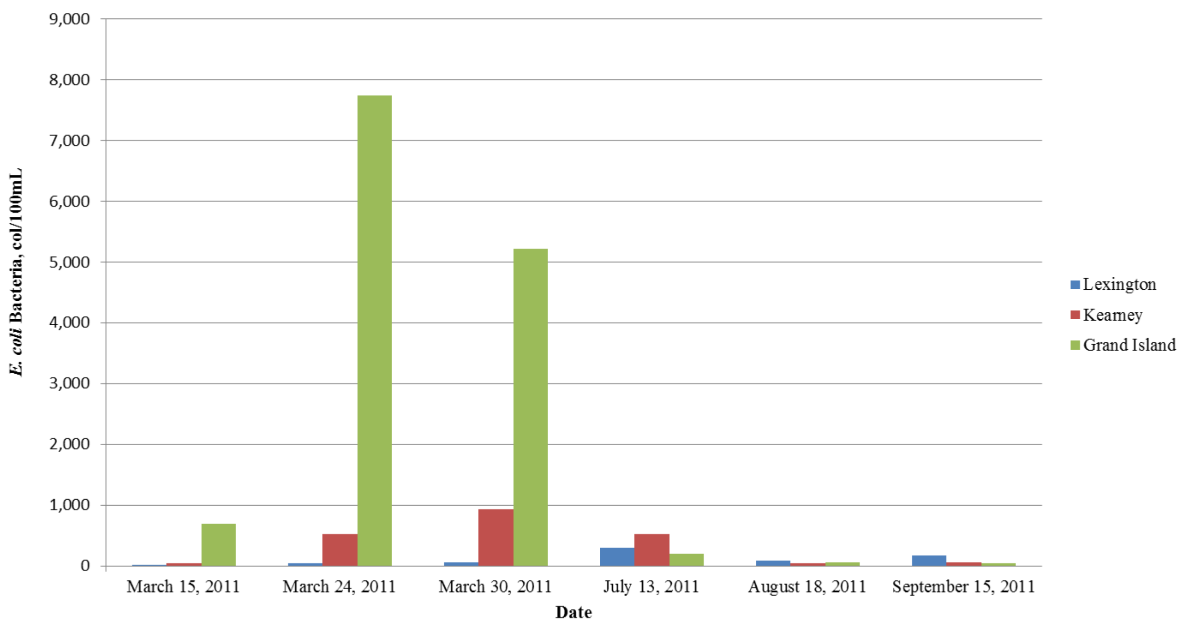


Figure 8. *E. coli* Bacteria, Platte River, NE, 2011.

Table 2. Minimum and Maximum Water Quality Values, on the Central and Lower Platte River (2011).

Water Quality Parameter	Central Platte		Lower Platte	
	Minimum	Maximum	Minimum	Maximum
Dissolved Oxygen, mg/L	4.4	17.0	3.8	13.9
Temperature, °C	0.0	34.3	0.4	33.7
Turbidity, NTU	4	434	40	5,579
Specific Conductance, mS/cm	0.495	1.028	0.385	1.283
pH	7.0	9.0	7.4	9.2

Tier 1 Hypotheses and Big Questions

There are no Tier 1 Hypotheses identified for water quality. The Program has focused on water quality and determining potential adverse impacts to pallid sturgeon (*Scaphirhynchus albus*). Several reports review water quality preferences and tolerances for pallid sturgeon. The *Pallid Sturgeon Literature Review* (Peters and Parham, 2008) completed for the Program identified dissolved oxygen concentrations of 4.87 to 18.41 mg/L for telemetry tracked pallid sturgeon caught in the lower Platte River. Another literature review found that species of sturgeon that do not occur in the Platte River are susceptible to dissolved oxygen concentrations less than 3 mg/L (Blevins, 2011). The dissolved oxygen data collected for 2011 in the central and lower Platte River ranged from 3.8 to 17.0 mg/L (Table 2) and were generally within the ranges found in the literature for pallid sturgeon and above the minimum standard for warm-water fish of 5.0 mg/L set by the United Sates Environmental Protection Agency (USEPA) (USEPA, 1986).

