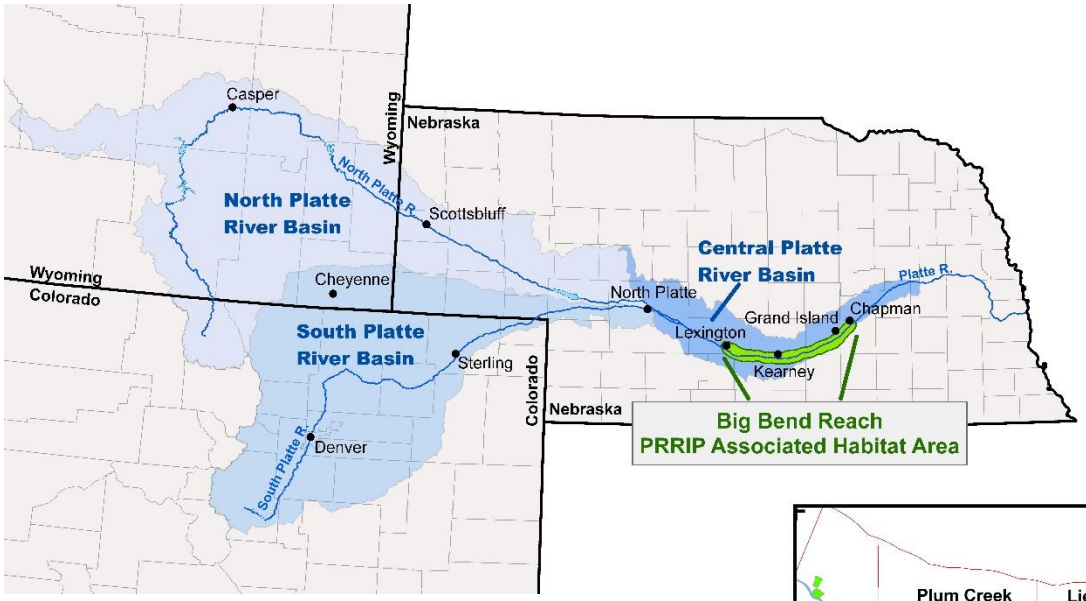
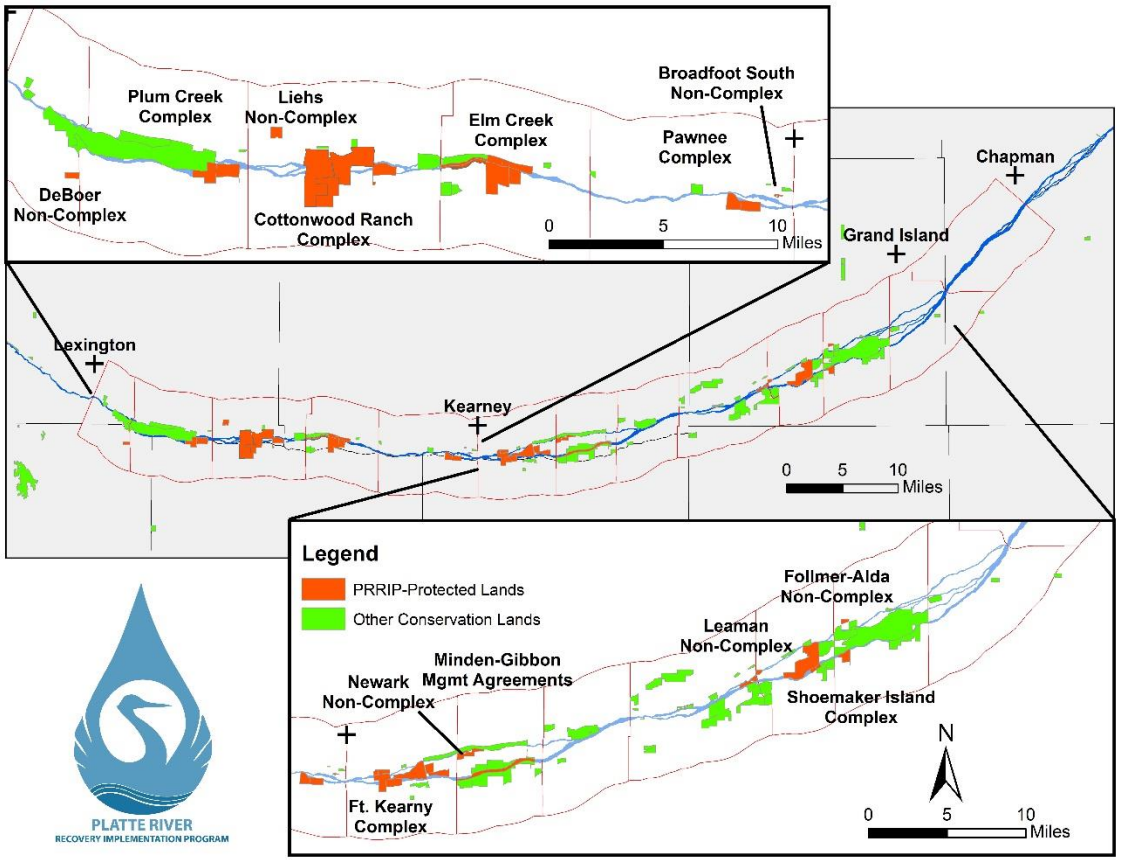
PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

2015
State of the Platte



Map depicting Program area, including the Associated Habitat Reaches on the central and lower Platte River.



Program habitat complexes in the Associated Habitat Reach.

2015
State of the Platte

Adaptive Management Plan (AMP)
2015 "Big Question" Assessments*
February 20, 2017

*updated primarily with 2007-2015 data

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PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

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INTRODUCTION

The Platte River Recovery Implementation Program's ("Program" or "PRRIP") Executive Director's Office (EDO) developed this document for the Governance Committee (GC). It is intended to serve as a synthesis of Program monitoring data, research, analysis, and associated retrospective analyses to provide important information to the GC regarding key scientific and technical uncertainties. These uncertainties form the core structure of the Program's Adaptive Management Plan (AMP) and are directly related to decisions regarding implementation of management actions, assessment of target species' response to those management actions, how best the Program can spend its resources (money, land, water, etc.), and ultimately the success or failure of the Program.

A quick reference assessment for each of eleven Big Questions is provided in Table 1 below, followed by an assessment write-up for each Big Question. Each assessment includes information noting any updates or changes from previous State of the Platte reports. This document contains endnotes to identify key documents or data sets that are important to read and understand when reviewing this report. Those endnotes include hyperlinks to information available in the Public Library section of the Program's web site.

KEY OBSERVATIONS AND PROGRESS

The 2015 State of the Platte Report includes assessments incorporating Program data from years 2007-2015. Three of ten Big Questions are answered conclusively and five of ten are trending in a direction that will affirm or reject important hypotheses. One question (#9) has changed in practice and is now being addressed by the GC. Question #10 will be assessed throughout the remainder of the First Increment and the EDO is suggesting a language change to bring the question more in line with relevant Priority Hypotheses.

SHORT-DURATION HIGH FLOWS AND TERNS/PLOVERS

The Program completed a series of tern and plover habitat synthesis chapters that were peer reviewed and unanimously accepted by the GC in 2015. In 2016, the GC completed a Structured Decision Making (SDM) process to reach the final "Adjust" step of adaptive management regarding this question by deciding to change management actions in response to Program learning. The GC made three decisions:

- Acquire up to an additional 60 acres of off-channel nesting habitat.
- Maintain up to 10 acres of on-channel nesting habitat.
- Not release water solely for tern/plover nest initiation.

TERN/PLOVER NESTING HABITAT

Program data analysis and synthesis indicate that while there is a strong positive correlation between habitat availability and tern/plover reproductive success, off-channel nesting habitat appears to be sufficient to support terns and plovers in the central Platte River to stabilize and increase tern and plover populations. There is a need for available foraging habitat in the channel, but data analyses indicate that availability of tern forage (i.e. small fish) is high at nearly all flow levels during the summer nesting season.

PALLID STURGEON AND PROGRAM WATER MANAGEMENT

Attempts to resolve concerns about the potential impact of Program flow management actions in the central Platte River on pallid sturgeon in the lower Platte River have not been successful. It is now clear that as stated, Big Question #9 is no longer helpful to advancing learning about pallid sturgeon in the Program. In September 2016, the GC agreed to begin a step-wise, incremental process to address internal language inconsistencies in the Program document regarding pallid sturgeon, possibly changing the language of Big Question #9, and developing a clear statement of Program intent regarding pallid sturgeon and GC decision criteria moving forward. It is possible this incremental process will lead to further research in the form of an expanded stage change study and directed habitat selection. The process will begin in 2017 with a facilitated internal workshop and will include an independent expert workshop in 2018, both designed to help the Program set direction on pallid sturgeon next steps.

SCIENCE PANEL COMMENTS ON 2015 STATE OF THE PLATTE

This report was discussed with and reviewed by the Program's Independent Scientific Advisory Committee (ISAC) in fall 2016. The ISAC provided the following comments on the 2015 State of the Platte:

General Comments

- The new format works well. It concisely summarizes information for the GC, while providing the TAC with more details through endnotes.
- It would be helpful to include the bottom line messages below each figure, to save time, and improve clarity.
- It would be worth having an appendix which shows progress on land and water, or this material could be at the front of the document.
- Many of the priority hypotheses were not phrased in a form that's testable, or are no longer relevant, or can only be tested in certain areas. This should be made clear (e.g., use 'NT' for 'Not Testable' or 'NR' for 'Not Relevant'), with an explanation of why these categories apply.
- Several hypotheses state "under a balanced sediment budget". It has proven to be very difficult to draw reliable conclusions on whether the sediment budget is balanced in the Central Platte, due to high levels of spatial and temporal variation in sediment transport.
- The ISAC has provided the EDO with many detailed comments to improve the graphics and/or text in the document; the following bullets focus only on those Big Questions (BQ) where the ISAC had major comments

Big Question #3

- It seems fair to conclude that there is channel degradation upstream (based on multiple lines of evidence, including grain size), and that it is worth doing sediment augmentation. Green LIDAR might help to get a census of channel change, and to separate incision from widening.
- Further downstream, the signal of sediment augmentation will likely get lost in the noise of year to year and spatial variation, even with Green LIDAR. Sediment augmentation may still be a good thing to do, even if you can only prove its benefit for the upstream area.
- Effect sizes should be defined for each performance measure used to assess whether sediment augmentation has been effective. If Green LIDAR works, then it should be possible to use Geomorphic Change Detection software.

Big Question #5

- A histogram of whooping crane habitat selection is more relevant to BQ5 than trends through time in relative use.

Big Question #6

- As the ISAC has mentioned in previous reports, the Program needs to examine (and possibly reject) alternative hypotheses to explain the observed increase in tern and plover nesting (e.g., meta-population trends, movement of birds from non-program to program lands, movement of birds from Lake McConaughy). Response to BQ6 is still two thumbs up, but other hypotheses need to be addressed.

Big Question #8

- Important to note that tern productivity was fine during very dry periods in 2002-2006.

Big Question #9

- BQ 9 has been answered positively. Based on the ISAC report from August 2015, it's reasonable to conclude 2 thumbs up for the area below the Elkhorn River. The ISAC recommended more study above the Elkhorn based upon observations of adult pallid sturgeon above the Elkhorn. Predicted changes in water surface elevations and velocities above the Elkhorn are likely to be within the error range of model accuracy.
- The Program will host an internal workshop in 2017 to address other issues related to pallid sturgeon and to generate other questions for consideration by an expert workshop.

Big Question #10

- BQ10 could be rephrased as: "Do Program management actions in the central Platte River cumulatively lead to detectable changes in the physical environment, habitat, and consequently population responses by least terns and piping plovers in the central Platter River and use of this area by whooping cranes?"

TECHNICAL COMMITTEE COMMENTS ON 2015 STATE OF THE PLATTE

This report was discussed with and reviewed by the Program's Technical Advisory Committee (TAC) in fall 2016. Several comments from TAC members and members of the former Adaptive Management Working Group (AMWG) that helped to develop the AMP are included in a dedicated column in the table found in Appendix A.