The *Pallid Sturgeon Literature Review* (Peters and Parham, 2008) identified temperatures from 3.5 to 33.7°C for telemetry tracked pallid sturgeon caught in the lower Platte River. Blevins (2011) listed an optimal growth range for Acipenseridae of 15.0 to 25.0°C and a minimum of 10.0°C for growth. The temperature data collected for 2011 ranged from 0.4 to 33.7°C at Louisville. Chipps et al (2010) conducted a laboratory study on 18 juvenile pallid sturgeon from the upper Missouri River that revealed optimal temperature for feeding and growth up to 28°C, at temperatures between 30 to 33°C fish exhibited signs of stress, and at temperatures greater than 33°C, juvenile pallid sturgeon started to die.

Discharge data was collected; however, the literature review only states "high discharge events produce flow velocities that scour deeper channels and deposit sandbars which create and maintain the habitats favored by pallid sturgeon".

Turbidity measured in Nephelometric Turbidity Units (NTU) at Louisville ranged from 40 to >3,000 NTUs. The literature review did not present favorable turbidity data for the various pallid sturgeon telemetry studies performed. However, the review states that in general, pallid sturgeon are considered to be a large, turbid river species. Studies in Montana found turbidity in suitable habitat in the Missouri River from Fort Peck Dam to Lake Sakakawea and in the Yellowstone River within a range of 12 to 6,400 NTU (Tews, 1994).

Research on favorable ranges of specific conductance and pallid sturgeon is limited. The specific conductance of the Platte River is similar to that of the Missouri River (Pillsbury, 1981) and pallid sturgeon appear to tolerate much greater salinities than indicated by the levels recorded during 2011 (Blevins, 2011).

Other water quality parameter monitored included pH which is not mentioned in the pallid sturgeon literature review.

The Program did not conduct activities during the 2011 monitoring season. Therefore, Program water-related activities avoided adverse impacts to pallid sturgeon in the lower Platte River.

Conclusions

- General takeaway messages from 2011 monitoring results
    - Implementation of the Protocol successfully resulted in the collection of data that characterized the water quality of the central and lower Platte River that can be used to assess the influence of future Program activities on Platte River water quality. The data collected identified spatial and temporal variations in the water quality of the Platte River:
        - Turbidity and discharge at the downstream location (Louisville) was significantly different than the other seven monitoring locations.
        - Seasonal variations in turbidity and discharge at Louisville were higher than the other seven monitoring locations.
        - Weekly mean dissolved oxygen concentrations were highest during cold water periods and lowest during the summer months. That seasonal trend is consistent with the inverse relationship between dissolved oxygen in that solubility of dissolved oxygen in water decreases as temperatures increase. This temporal trend was evident at all monitoring locations.
        - Water temperature exhibited the same seasonal temporal trend at the eight monitoring locations trending upward from study initiation in March, peaking during the summer months, and then declining with the onset of fall.
    - The dissolved oxygen, temperature, and turbidity data collected during 2011 from the lower Platte River were generally within the water quality ranges found in the literature for pallid sturgeon.
        - Dissolved oxygen readings in a small number of samples (1.1%) were observed less than the USEPA criteria (5 mg/L) for warm water fish.
        - Temperature readings were within the preferred range for pallid sturgeon; however, temperature readings taken at Louisville were 30°C for 6.0% of instantaneous readings taken during the 2011 monitoring period. Less than 1.0% of instantaneous Platte River water temperature readings taken at Louisville were >33°C during the 2011 monitoring period.
        - Turbidity in the lower Platte River during the monitoring period was within the ranges observed for pallid sturgeon in the Yellowstone River.
    - The dissolved oxygen, and temperature data collected for the 2011 in the central Platte River were generally within ranges suitable for pallid sturgeon and turbidity in the central Platte River was significantly less than literature in waters where pallid sturgeon are known to occur.
        - Dissolved oxygen readings were observed less than the USEPA criteria (5 mg/L) for warm water fish. Dissolved oxygen at the seven central Platte monitoring locations were less than 5 mg/L for less than 1% of instantaneous readings taken during the 2011 monitoring period.
        - Temperature readings were within the preferred range for pallid sturgeon; however, temperature readings taken at the seven central Platte monitoring locations were 30°C for 2.6% of instantaneous readings taken during the 2011

        monitoring period. Less than 1% of central Platte instantaneous water temperature readings had were >33°C.
        - Turbidity in the central Platte River was significantly less than what is preferred by pallid sturgeon as reported in the literature. The maximum observed turbidity at the seven monitored sites representing the central Platte River was 434 NTU compared to a maximum referenced turbidity of 6,400 NTU.
    - Water quality variances include higher temperatures in the summer that lowered the dissolved oxygen concentrations. However, the data were within the ranges that pallid sturgeon are known to occur (Peters and Parham, 2008).

Recommendations for 2012

- Adjustments to monitoring protocol and/or methodology
    - 2011 was the third and final year of the collection of baseline water quality data. The Program should consider Program action-based monitoring in the future to determine whether Program actions affect Platte River water quality. This can be completed by comparing action-based monitoring data to the baseline water quality data. A Protocol Addendum would be required to identify proposed changes in the monitoring frequency or locations to adequately assess water quality effects associated with Program actions. Additionally, annual monitoring plans should be created based on the Protocol Addendum and anticipated Program actions.
- Adjustments to data analysis
    - Additional data analysis should be conducted in 2012 for comparison of Program action-based water quality data to baseline water quality data. Additional data analysis methods should also be provided in the Protocol Addendum.

References

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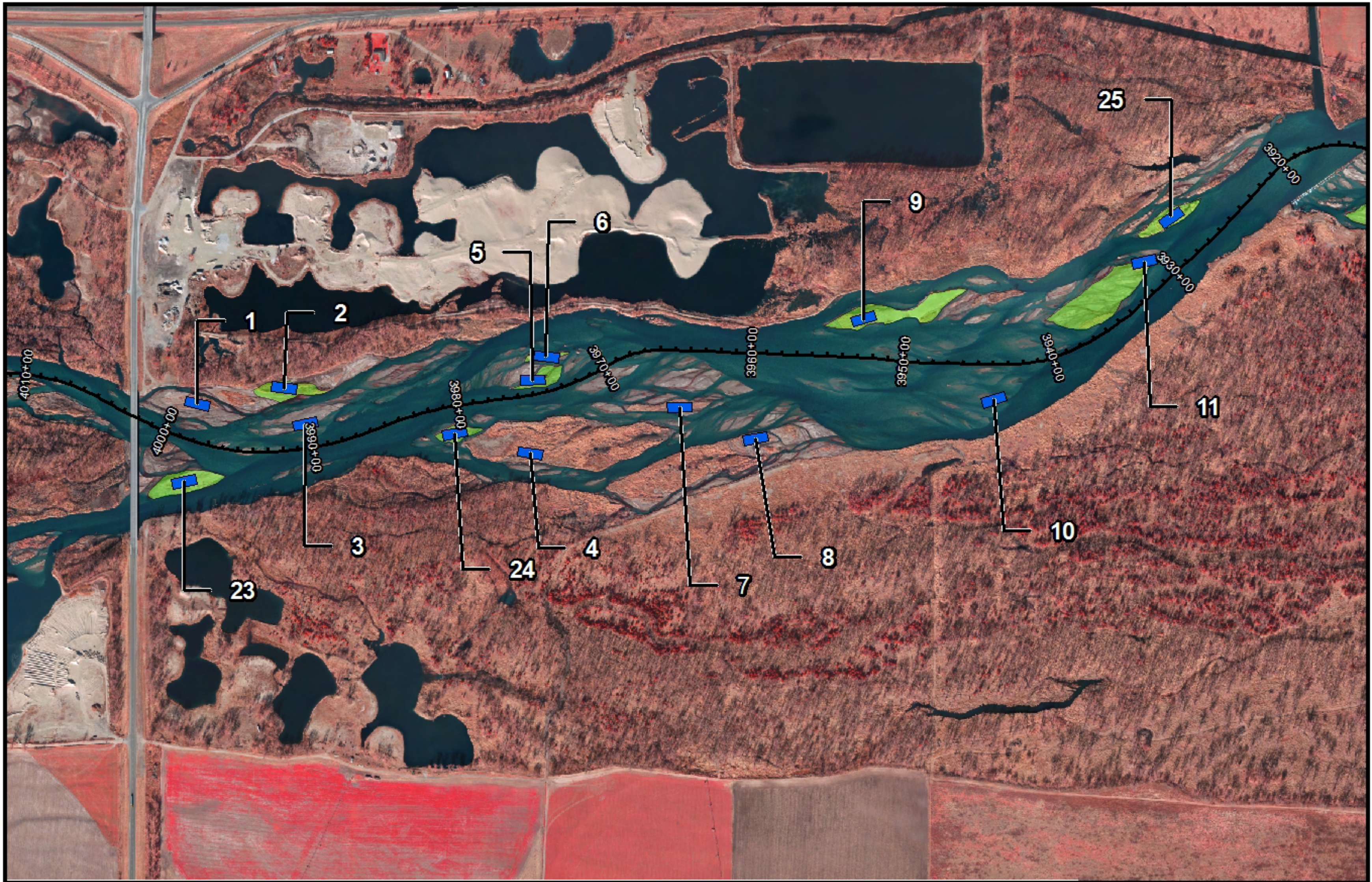
APPENDIX A