In addition, the following written comments were submitted by the U.S. Fish and Wildlife Service:

BQ2 - While there is certainly a positive correlation with herbicide application and phragmites reduction from 2009-2012, the Service believes there were ancillary benefits derived from the corresponding high flows that occurred those years (2010 and 2011). For instance, while phragmites scour may not occur at anticipated or needed levels (lateral erosion occurs as some levels), high flows are responsible for some of the phragmites physical removal and are likely responsible for physically removing a lot of treated, dead phragmites. Without that removal, they would remain within macroforms, causing them to remain immobile and capable of being re-established by more vegetation in the future. As stated within this section (bullet 2), the 40-day mean peak is the best predictor of UOCW. Physical removal of phragmites (dead or alive) or maintenance of a phragmites free channel appears to be at least partially correlated to these flows (Phragmites is a part of the what goes into UOCW measurements). It remains unknown what incremental benefit would be achieved from implementation of SDHF- however we do agree, that based on existing science, continued herbicide treatment in combination with flow management (TBD exactly what flow management) and in some years- disking, is needed to maintain suitable whooping crane habitat in the immediate and foreseeable future. We recommend revising the statement "The reduction is positively correlated with herbicide application and not correlated with peak flow magnitude or inundation duration" to state "The reduction is positively correlated with herbicide application though ancillary benefits may occur from peak flows and other high flow events which occurred during this time-period". Changing peak flow magnitude and duration to SDHF would strengthen this too as it sets bounds on what types of flows the question is getting at. Peak flow magnitude and duration does not seem like the right wording as the big question is specific to SDHF.

As for SDHF, I maintain my opinion that there may be benefits to maintaining the flexibility to release a SDHF (flow event of up to 8,000 cfs) in some years. However, we also acknowledge the reality- through 10 years of implementation, the flexibility to achieve even 5,000 cfs and certainly the higher ends of that (8,000 cfs) has been challenging. The decision of how much capacity to maintain at the chokepoint is ultimately a GC decision and may be influenced by cost, logistics and science. However, we remain supportive of increasing the choke point capacity to the maximum extent possible. We also anticipate exploring different flow management strategies in the future. Ultimately, we believe a "mechanical only" approach is not sufficient (regardless of the success/failure of SDHF) - a flow management strategy capable of providing system scale benefits is a priority for the Service.

BQ3 - It is the Service's goal to stop incision in the South Channel below J-2 as this ensures the effects of the clear water return are completely mitigated. This bullet states augmentation is needed to "slow" incision in that channel. It was my understanding the PRRIP agreed to the management strategy of "offsetting the existing deficit in the South channel of Jeffery Island (not just slow). Adjusting the amount or type of sediment (method of augmentation, grain size. etc.,) would be a potential way of addressing this if the long-term trend doesn't change and degradation is only "reduced" from what it used to be in that channel. However, it is encouraging to see initial data indicating degradation ending at the Overton bridge.

The corresponding graphic on this page depicts the elevation in 2009 and 2014, what is not indicated is what was the expected rate of degradation in absence of sediment augmentation and how much has that rate changed. If historic data can be incorporated in to show how that rate of degradation has slowed, that may help tell the whole story. We agree, it will be difficult to answer in the short term. We are committed to continuation of sediment augmentation and believe it is a necessary component of the PRRIP. Again, it is encouraging to see that degradation is negligible or non-existent the last few years by the time we get to Overton.

It is suggested that 5-7 years of response monitoring is necessary to assess the success of augmentation. Whatever varying degrees of success or failure are concluded from the monitoring, the Service is committed to finding a solution (using sediment augmentation) to offset the deficit- if current methodologies are proven unsuccessful, the "adjust" phase will be to try new methods, not abandon fixing the sediment deficit.

BQ4 - I think the question itself should be revised. It seems to almost combine FSM and MCM. Flow consolidation was an FSM action. We determined its infeasible. We recommend putting that in its own question (e.g. Is flow consolidation feasible and if, feasible, is it necessary?) and answering conclusively that it's not even feasible so it doesn't matter if it's necessary. In its place, add disking and herbicide which is really what this is trying to get at (i.e. are the mechanical actions of MCM necessary). I would also add to the front of the question, "given existing constraints, are mechanical channel alterations…etc.". In other words, the graph in this question and the peak flows in 2015 showed that it is entirely possible to create and maintain habitat if we had an unlimited capacity to release long duration peak flows. If we released 15,000 cfs every year or two, I would expect we could get good WC habitat without mechanical actions. However, that's not practicable given existing constraints.

BQ5 - The last two fall migrations ('15/'16) marked the two highest fall totals of detected observational WC sightings (34 in 2015, 24 in 2016). Collectively, those would have represented 11% and 7% of the population were documented in the Platte. As fate would have it, the majority of these WC's are not included in the systematic trend graph due to arriving past PRRIP systematic survey dates, being outside the PRRIP designated area (1 mile downstream), or only being picked up observationally. While systematic sampling certainly has its benefits, we caution making conclusions that use in the fall has declined since 2001. In 2016 alone, 21 of the 24 WC's arrived on the Platte past the PRRIP dates. It may be beneficial since PRRIP has invested in additional flights past its systematic season dates to include a graph depicting some of that data. We believe use is still increasing in the spring AND fall but doesn't appear as obvious in the fall due to recent abnormally warm falls and late migrations. Including a 3rd trendline and corresponding data points showing how many total WC's were documented might be valuable. It's certainly possible that large numbers of late arriving WC's have occurred consistently in the past as well, but our database, which has no monitoring timing bias (a WC is just as likely to get reported by the public in mid-late Nov. as it is in Oct.) does not indicate that to be likely. Fall use will likely always have lower numbers than spring, however, use appears to be stable or slightly increasing. We recommend pointing out some of this. We also request the "2015 Assessment" be modified to state that spring WC use has increased significantly and fall use has slightly declined.

Proportionate spring crane use days appear to have almost tripled from 2001-2015 (see figure 5), though it is stated this doesn't meet the scientific standard of "significant". Please clarify why you estimate with confidence that "proportionate spring and fall crane use days have not increased because of increased Program management activities and habitat availability". Is this attempting to get at whether length of stay has increased or is it related to WC use of Program lands? If so, maybe phrase it that way. Aside from what's happening in the fall, it appears both the proportion of the population and the length of stay is increasing in the spring.

This is meant to be tied to table 1 land plan conditions. The big question related to habitat suitability indicates WC's disproportionately select for wider UOCW's and wider UFW's. However, the suitability was modeled to be the same for those widths in table 1 as the 600 UOCW/100UFW. I guess the way I look at it is that we've confirmed use IS in fact related to suitability but that suitability peaks and is maintained anywhere above 600 ft (UOCW). The wording of the hypothesis will be incorrectly interpreted without specifically touching on the land plan values vs. what the model shows. I would suggest stating "evidence points to affirming that WC's use is related to habitat suitability, however, it is modeled to be maximized around 600 ft and above UOCW w/ 1000 ft UFW as opposed to those prescribed in the land plan table 1". For the record, I maintain that while the model might not show it at this point, the Service still supports managing for those conditions in table 1. We understand it may not always be fiscally possible or environmentally feasible to get those conditions and that the incremental benefit from 600 ft. to 1000 ft. isn't as much "bang for the buck" as hypothesized. However, we do still feel there are incremental benefits.

BQ8 - The Service's 800 cfs target flow was not solely developed for forage fish. It was developed for the entire fish community in the central Platte River.

BQ9 - We have no comment related to this assessment as an initial path forward has been agreed upon which we hope will help resolve differences of opinion that exist among the Service, EDO, and other PRRIP participants related to the Pallid Sturgeon.

TABLE 1. 2015 BIG QUESTION ASSESSMENTS

PRRIP Big Question	2015 Assessment	Basis for assessment
Implementation – Program Management Actions and Habitat		
1. Will implementation of SDHF produce suitable tern and plover riverine nesting habitat on an annual or near-annual basis?		Conclusively answered. GC utilized Structured Decision Making (SDM) in 2016 to complete the "Adjust" phase of adaptive management related to this question.
2. Will implementation of SDHF produce and/or maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis?		Trending negative; peer review underway for the whooping crane habitat synthesis chapters and manuscripts related to the Program's vegetation and lateral erosion research being published; those documents will likely support a "two thumbs down" assessment in the 2016 State of the Platte.
3. Is sediment augmentation necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?		Trending positive and certainty about the sediment deficit in the south channel above the Overton bridge; uncertainty about the role of that deficit in habitat creation and maintenance in the rest of the Associated Habitat Reach (AHR).
4. Are mechanical channel alterations (channel widening and flow consolidation) necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?		Trending positive; peer review underway for unobstructed channel width analysis and the Program's vegetation scour research being published will likely support a "two thumbs up" assessment in the 2016 State of the Platte.
Effectiveness – Habitat and Target Species Response		
5. Do whooping cranes select suitable riverine roosting habitat in proportions equal to its availability?		Peer reviews of the WEST habitat selection report and the habitat synthesis chapters are underway and this will change to a conclusive answer in the *2016 State of the Platte*.
6. Does availability of suitable nesting habitat limit tern and plover use and reproductive success on the central Platte River?		Conclusively answered. Tern and plover breeding pair manuscript published in 2016 best addresses this question.
7. Are both suitable in-channel and off-channel nesting habitats required to maintain central Platte River tern and plover populations?		Conclusively answered. Tern and plover breeding pair manuscript published in 2016 best addresses this question.
8. Does forage availability limit tern and plover productivity on the central Platte River?		Pending publication of manuscript will result in conclusive answer for this hypothesis related to terns in the *2016 State of the Platte*. Separate analysis and manuscript will be completed for plovers in 2016-17.
9. Do Program flow management actions in the central Platte River avoid adverse impacts to pallid sturgeon in the lower Platte River?		The premise of this question has changed and the Program is now starting a process to refine relevant Program goals, objectives, and hypotheses as well as the language of this question, define decision criteria, and design potential pallid sturgeon research.
10. Do Program management actions in the central Platte River cumulatively lead to detectable changes in the physical environment, habitat, and consequently population responses by least terns and piping plovers in the central Platter River and use of this area by whooping cranes?		The wording of this question was changed in October 2016 to better reflect the relationships referenced in several system-related priority hypotheses. Collecting the data necessary to answer all relevant system-related priority hypotheses. The S1 hypotheses and BQ #10 will be addressed in years 2017-2019.

READING THE BIG QUESTION ASSESSMENTS

To assist the GC with quickly evaluating the 2015 Big Question assessments, the icons in Table 2 are used to visually summarize the basic conclusion for each question. Thumbs up or down indicate a trend in the affirmative or negative and may point to the need to re-evaluate management actions based on collected data and analysis. The "unknown character" is used when there is not enough evidence to indicate a trend in either direction or more time is needed to collect appropriate data and conduct analyses. These icons are intended to provide the GC with a quick and visual means to see where the Program stands each year in moving towards resolution of the Program's most significant scientific questions as they relate to management decision-making.

New in the 2015 State of the Platte is the addition of a status update on all original priority hypotheses in the AMP. Each Big Question assessment includes an indicator of the "test results" for relevant priority hypothesis. Hypothesis Test Results are indicated as one of the following categories:

Hypothesis answered conclusively – affirmed.

Hypothesis answered conclusively – rejected.

Hypothesis not yet answered – ongoing implementation, analysis, and synthesis.

Not currently being addressed through implementation of the AMP and related data analysis and synthesis.

See **Appendix A** for a more detailed status report for each priority hypothesis in the AMP.

TABLE 2. QUICK REFERENCE LEGEND EXPLAINING ICONS USED TO ASSESS BIG QUESTIONS.

Icon	Trend or Answer Explained by Icon
	• Big Question and underlying hypotheses **answered conclusively** in the **affirmative** • Foundational documents, analysis, and other references on which this assessment is based have undergone peer review through the PRRIP peer review process and/or publication in refereed journals • Governance Committee should consider adjustments to decisions related to PRRIP management actions
	• Affirmative answer or trend, but Big Question and underlying hypotheses **NOT answered conclusively** • Assessment can be based on draft documents and analysis, but peer review and/or publication may be pending • To the extent possible, consider what information is necessary to change this designation
	• Evidence thus far is **inconclusive**; no affirmative or negative answer/trend to Big Question and underlying hypotheses • Assessment can be based on draft documents and analysis, but peer review and/or publication may be pending • To the extent possible, consider what information is necessary to change this designation
	• Negative answer or trend, but Big Question and underlying hypotheses **NOT answered conclusively** • Assessment can be based on draft documents and analysis, but peer review and/or publication may be pending • To the extent possible, consider what information is necessary to change this designation
	• Big Question and underlying hypotheses **answered conclusively** in the **negative** • Foundational documents, analysis, and other references on which this assessment is based have undergone peer review through the PRRIP peer review process and/or publication in refereed journals • Governance Committee should consider adjustments to decisions related to PRRIP management actions

Big Question #1

Will implementation of Short-Duration High Flow releases produce suitable tern and plover riverine nesting habitat on an annual or near-annual basis?

2015 Assessment

- Observational studies of natural high flow events since 2007 have provided sufficient data to test the hypothesis that SDHF releases will create suitably-high sandbars.
- Full SDHF magnitude of 8,000 cfs is not sufficient to create sandbars exceeding the PRRIP's minimum height suitability criterion.
- Sandbars created by SDHF releases will be inundated during the nesting season in most years.
- Peak flow magnitudes of 15,000 cfs will produce sandbars meeting the minimum height criterion. However, suitably-high sandbar area would be well below the Adaptive Management Plan objective of 10 acres per river mile.