ELM CREEK FSM “PROOF OF CONCEPT” 2012 BAR CLEARING PLAN



TETRA TECH

Elm Creek Upstream Bar Clearing Plan

Bars to be Cleared 2012

Veg Plots

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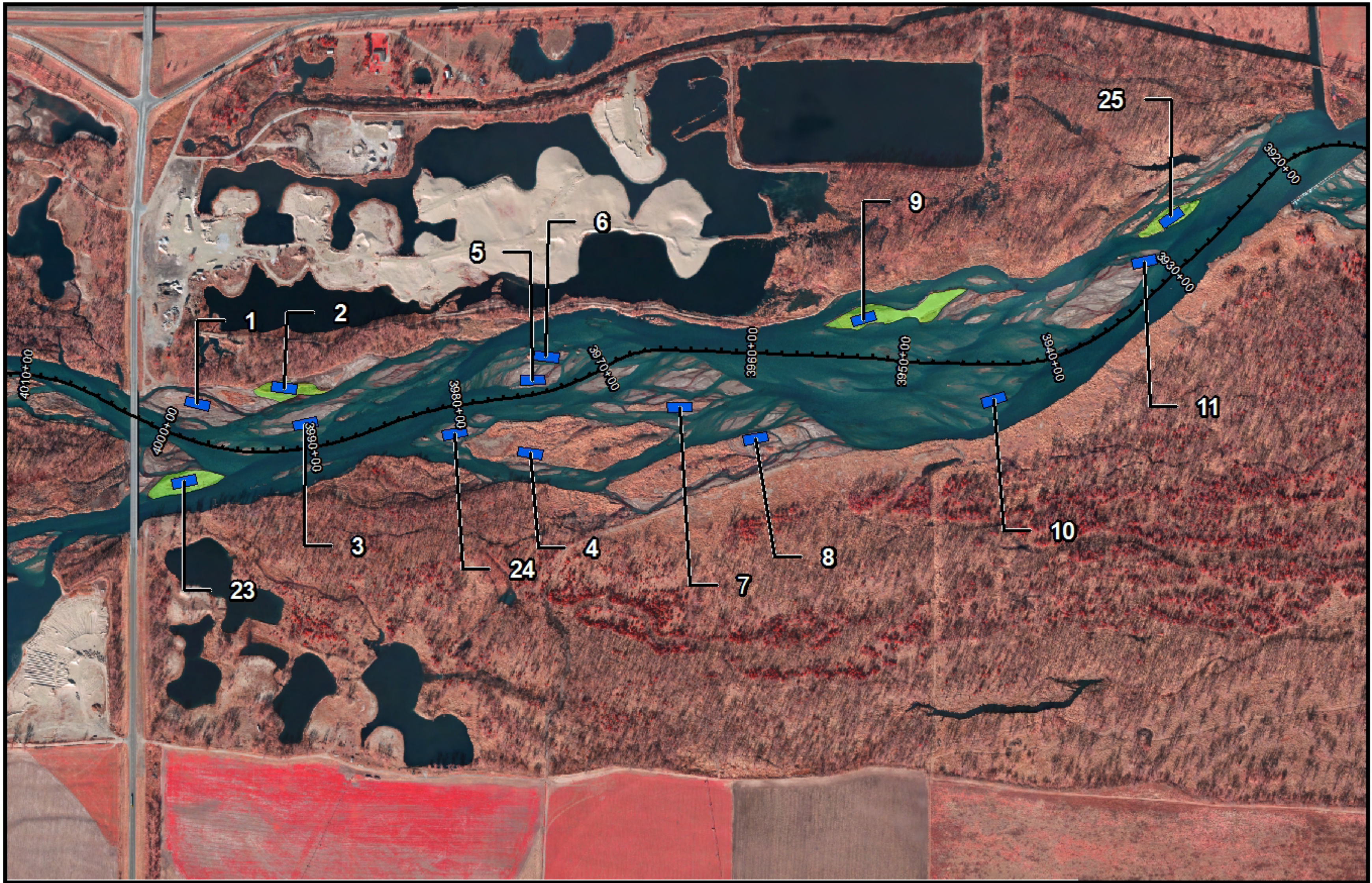
Feet