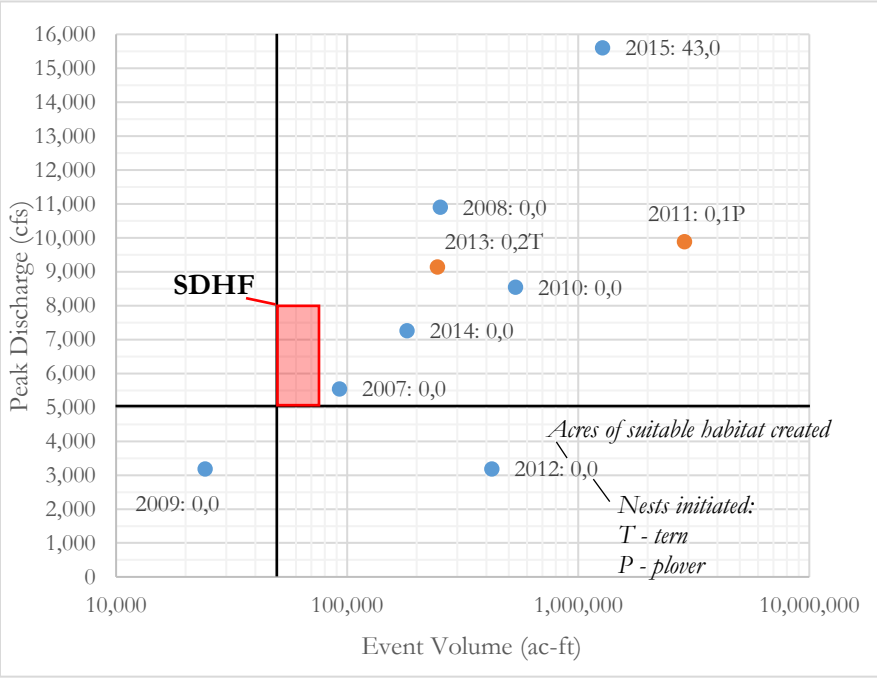


Figure 1. First Increment peak flow event magnitudes and volumes in relation to SDHF. Four events (2010, 2011, 2013, and 2014) exceeded SDHF magnitude and duration and did not produce suitably-high sandbar nesting habitat.

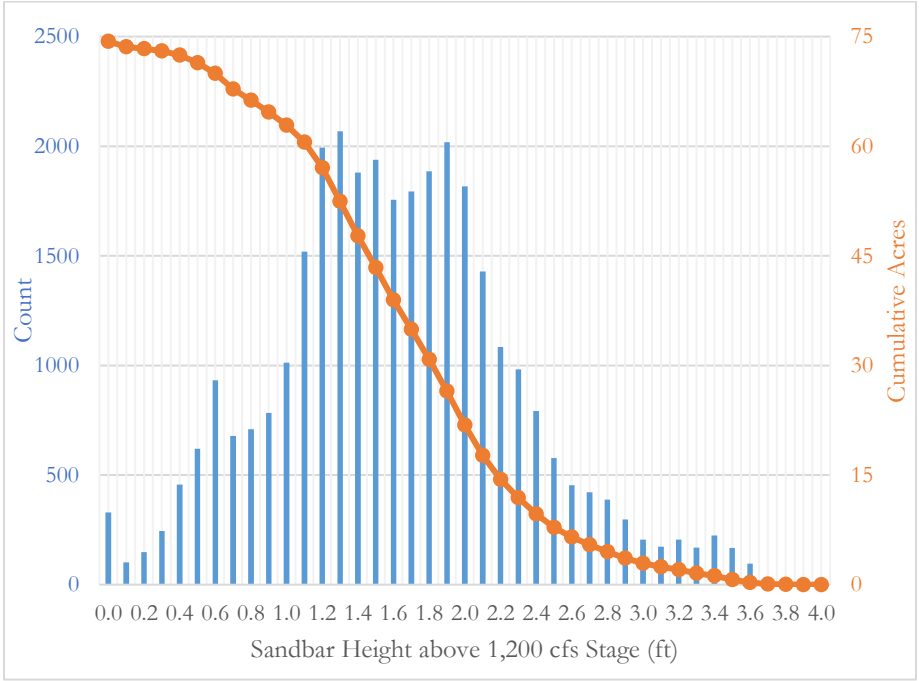


Figure 2. Height distribution of emergent sandbar area produced during the 2015 peak flow event in the portion of the AHR downstream of Kearney. The 15,000 cfs event produced 43 acres of sandbar habitat exceeding the minimum height suitability criterion of 1.5 ft above 1,200 cfs stage. Median height of bars was 1.6 ft above 1,200 cfs stage.

What the science says in 2015:

- The original analysis of SDHF performance assumed sandbars build to the water surface during peak flow events. The median height of sandbars formed during natural high flow events in 2010, 2011, 2014, and 2015 was 1.2 – 2.3 ft below peak stage.[1]
- Four peak flow events (2010, 2011, 2013, and 2014) that exceeded SDHF magnitude and duration did not produce sandbar habitat exceeding the minimum height criterion (Figure 1).
- A natural high flow event of 15,000 cfs in 2015 produced sandbars exceeding the minimum height criterion. The median height of sandbars formed 2015 was 1.6 ft above 1,200 cfs stage (Figure 2).
- Approximately 43 acres of mid-channel bar area ≥ 1.5 ft above 1,200 cfs stage were present in the portion of the AHR downstream of Kearney in November of 2015 (Figure 2). This equates to 0.8 acres per river mile.

We estimate with confidence that:

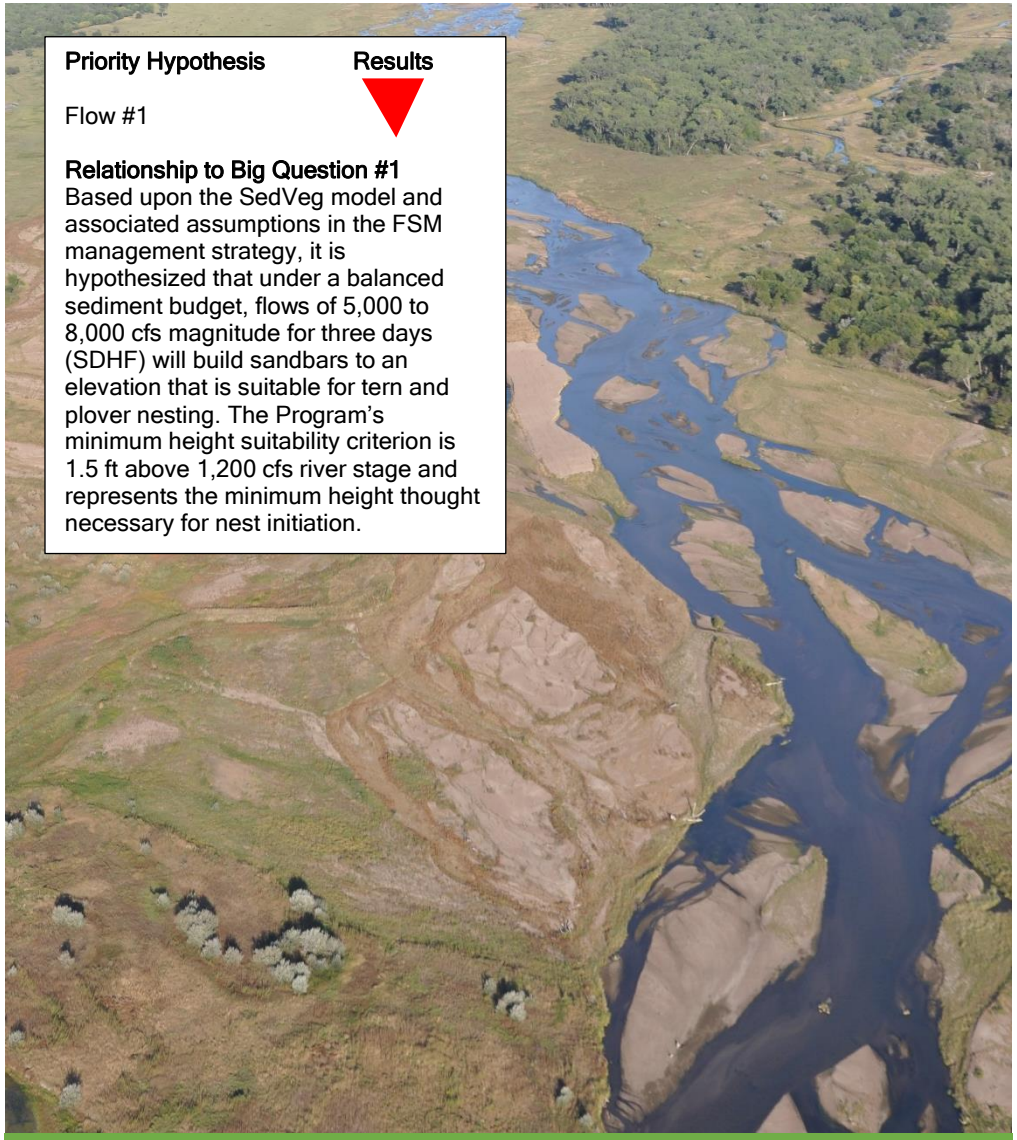
- SDHF duration of three days at peak would not be sufficiently long to mobilize the bed and produce many new sandbars.
- Sandbars created by a full SDHF magnitude of 8,000 cfs would be 0.5 – 1.0 ft lower than the minimum height criterion and would be inundated at flows experienced in the AHR during most nesting seasons.
- Peak flow magnitudes of 15,000 cfs will produce sandbars exceeding the minimum height criterion given sufficiently long duration at peak.
- Even at a discharge magnitude of 15,000 cfs, total suitable sandbar area would be well below the AMP objective of 10 acres per river mile.

Answering BQ #1 during the First Increment

- Six tern/plover habitat synthesis chapters serve as the best source for synthesized reference data for this question. Those chapters have been peer reviewed and accepted by the Governance Committee.[2]
- Geomorphic and species monitoring data collected in 2015 are consistent with and support the analyses and conclusions presented in the synthesis chapters.

Management Implications:

- Big Question #1 has been answered with a definitive "two thumbs down." The Governance Committee has moved into the final "Adapt" stage of adaptive management and is considering alternative methods to mechanically create and maintain on- and off-channel nesting habitat.



Big Question #2

Will implementation of Short-Duration High Flow releases produce and/or maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis?

2015 Assessment

- Mature phragmites plants or plant patches have a very low probability of being eroded at the highest flow magnitudes and velocities observed in the AHR. An herbicide control program is ongoing.[3]
- Program analyses strongly support the assertion of a positive relationship between peak flow magnitude and unobstructed channel width (UOCW) in the AHR. 40-day mean peak discharge is the best hydrologic predictor of UOCW.
- The comparatively short duration and low volume of SDHF limits the predicted increase in in UOCW to ≤ 12 ft. SDHF duration is not sufficient to maintain UOCWs that are suitable for whooping crane roosting.
- Disking in combination with herbicide application will produce suitably-wide UOCWs. However, the beneficial effects of these management actions are limited to locations where they are applied.

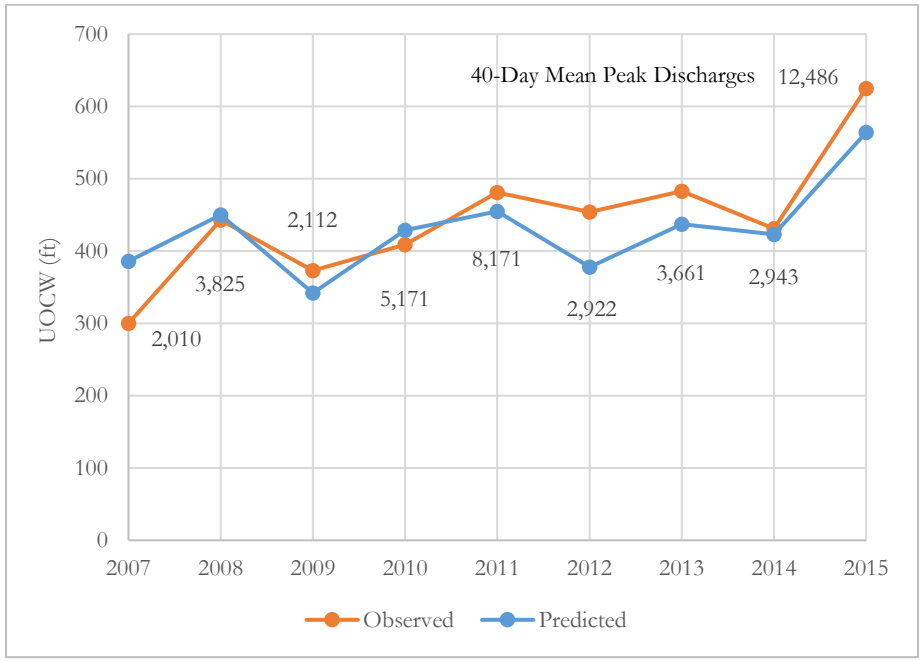


Figure 3. Observed versus predicted mean unobstructed channels widths (UOCW) in the AHR during the period of 2007-2015. Error in predicted UOCW ranged from 2% to 29% of observed and averaged 10%. Accordingly, the UOCW model provides good predictive capacity for evaluating the efficacy of SDHF releases.