TETRA TECH

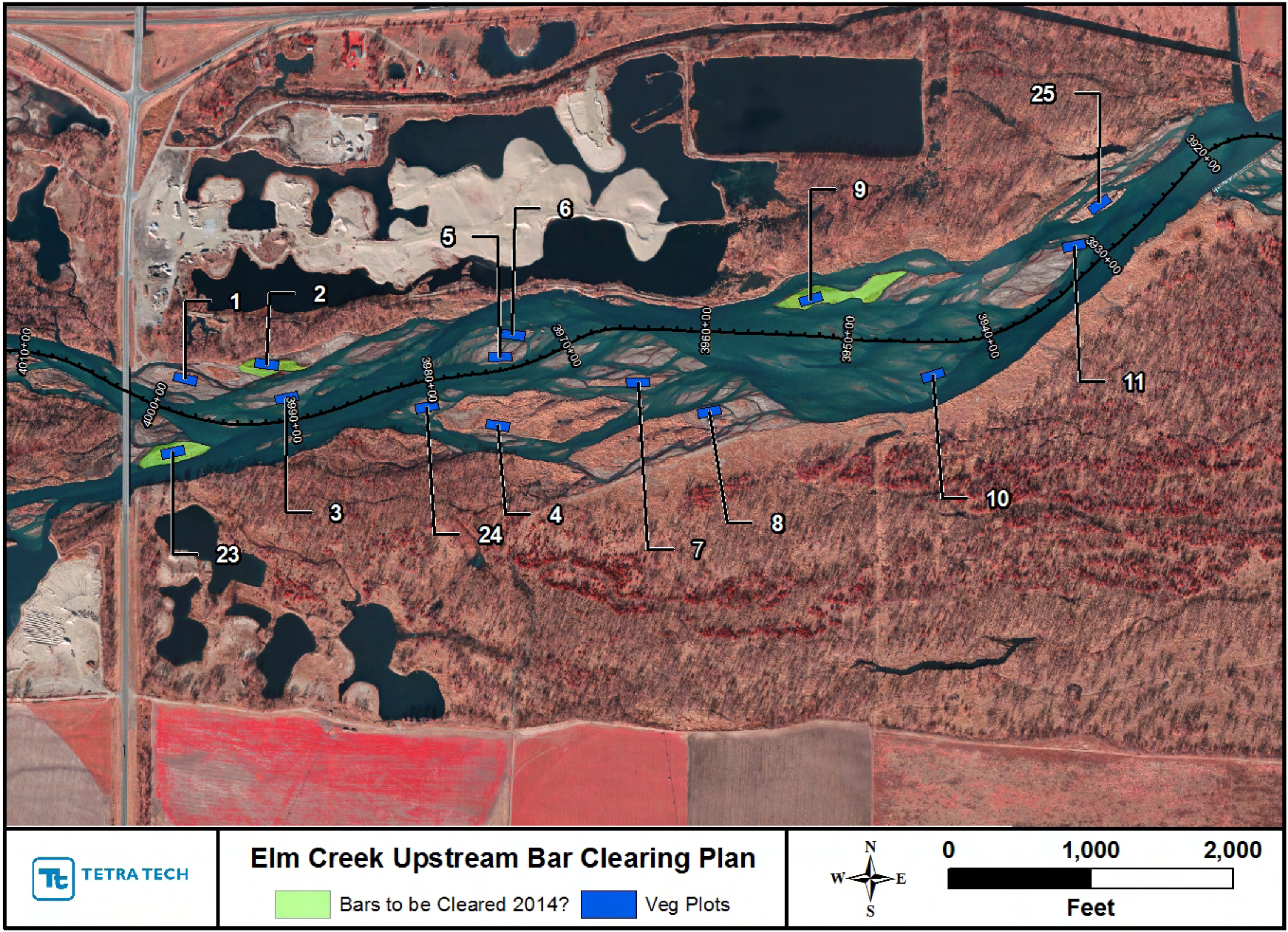
Elm Creek Upstream Bar Clearing Plan

Bars to be Cleared 2013 | Veg Plots

N W E S

0 1,000 2,000

Feet



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TETRA TECH