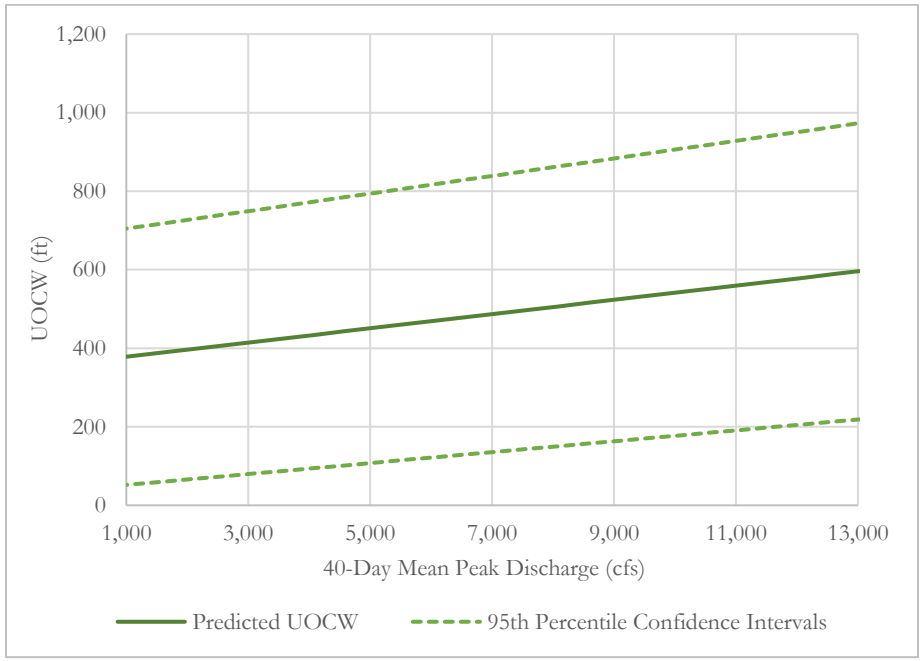


Figure 4. Modeled relationship between 40-day mean peak discharge and UOCW with spraying but no channel disking. The 40-day mean peak discharge for a full SDHF release is approximately 1,300 cfs, resulting in a predicted UOCW of less than 400 ft. UOCWs of 500 – 700 ft are highly suitable for whooping crane roosting.

What the science says in 2015:

- Phragmites occurrence and percent cover declined significantly during the period of 2009-2012 and were stable to slightly increasing in 2013 and 2014. The reduction is positively correlated with herbicide application and not correlated with peak flow magnitude or inundation duration.[4]
- 40-day mean peak discharge is the best hydrologic predictor of UOCW in the AHR. Other metrics useful in predicting UOCW include bankfull wetted width, median bed material grain size, and whether spraying or disking occurred.[5]
- Predictions of mean 2007 -2015 UOCW in the AHR based on these metrics are, on average, within 10% of observed, indicating good predictive ability (see Table 3).

We estimate with confidence that:

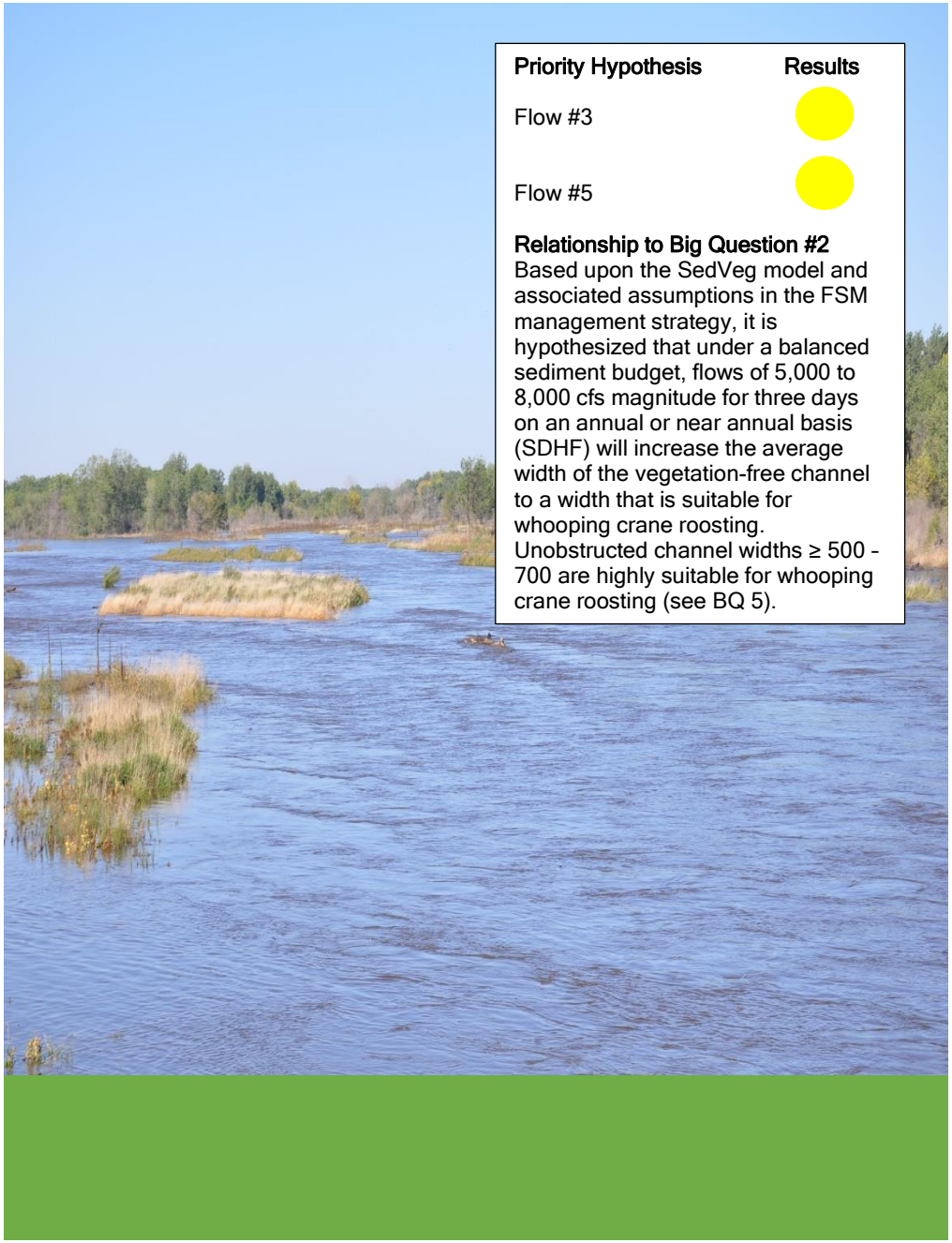
- Implementation of SDHF will have a minimal influence on UOCW in the AHR due to the limited influence (≤ 12 ft) on 40-day mean peak discharge, which is the best predictor of UOCW. This is not sufficient to produce suitably-wide UOCWs during dry years.
- During wet years, the much greater magnitude and duration of natural peak flow events would eclipse any positive benefit of SDHF releases.
- Implementation of disking and herbicide increases UOCW by an average of 126 ft, producing suitably-wide UOCW in all but the driest years.
- Mechanical management actions like disking and herbicide application do not provide the system-scale beneficial effects of natural peak flow events.

Answering BQ #2 during the First Increment

- The Program's directed scour research, now in press, will serve as the best source for synthesized reference data for phragmites scour resistance.
- The Program's whooping crane data synthesis chapters, now in peer review, will serve as the best source for synthesized reference data for the relationship between SDHF and unvegetated channel width.
- Once the whooping crane data synthesis chapters are peer reviewed and approved by the GC, the EDO will consider Big Question 2 to be answered with a definitive "two thumbs down."

Management Implications:

- Implementation of SDHF releases as currently envisioned will not create and/or maintain suitably-wide UOCWs for whooping cranes.
- Implementation of disking and herbicide application at Program habitat complexes will create and maintain suitably-wide UOCWs for whooping cranes.
- Mechanical management actions like disking and herbicide application at Program habitat complexes do not have the system-scale beneficial effects of flow releases.



Big Question #3

Is sediment augmentation necessary for the creation and/or maintenance of suitable riverine tern, plover and whooping crane habitat?

2015 Assessment

- The south channel reach from the J2 Return to the Overton bridge is incising and narrowing due to degradation from clear water hydropower returns. Downstream from Overton, the large degree of spatial and temporal variability in channel form makes it difficult to draw conclusions about sediment balance.
- South channel degradation has resulted in a portion of that reach transitioning from a wide braided planform to a narrow wandering planform, which is less suitable for use by the Program's target species.
- Augmentation of sediment in the south channel is necessary to slow incision and narrowing and prevent degradation from progressing downstream past the Overton bridge.
- It will be challenging to measure the effectiveness of augmentation given that the desired beneficial effect is slowing and ultimately halting of a long-term trend to prevent degradation downstream of the Overton bridge.

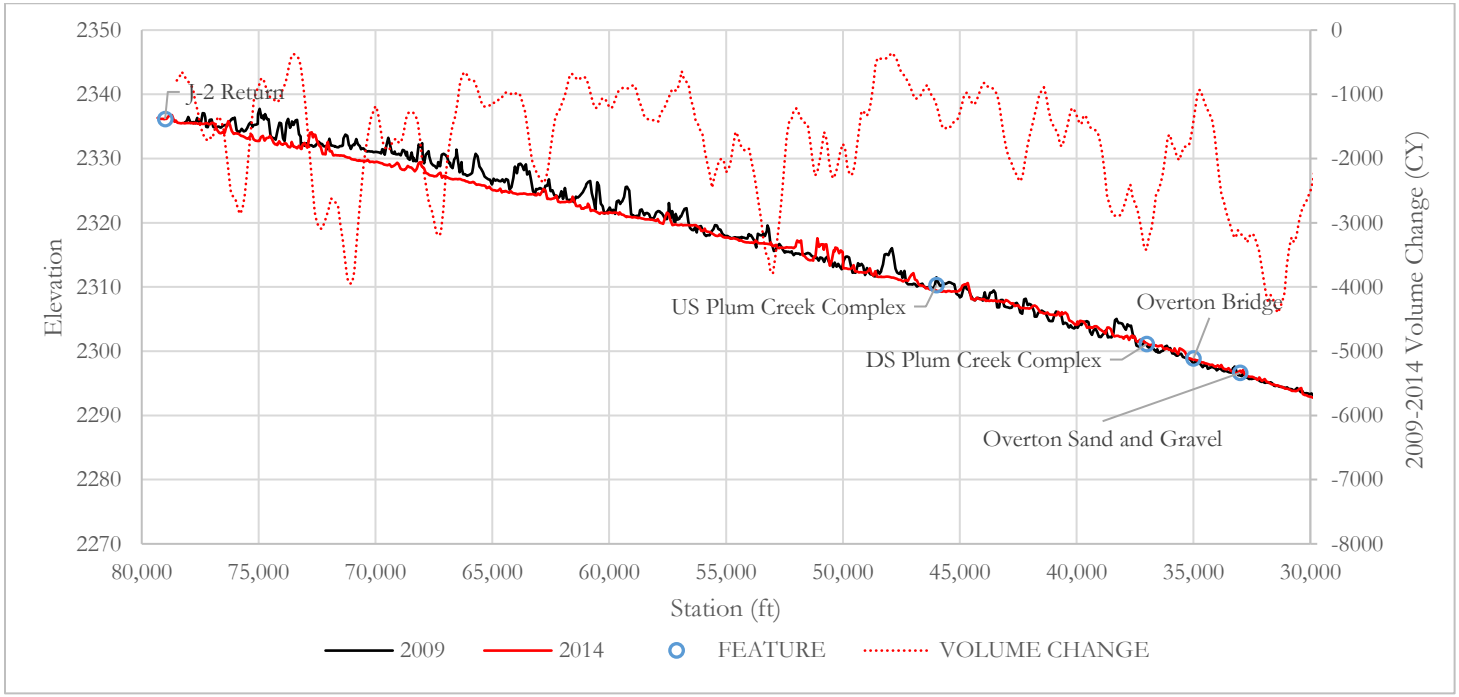


Figure 3. 2009 to 2014 longitudinal profile and volume change for the reach from J2 Return to Overton bridge. Volume change in the reach immediately downstream of the J-2 Return is caused by channel incision. Futher downstream, volume change is due primarily to channel widening.