Elm Creek Upstream Bar Clearing Plan
Bars to be Cleared 2014?
Veg Plots
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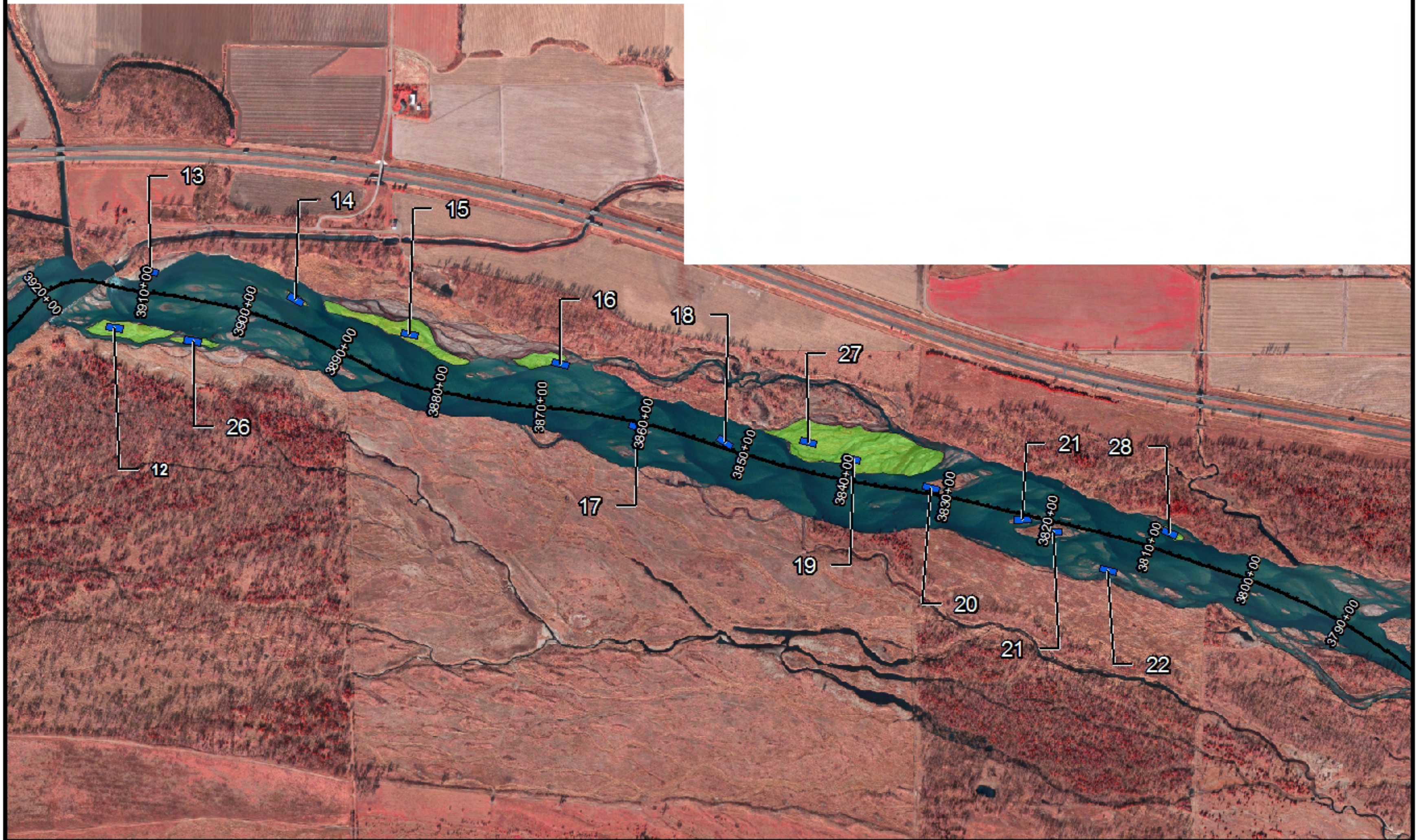