What the science says in 2015:

- Sediment transport modeling indicates a mean annual sediment deficit of 55,000 tons in the south channel segment extending from the J2 Return downstream to the Overton bridge, ranging from 0 tons in dry years to >100,000 tons in wet years.[6]
- Between 2009 and 2014, that reach lost an average of 127,000 CY of sediment annually due to incision and lateral erosion of banks.[7]
- Incision and associated reduction in channel slope was greatest immediately downstream of the J2 Return and was negligible at the Overton bridge (Figure 3).
- Full-scale sediment augmentation will not be 100% efficient. A proportion (~ 10%) of the augmentation material will either be too coarse to be mobilized from the augmentation site or so fine that it is rapidly transported out of the reach.

We estimate with confidence that:

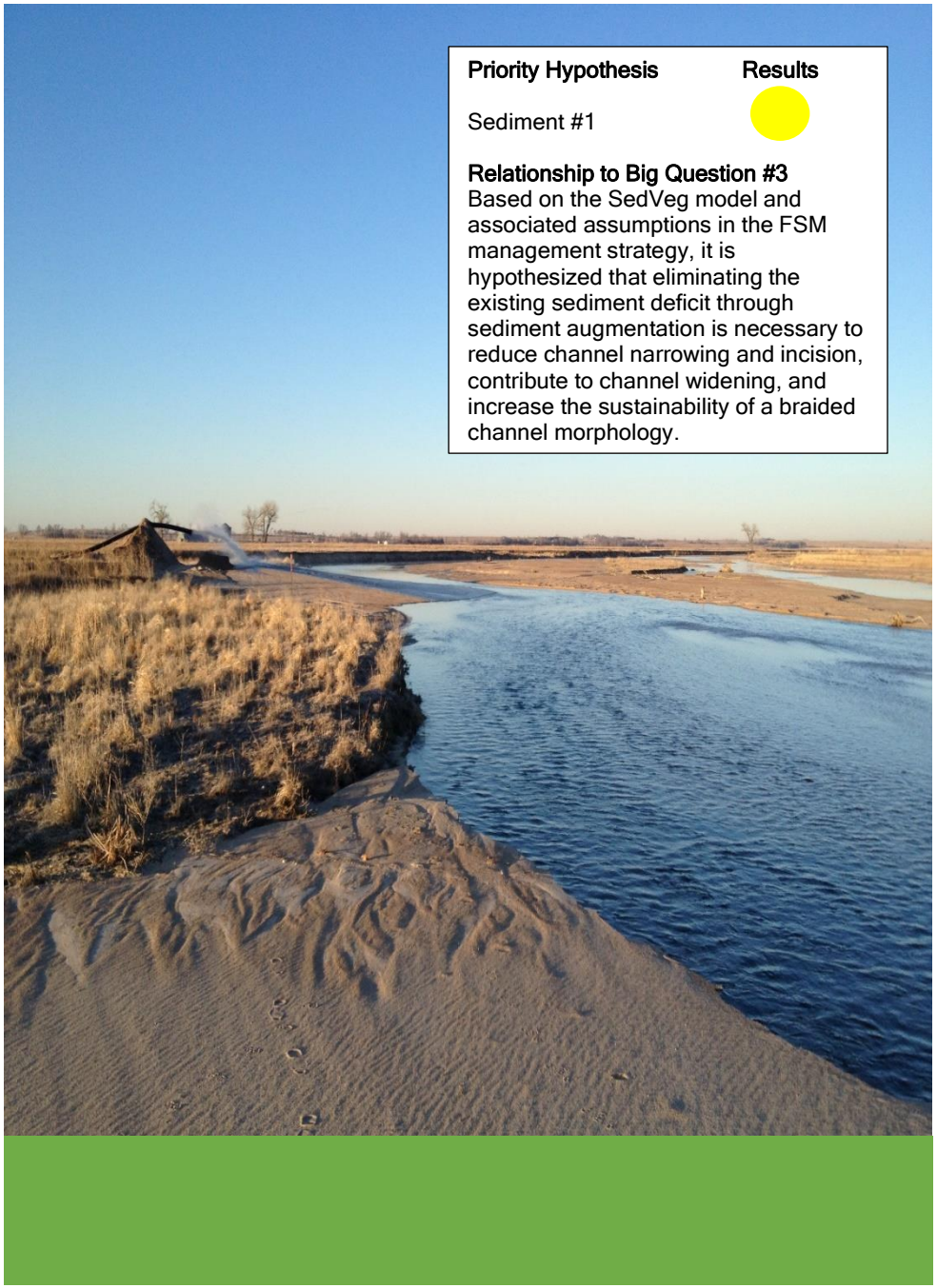
- Observed incision in narrowing and associated planform change in the south channel result in a channel configuration that is not suitable for use by the Program's target species.
- In absence of augmentation to offset the south channel deficit, incision and narrowing will progress downstream past the Overton bridge and negatively affect habitat suitability at the Program's Cottonwood Ranch complex.
- Augmentation of 80,000 tons of sand annually downstream of the J2 return will be sufficient to allow the Program to evaluate augmentation efficiency.
- Measuring augmentation effectiveness will require assessment of changes (or lack thereof) in channel slope, volume, width, and bed material. It may be challenging to quantify beneficial effects.

Answering BQ #3 during the First Increment

- The existence and negative impacts of a sediment deficit downstream of the J2 Return has been well documented by the Program and others.
- The effectiveness of sediment augmentation in offsetting the deficit and halting degradation is not known.
- Full scale operations will likely begin in the fall of 2016 and it is anticipated that five to seven years of implementation and response monitoring will be necessary to assess augmentation efficiency and effectiveness.

Management Implications:

- If the south channel sediment deficit persists, incision and narrowing will progress downstream past the Overton bridge, negatively influencing habitat suitability an increasingly larger portion of the AHR.
- Full scale sediment augmentation may be effective in halting the long-term trend of incision and narrowing. The beneficial effects of augmentation need to be assessed through five to seven years of implementation and effectiveness monitoring.



Big Question #4

Are mechanical channel alterations (channel widening and flow consolidation) necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?

2015 Assessment

- Peak flows in the AHR are generally not sufficient to remove mature woody vegetation or erosion-resistant species like phragmites.
- Mechanical clearing and leveling are necessary to create suitable channel configurations and facilitate channel adjustments to changes in flow and sediment.
- Ongoing mechanical management actions like herbicide application and disking are necessary to maintain suitably-wide unobstructed channel widths (UOCWs) for target species.
- Flow consolidation, a mechanical management action which consists of mechanically confining 90% of total river flow into a single channel, may support the maintenance of suitable UOCWs but is not implementable due to regulatory and legal impediments.

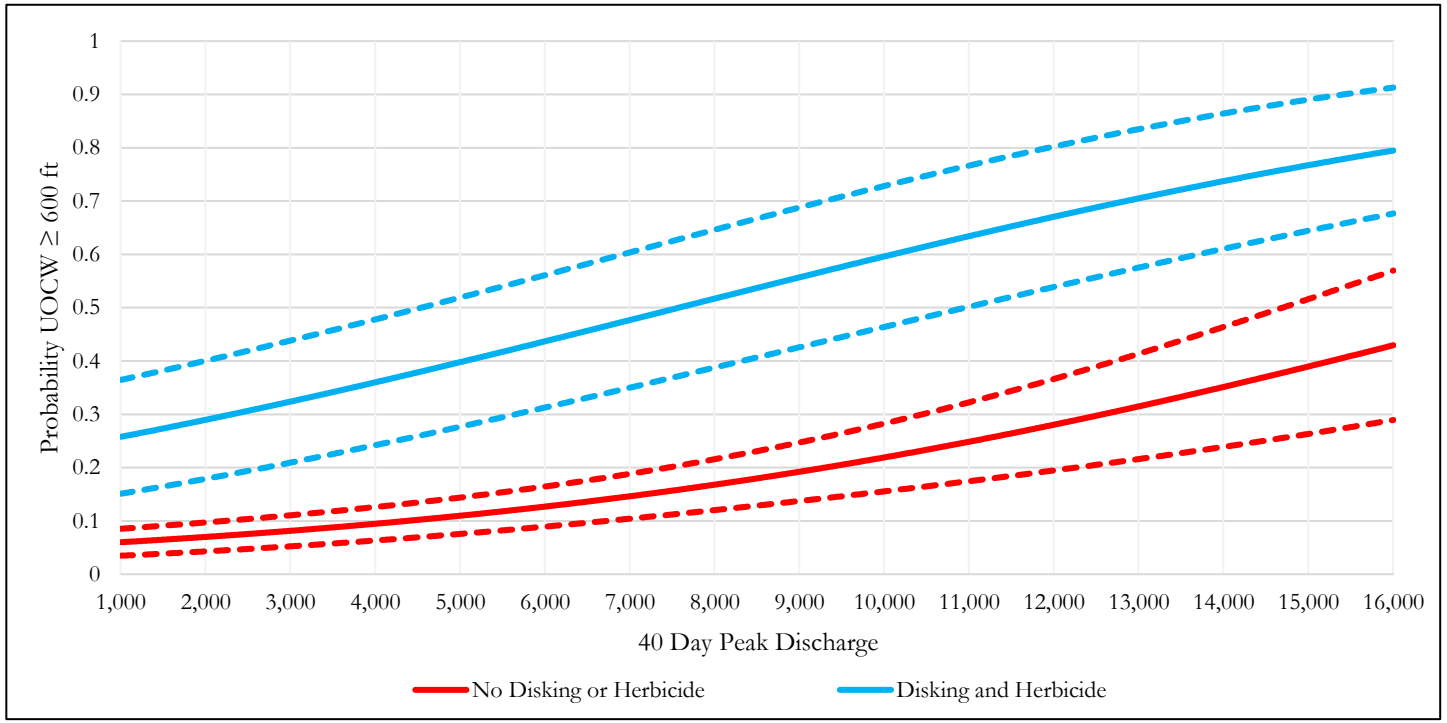


Figure 4. Predicted probability of a transect measuring ≥600 ft in unobstructed channel width (highly suitable for whooping cranes) in relation to 40-day peak discharge at transects with (blue) or without (red) mechanical management actions in the AHR from 2007 to 2015. Dashed lines indicate 95% confidence intervals. Disking and herbicide application provides a significantly greater probability of having channels having more than 600 ft of unobstructed channel width.

What the science says in 2015:

- Phragmites is extremely erosion-resistant and SDHF flow depths and velocities are only sufficient to scour the very weakest individual plants. Ability to scour woody vegetation also decreases dramatically in the year following seed germination.[8]
- Locations that are mechanically maintained through herbicide application and disking have a significantly higher probability of being suitably wide for whooping crane roosting (Figure 4).

We estimate with confidence that:

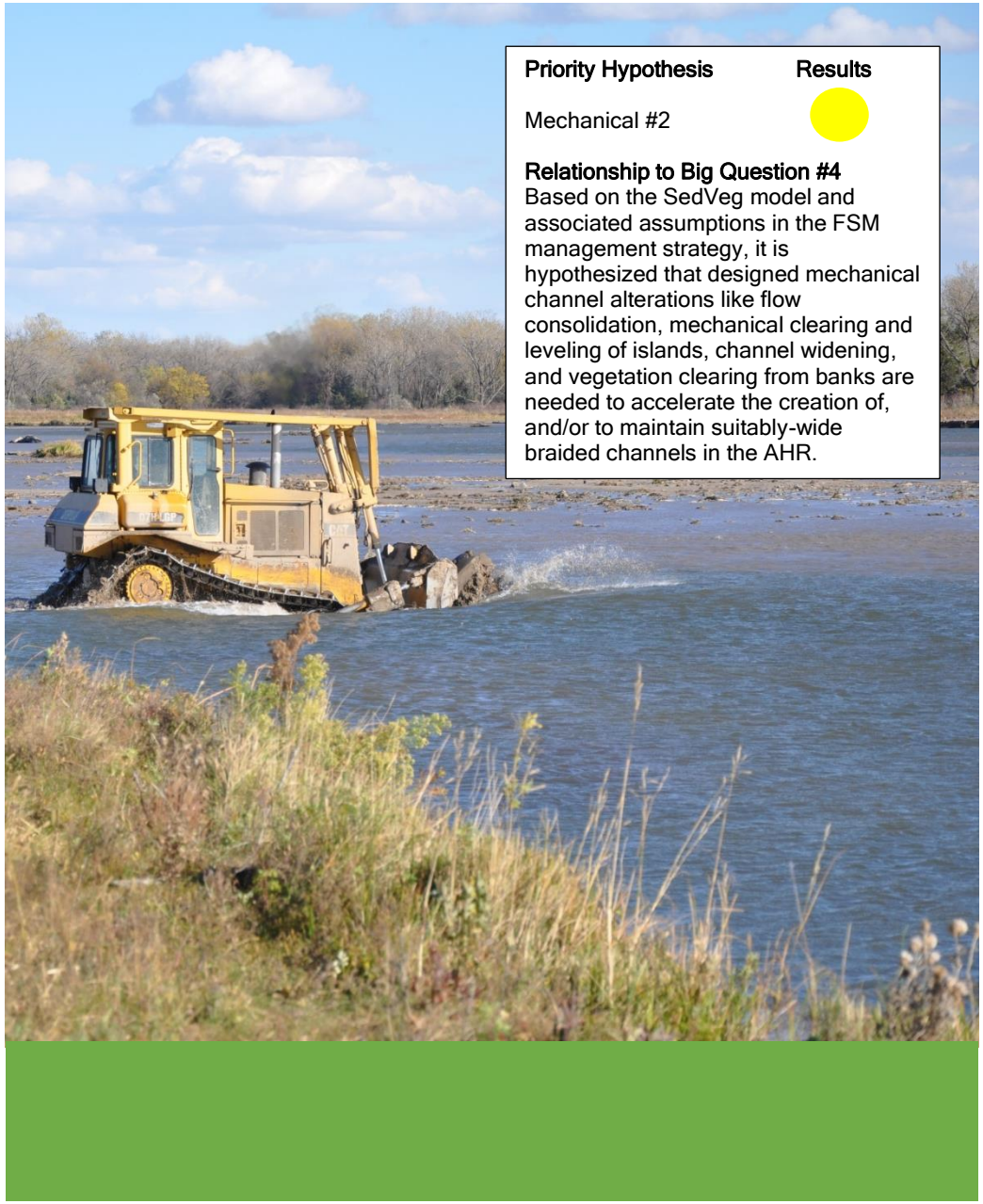
- Mechanical clearing, leveling, and channel widening are necessary to create suitably wide channels at Program habitat complexes.
- Herbicide application and disking are necessary at Program habitat complexes in most years to maintain suitably-wide UOCWs.
- The beneficial effects of mechanical management actions are largely limited to the locations where they are implemented. They do not provide the system-scale beneficial effects typically associated with flow and sediment management actions.

Answering BQ #4 during the First Increment

- The Program's directed scour research, now in press, will serve as the best source for synthesized reference data for phragmites scour resistance.
- The Program's whooping crane data synthesis chapters, now in peer review, will serve as the best source for synthesized reference data for the relationship between mechanical actions and unvegetated channel width.
- Once the whooping crane data synthesis chapters are peer reviewed and approved by the GC, the EDO will consider Big Question 4 to be answered with a definitive "two thumbs up."

Management Implications:

- It was originally hypothesized that mechanical actions were necessary to create desired channel configurations that would subsequently be maintained through Short Duration High Flow releases. SDHF has been shown to be ineffective at maintaining suitable channel widths. Accordingly, ongoing mechanical maintenance will be necessary to maintain suitable UOCWs at Program habitat complexes.
- Due to regulatory and legal issues flow consolidation has been abandoned as a potential Program management action.



Big Question #5

Do whooping cranes select riverine roosting habitat in proportions equal to its availability?

2015 Assessment

- Results of habitat selection analyses within the AHR and throughout the Great Plains indicate whooping cranes select unobstructed channel widths of ~600 feet and unforested corridor widths of ~1,000 disproportionately to availability.[9,10]

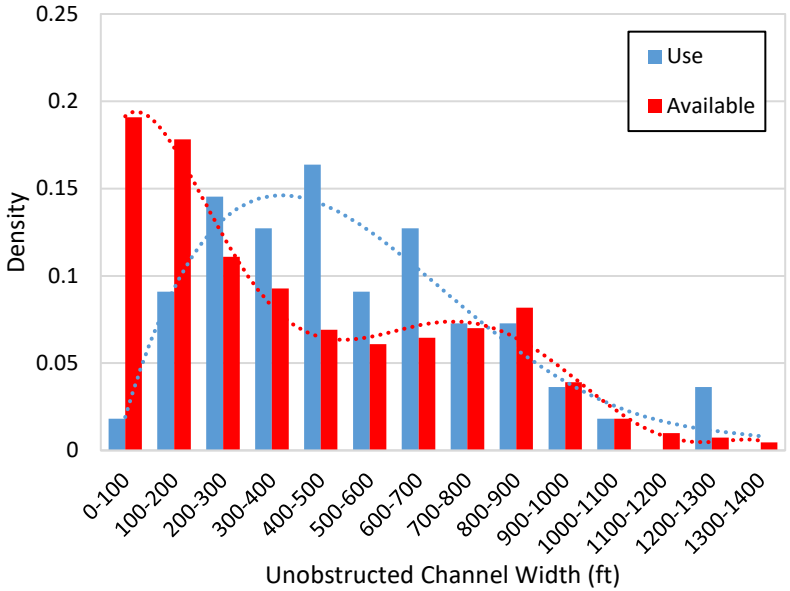


Figure 5. Distribution of unobstructed channel width (UOCW) at use (n=55) and available riverine roost locations in the Associated Habitat Reach (AHR). Use locations were selected disproportionately more than availability from 400-700 ft of UOCW, suggesting UOCWs of ~600 ft are favorable for whooping crane roosting on the central Platte River. Density curves are represented as dashed lines.

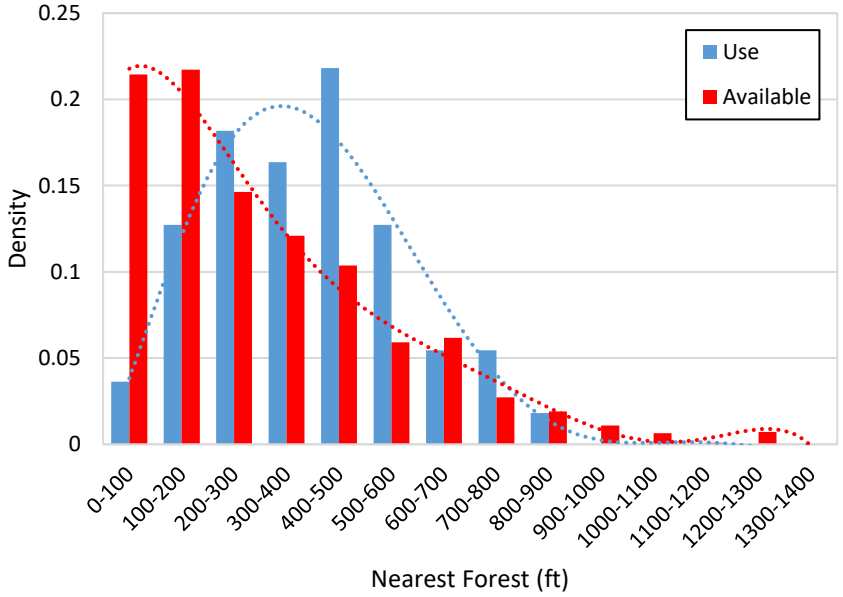


Figure 6. Distribution of nearest forest (NF) at use (n=55) and available riverine roost locations in the Associated Habitat Reach (AHR). Use locations were selected disproportionately more than availability from 400-600 ft of UOCW, suggesting total unforested corridor widths of ~1000 ft (suitable NF multiplied by 2) are favorable for whooping crane roosting on the central Platte River. Density curves are represented as dashed lines.

What the science says in 2015:

- First Increment habitat management efforts implemented by the Program to date include, but are not limited to, tree removal and bank line disking to increase unobstructed view widths, channel disking and widening to increase unobstructed channel widths, and flow releases and sediment augmentation to test hypotheses related to increasing river braiding and areas of suitable depth for whooping crane roosting.

We estimate with confidence that:

- Whooping cranes select unobstructed channel widths of ~500 – 700 feet and unforested corridor widths of ~1,000 disproportionately to availability.[9,10]

Answering BQ #5 during the First Increment

- Detailed habitat selection analyses have been completed and are currently undergoing the Program's independent third party peer review.[9,10] Upon Program acceptance of the whooping crane habitat synthesis chapters and the WEST whooping crane report peer reviews, Program staff consider results of these analyses to be sufficient evidence to change the assessment for this Big Question to 2 thumbs down in 2016.

Management Implications:

- Based on findings of habitat selection analysis, the Program should continue to manage to provide unobstructed channel widths that are ≥600ft and unforested channel widths that are ≥1,000ft.

Big Question #6

Does availability of suitable nesting habitat limit tern and plover use and reproductive success on the central Platte River?

2015 Assessment

- Long-term monitoring and data analyses indicate there is a strong positive correlation between Program-defined suitable ***nesting*** habitat and tern and plover breeding pair counts within the AHR.[11,12] During the Program's First Increment, the tern and plover populations on the central Platte River have increased significantly and proportionately to increases in habitat availability.

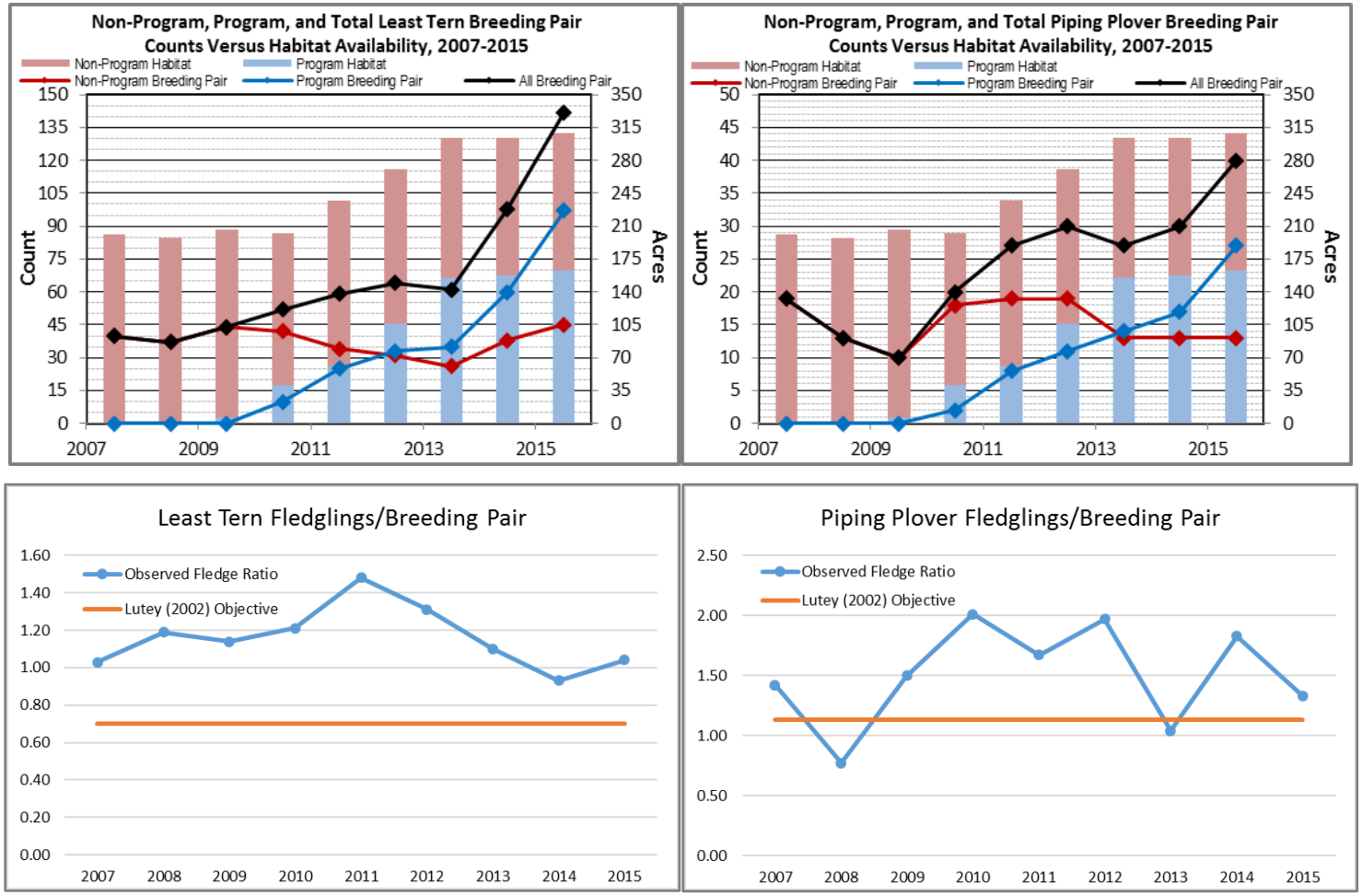


Figure 7. Tern (top left) and plover (top right) Program, non-Program, and total breeding pair counts (solid lines) and Program and non-Program habitat availability based on Program habitat availability assessments and tern (bottom left) and plover (bottom right) reproductive success as compared to the Lutey (2002) objective, 2007-2015.

What the science says in 2015:

- The Program and its partners have created in-channel (sandbars) and off-channel (sandpits) nesting habitat to evaluate hypothesized relationships between habitat availability and tern and plover use and productivity within the Program Associated Habitat Area. The Program has created and maintained ~90 acres of off-channel and ~65 acres of in-channel nesting habitat for terns and plovers.[11] In addition, Program partners have constructed and/or managed ~60 acres of off-channel and ~25 acres of in-channel nesting habitat.
- Numbers of tern breeding pairs has increased nearly 7-fold (21 to 142) and plover breeding pair counts have increased 4-fold (10 to 40) within the AHR since 2001 while increases of similar magnitude have not been observed throughout the species' ranges. While overall numbers of tern and plover breeding pairs within the AHR have increased significantly, habitat availability and use of non-Program habitat has remained steady. We have observed a high, positive correlation between tern and plover breeding pair counts and habitat availability. Program data also indicate breeding pair counts increase at a similar rate as habitat availability. Though populations of both species increased during this timeframe, increases of similar magnitude have not been observed throughout the species' ranges. Metapopulation analyses are currently underway.
- Reproductive success, as measured by fledglings/breeding pair, have remained high and generally above the Lutey (2002) objective for maintaining stable to increasing populations within the AHR.

We estimate with confidence that:

- There is a high correlation between habitat availability and breeding pair counts and as the Program increases suitable off-channel nesting habitat, numbers of tern and plover breeding pairs within the AHR will increase until habitat availability exceeds population demands.

Answering BQ #6 during the First Increment

- Tern and plover data collected to date and published in the 2015 Breeding Pair publication[12] serves as the best source data for this question.
- The 2015 Tern and Plover Monitoring and Research Report[13] has also been reviewed and accepted by the Program and serves as additional evidence of the ongoing increasing trend in tern and plover use of the AHR.

Management Implications:

- Based on results of Program analyses, the Program should continue to increase off-channel habitat availability until numbers of terns and plovers within the AHR no longer continues to increase.

Big Question #7

Are both suitable in-channel and off-channel nesting habitats required to maintain central Platte River tern and plover populations?

2015 Assessment

- Long-term monitoring and data analyses indicate both in-channel and off-channel ***nesting*** habitats are not necessary to maintain the central Platte River population of terns and plovers. During the Program's First Increment the increase in tern and plover populations on the central Platte River is the result of use and productivity at off-channel nesting habitats.[10] River survey and observational data, however, indicate the river is a valuable source of ***forage*** for both species as forage availability appears to be lower on off-channel habitats.[14]

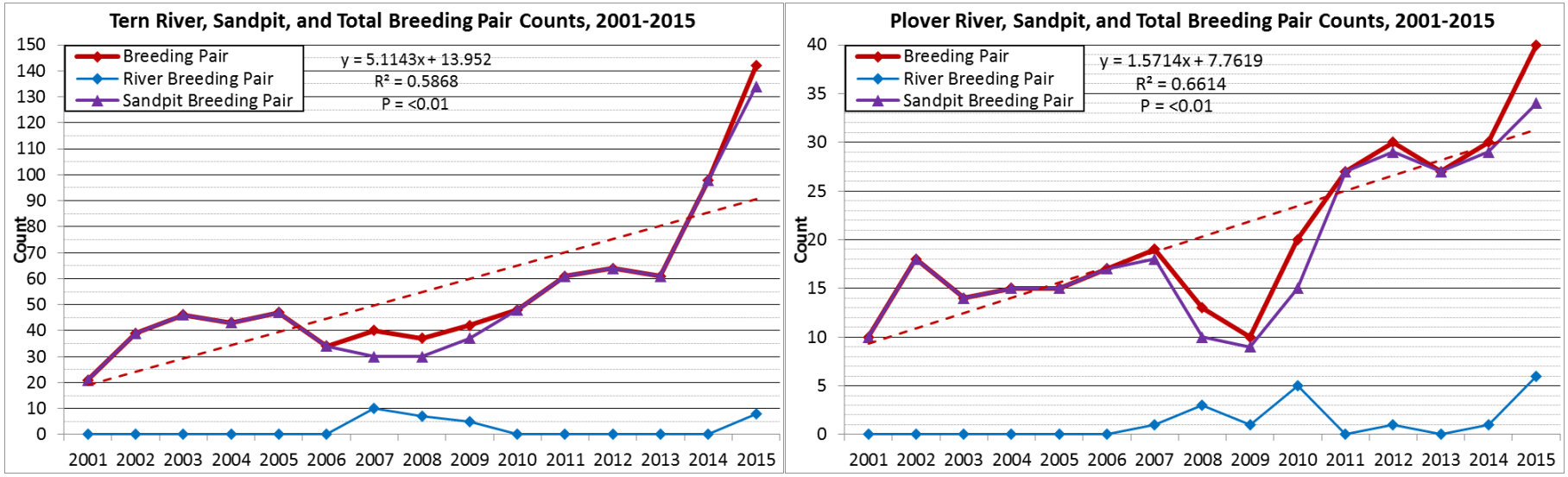


Figure 7. Annual tern (left plot) and plover (right plot) total, riverine, and sandpit breeding pair counts, 2001-2015. Trend lines (dashed lines) represent significant increases in tern and plover breeding pair counts during 2001-2015 with the most substantial increases occurring since inception of the Program. Breeding on sandpits is responsible for the increase.

What the science says in 2015:

- The Program and its partners created in-channel (sandbars) and off-channel (sandpits) nesting habitat to evaluate hypothesized relationships between in- and off-channel habitat availability and selection of terns and plovers. Early Program efforts largely focused on off-channel nesting sites as flows and permitting challenges precluded construction of in-channel nesting islands. Program efforts in recent years were directed at maintaining off-channel nesting habitat and constructing and maintaining suitable in-channel habitat.
- The creation and maintenance of off-channel nesting habitat resulted in substantial use and productivity since 2001. During this same timeframe, in-channel habitat availability and tern and plover nesting and productivity have been sporadic and thus has not contributed to the maintenance of the central Platte River populations. Despite the limited use and productivity of in-channel nesting habitat, we observed significant increases in the numbers of tern and plover breeding pairs within the AHR from 2001-2015.[11]
- Since 2001, breeding pair counts for terns increased nearly 7-fold (21 to 142) while plover counts increased 4-fold (10 to 40); both of which represent significant increases.[11] Though populations of both species increased during this timeframe, increases of similar magnitude have not been observed throughout the species' ranges.
- Efforts to create and maintain suitable in-channel nesting habitat have necessarily been opportunistic, but extensive. Though in-channel nesting habitat contributed little to the sustainability of both populations, ephemeral islands and river channels appear to provide an important source of forage for both terns and plovers. The abundant forage base provided by the river likely contributed to the high productivity observed on off-channel nesting sites since 2001.

We estimate with confidence that:

- Off-channel nesting habitat is necessary to maintain central Platte River tern and plover populations.
- Although an important forage source, direct maintenance of in-channel nesting habitat is not necessary to maintain tern and plover populations.

Answering BQ #7 during the First Increment

- Tern and plover monitoring data collected to date and the 2015 Breeding Pair publication[12] serve as the best source data for this question and indicate use of off-channel habitat resulted in increases in breeding pair counts and productivity within the AHR.
- The 2015 Tern and Plover Monitoring and Research Report[11] has also been reviewed and accepted by the Program and serves as additional evidence of the ongoing increasing trend in tern and plover use of the AHR attributable to use of and productivity on off-channel sites.

Management Implications:

- The Program should continue to increase and maintain off-channel nesting habitat for tern and plover production and population stability along the central Platte River.

Big Question #8

Does forage availability limit tern and plover productivity on the central Platte River?

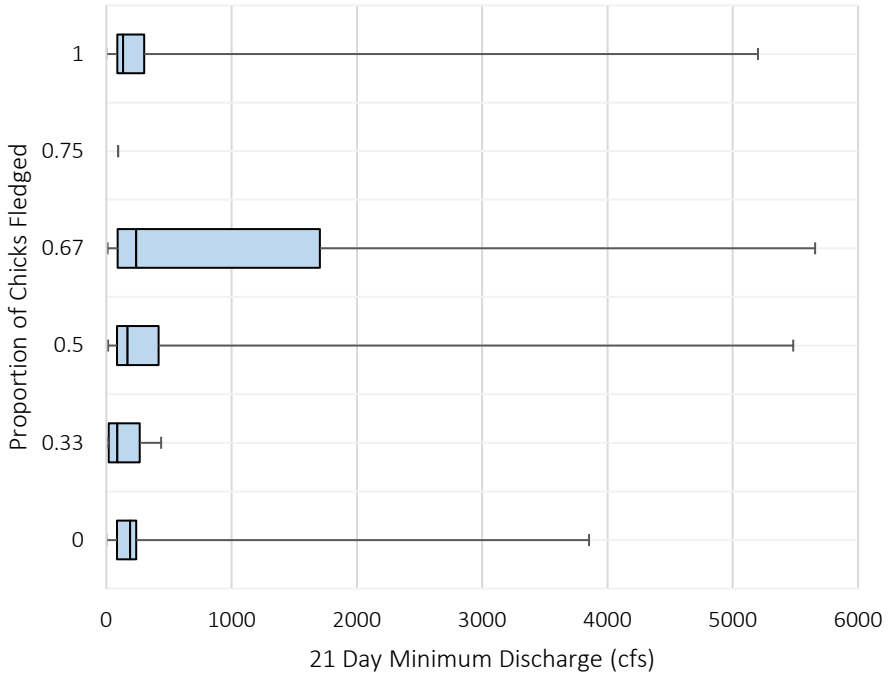


Figure 9. Proportion of fledglings for each brood ($\frac{number\ of\ chicks\ fledged}{number\ of\ chicks\ hatched}$) compared to 21-day minimum discharge. Due to wide variation of flows observed for different documented fledging successes, no model resulted in better predictions of fledging success than the null model, which indicates fledging success is independent of all flow variables tested.

2015 Assessment

- Analyses of flow versus productivity[15] indicate there is no relationship between flow, and thus forage fish abundance, and tern productivity as hypothesized and we suspect analyses of data linking forage availability and plover productivity would yield similar results. Given tern and plover productivity is high and a majority of confirmed mortalities have been attributed to adverse weather and predation, there is no evidence the forage base along the central Platte River limits tern and plover productivity. Further evaluations would involve capturing and weighing tern and plover chicks on multiple occasions to establish a more direct link between growth rates and forage abundance; however, Program stakeholders decided these additional expenses, efforts, and risk of injury to chicks are not warranted.

What the science says in 2015:

- Detailed analyses have been completed and the resulting manuscript is in publication. In the manuscript, we synthesize independent sets of data and found no relationship between tern productivity and flow during the nesting and brood rearing season.[15]
- Given the high levels of productivity observed on the central Platte River, it is unlikely flow, and thus forage fish abundance, limits tern productivity. We were unable to establish the hypothesized link between flow and productivity and plan to use results of our retrospective analyses to definitively answer this Big Question in 2016.
- Further evaluations of BQ #8 would likely entail system-wide, intensive, summer-long forage sampling, tern and plover behavioral studies, and potentially capturing and weighing chicks on multiple occasions to attempt to establish relationships between forage abundance, flow, productivity, and long-term survival. Program stakeholders previously indicated additional expenses, efforts, and risk of injury to chicks are not warranted as it appears forage abundance and reproductive success are adequately high to support central Platte River tern and plover populations.

We estimate with confidence that:

- Forage availability does not limit tern and plover productivity on the central Platte River.

Answering BQ #8 during the First Increment

- The forage fish manuscript[15] serves as the best source for synthesized reference data for this question. The results of these analyses indicate flow, and thus forage availability, does not limit tern and plover productivity within the AHR. Program staff will consider results of these analyses to be sufficient evidence to change the assessment for this Big Question to two thumbs down in 2016.
- A similar synthesis of data could be developed for plovers; however, given results of the Foraging Habits Study and high levels of productivity observed to date, there is a complete lack of evidence forage abundance limits plover productivity.

Management Implications:

- Data analysis and synthesis do not support Program summer flow releases to maintain the 800 cfs target.
- Based on these data, a revised summer flow target in the range of 200-600 cfs would likely be sufficient to meet the objective of an abundant and diverse forage base for terns.

Big Question #9

Do Program flow management actions in the central Platte River avoid adverse impacts to pallid sturgeon in the lower Platte River?