Elm Creek Downstream Bar Clearing Plan

Bars to be Cleared 2012

Veg Plots

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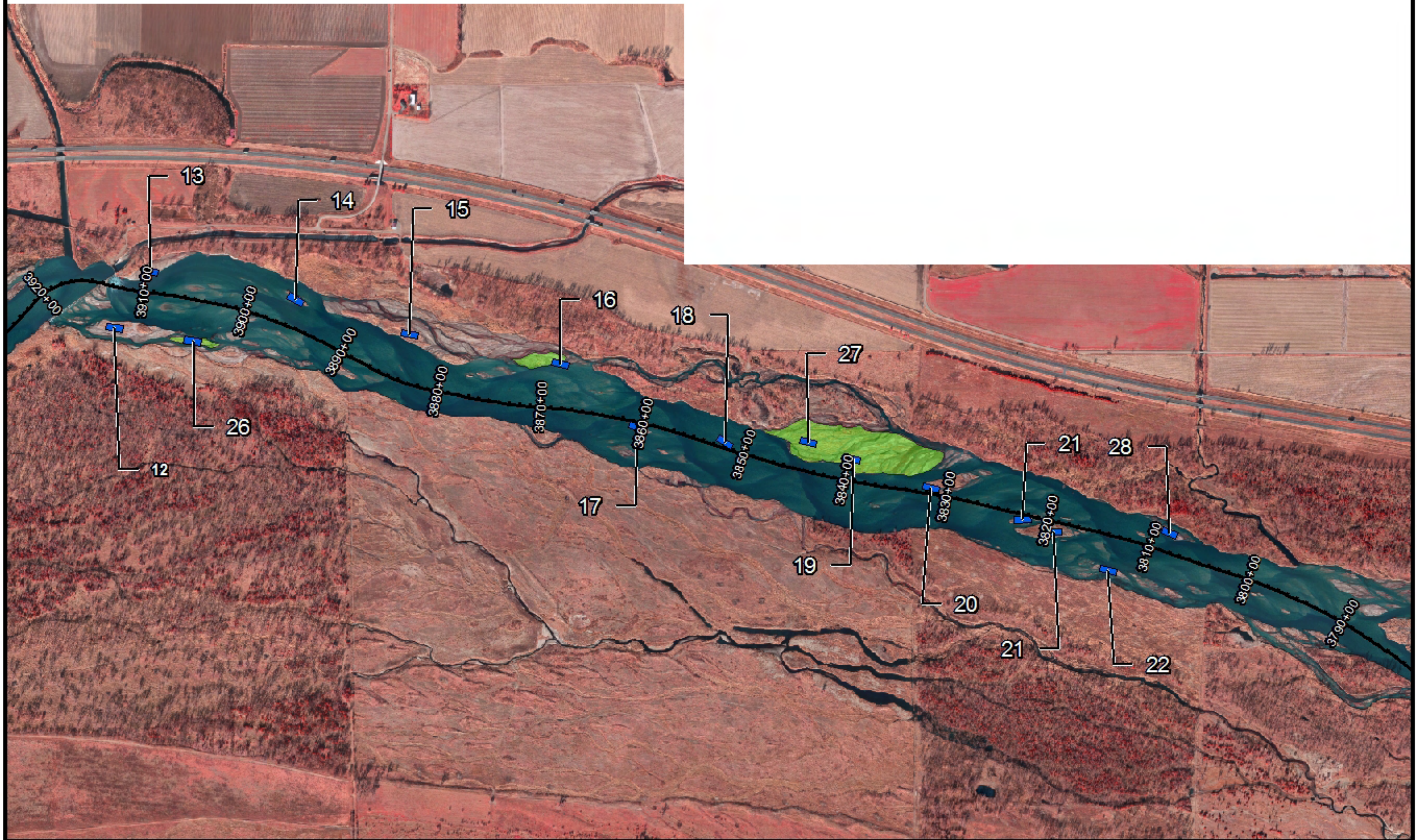


TETRA TECH

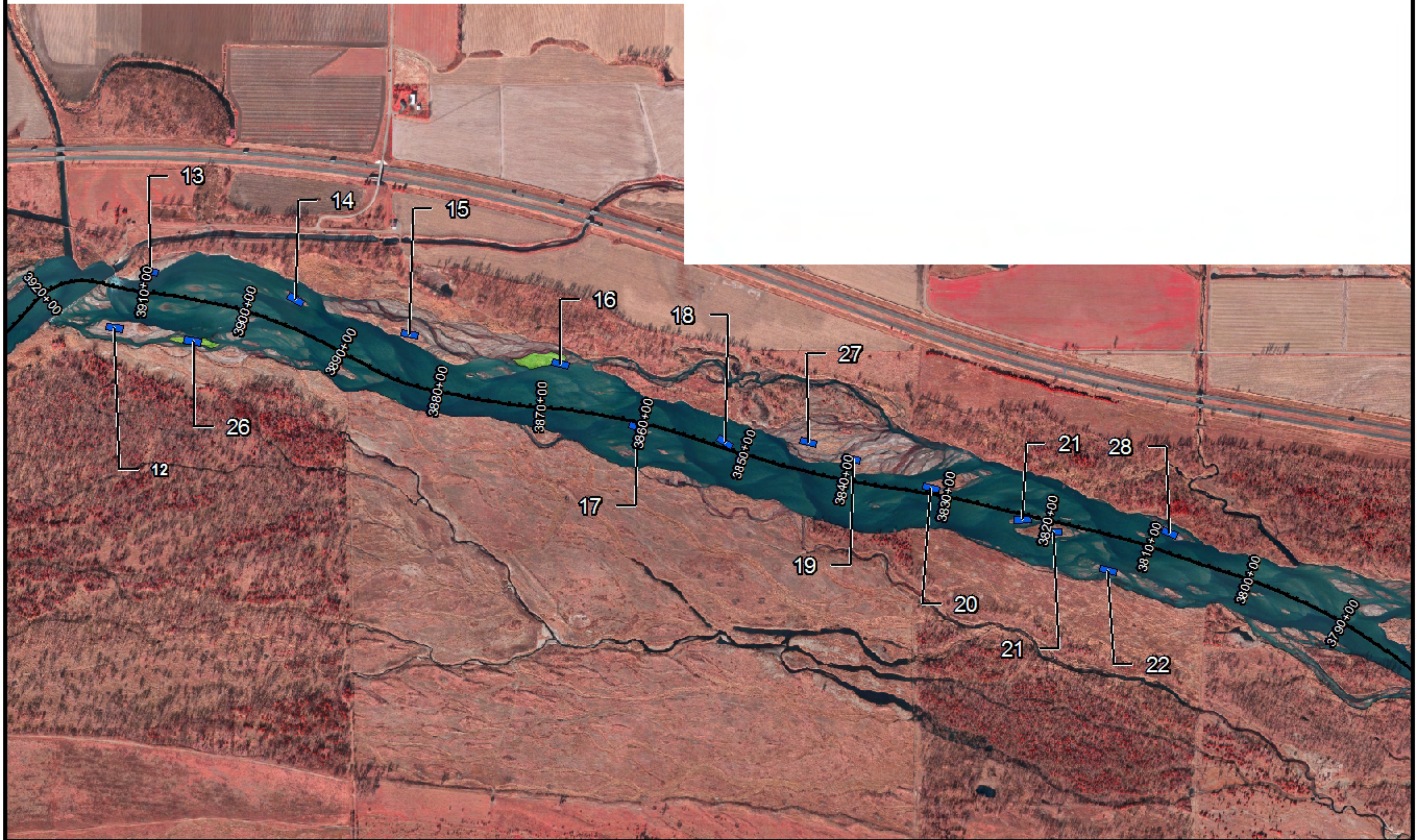
Elm Creek Downstream Bar Clearing Plan

Bars to be Cleared 2013 | Veg Plots

N W E S

0 1,500 3,000

Feet



TETRA TECH

Elm Creek Downstream Bar Clearing Plan

Bars to be Cleared 2014? | Veg Plots

N W E S

0 1,500 3,000

Feet