Credit: USFWS

2015 Assessment

- The GC approved the following motion in 2012: *The Governance Committee accepts the Technical Advisory Committee recommendation to accept the Lower Platte River Stage Change Study Peer Review and Lower Platte River Stage Change Study as final without revisions, with the understanding that the tool can be subsequently used to evaluate Program actions but is not a statement on Program policy implications for pallid sturgeon.*[16]
- Stage change study analyses concluded central Platte River flow management actions are likely to avoid adverse impacts to pallid sturgeon in the lower Platte River because the relative change in habitat due to Program water management activities would be small to undetectable.
- Any potential Impacts could be avoided through development of operational rules that prohibit Program diversions when lower Platte River discharges fall below 4,000 cfs.
- The EDO followed the established process to assess this Big Question as answered with two thumbs up in 2014. In 2016, the Service concluded they "do not support two thumbs up at this time for Big Question 9 because of lingering uncertainties."
- The premise of this Big Question has changed in practice.
- There is uncertainty about pallid sturgeon use of lower Platte, and there has been substantial new learning about pallid sturgeon and their use of lower Platte (evidence they are there all year, spawning ground, larval drift, etc.) since the stage change study was completed. At the time of stage change study, the primary issue was use of the lower Platte River by a small number of adult fish.
- In September 2016, the GC agreed to begin a step-wise, incremental process to refine goals, hypotheses and objectives, possibly re-state this Big Question, develop decision criteria, and possibly do additional pallid sturgeon research.
- Until that process is complete and uncertainties are resolved, this remains an open question for the Program and the EDO believes the Big Question is not helpful to current discussions.

What the science says in 2015:

- The general conclusion of the Program's Final Stage Change Study[16] is that Program water management activities will not result in measurable changes on flows in the lower Platte River and thus will result in little change to the amount of habitat available to pallid sturgeon.
- However, given that short-term connectivity could be problematic under certain, but infrequent, hydrological conditions, and assuming the biological significance of habitat connectivity for pallid sturgeon above 4,000 cfs, results of the stage change study could be used by the Program to implement proactive measures (e.g. altering excess-to-target-flow diversion timing or duration) to prevent potential negative impacts on habitat connectivity.

We estimate with confidence that:

- Flow diversions or releases by the Program would result in very small and undetectable changes in stage in the lower Platte River.
- As identified in the stage change study, these stage changes reside in the noise of gage error on the lower Platte River and thus will not result in a measurable change in lower Platte River stage.
- By extension, flow management actions that will not result in a measurable change in stage in the lower Platte River will not result in significant adverse effects on pallid sturgeon.

Answering BQ #9 during the First Increment:

- This question is not likely to be answered until the First Increment Extension. The Program will host an internal workshop in 2017 and an independent expert workshop in 2018 that will either help to resolve this question during the First Increment or guide activities that will keep the question open until sometime during the potential First Increment Extension.[17]

Management Implications:

- The primary Program water management actions that are hypothesized to result in flow and fish impacts in the lower Platte River are short-duration high flows (SDHF), target flow releases, and diverting target flow excesses.
- The Program is undergoing a process to develop flow management actions for the potential First Increment Extension.
- Central Platte River flow releases or diversions that could plausibly be detected in the lower Platte River during the remainder of the First Increment are not anticipated.

Priority Hypothesis	Results
PS2	▼

Relationship to Big Question #9
It is hypothesized that Program water management actions, such as diverting excesses to target flows for retimed release, will result in a measurable change in stage in the lower Platte River and thus affect pallid sturgeon habitat suitability.

Credit: USFWS

Big Question #10

Do Program management actions in the central Platte River cumulatively lead to detectable changes in the physical environment, habitat, and consequently population responses by least terns and piping plovers in the central Platter River, and use of this area by whooping cranes?

2015 Assessment

- The EDO is proposing modification to the language of this question to better link it to evaluation of several system-level Priority Hypotheses.
- The Program will work to evaluate this Big Question against multiple system Priority Hypotheses during the remainder of the First Increment.

What the science says in 2015:

- Thus far during the First Increment, this question has been addressed based on implmentation of Program management actions.
- Continued implementation of the Program's Land Plan, Water Plan, and Adaptive Management Plan continues to serve as the Reasonable and Prudent Alternative for the U.S. Fish and Wildlife Service's Final Biological Opinion on the Platte River and thus is helping to secure "defined benefits for the target species and their associated habitat to assist in their conservation and recovery".[18]
- The EDO proposes changing the language of this Big Question to provide clear and direct links to the system-level Priority Hypotheses (S1, S1a, S1b, and S1c).

We estimate with confidence that:

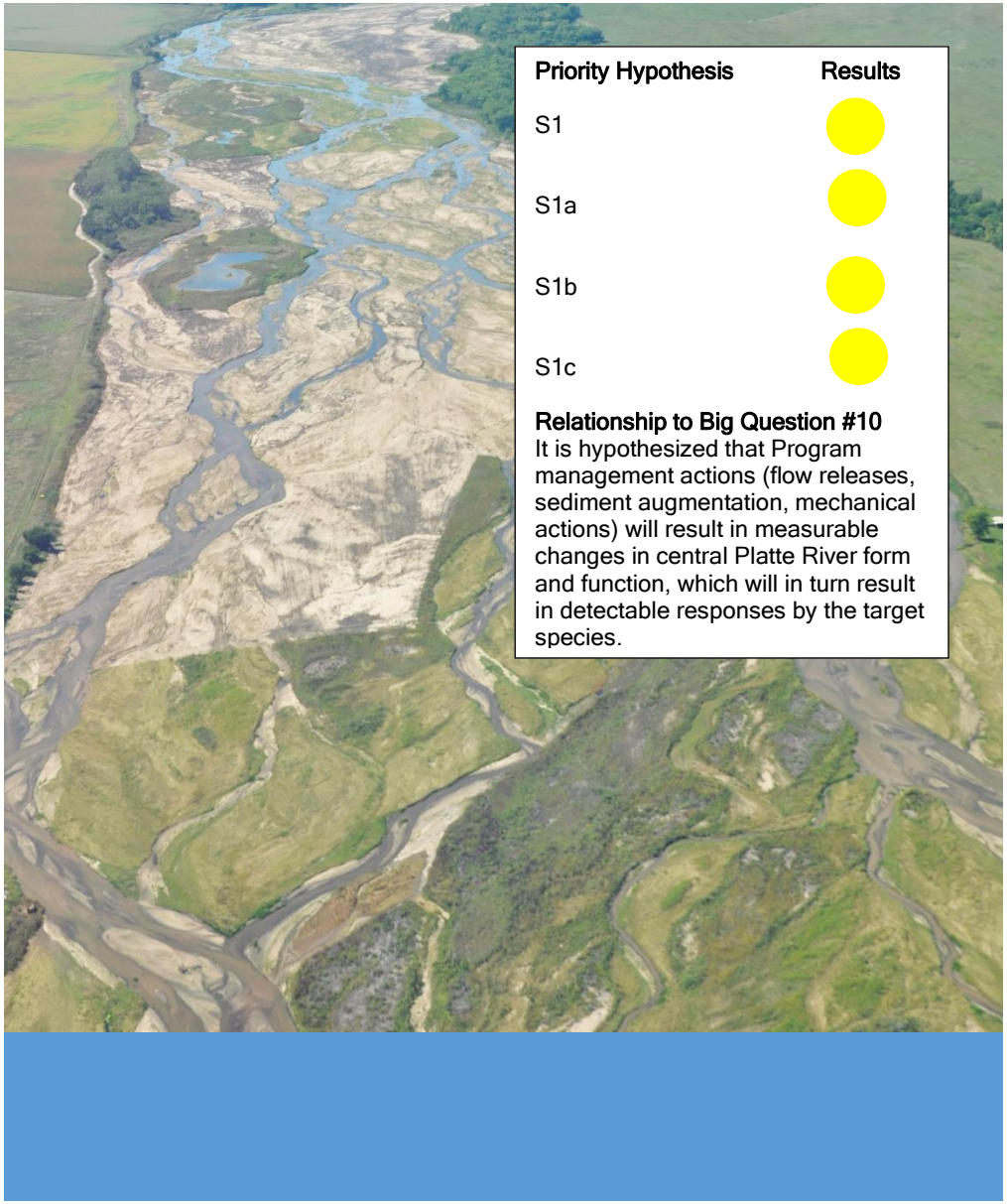
- The relationships underlying the system-level Priority Hypotheses can be analyzed based on current Program research and monitoring data.

Answering Big Question #10 during the First Increment:

- Evaluation of the underlying Priority Hypotheses related to this Big Question will continue during the remainder of the First Increment.
- The EDO believes trends related to these hypotheses can be reported by the end of the First Increment.
- However, the Program is currently negotiating a 13-year Extension of the First Increment due in part to the fact that water objective of reducing annual shortages to target flows by 130,000-150,000 acre-feet has not been met.
- A complete answer to this Big Question will most likely not be obtained until additional flow management actions are implemented and evaluated during the Extension.

Management implications:

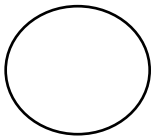
- Synthesis of multiple lines of evidence related to this Big Question and the underlying system-level hypotheses should provide guidance to the GC regarding Program land and water management toward the end of the First Increment and into the Extension.

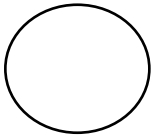


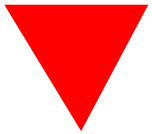
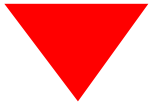
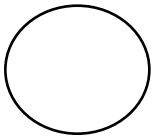
APPENDIX A

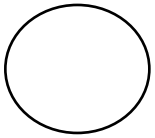
2015 State of the Platte Priority Hypotheses Status Table

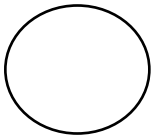
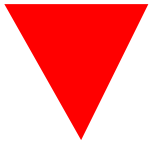
2015 State of the Platte Priority Hypotheses Status Table. Status of AMP priority hypotheses, as listed in Table 2 of the Adaptive Management Plan (Page 70). See color coding key at end of table.

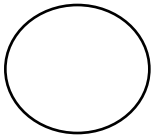
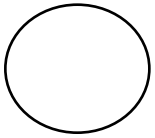
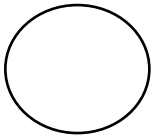
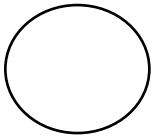
X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
System							
S1	The Platte River form can be modified by either mechanical/sediment/flow management (i.e., clear/level/pulse) or mechanical means along with non-Program managed flows (i.e., clear/level/mechanical).		#10	Geomorphology and vegetation monitoring, LiDAR and other aerial imagery, EDO analyses		Collecting the data necessary to answer all S1 hypotheses. To date, *State of the Platte* evaluations focused on BQ #1-#9. The S1 hypotheses and BQ #10 will be addressed in years 2017-2019.	OK with "Notes".
S1a	Program channel habitat restoration actions will result in detectable change to Platte River form and function.	Cannot detect a significant effect on indicators.	#10	Geomorphology and vegetation monitoring, LiDAR and other aerial imagery, EDO analyses		Same as S1.	The term "detectable" as in "measurable" is key, OK with "Notes" for now.
S1b	Program land management actions (i.e., restoration into habitat complexes) will have a detectable effect on target bird species use of the associated habitats.	Cannot detect a significant effect on indicators	#10	Geomorphology and vegetation monitoring, LiDAR and other aerial imagery, bird monitoring, EDO analyses		Same as S1.	There is a significant increase from sandpits on terns and plovers, the hypothesis may need to be broken down into more specific hypotheses.
S1c	Program actions will increase functional wet meadows in habitat complexes during the First Increment.		#10	N/A		Same as S1.	OK with "Notes".
S2	Implementing Program land and water management actions (i.e., habitat complexes and clear/level/pulse) will have a detectable effect on other species use of the associated habitats.	Within the overall management objectives for whooping cranes, terns and plovers, and pallids sturgeon, benefits can be provided to non-target listed species and non-listed species of concern thereby reducing the likelihood of future listing and improve overall ecosystem diversity.	N/A	N/A			

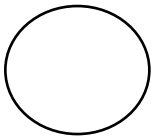
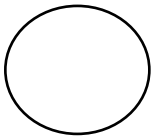
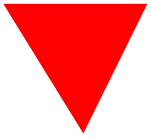
X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
Terns and Plovers							
T1	Additional bare sand habitat will increase the number of adult least terns.	Bare sand is not currently limiting number of adults.	#6	PRRIP tern/plover monitoring protocol, EDO analyses, tern/plover habitat synthesis chapters		*2015 State of the Platte* – monitoring and analyses indicate there is a strong positive correlation between Program-defined suitable ***nesting*** habitat and tern and plover breeding pair counts within the AHR.	It may not be necessary to update the X-Y graph but the conclusion should note the increase is due to off-channel sites. Or, at least that an end point for acres of habitat has been determined and the hypothesis is no longer relevant.
T2	Tern productivity is related to the number of prey fish (<3 inches) and fish numbers limit tern production below 800 cfs from May-Sept.	Prey fish do not limit tern production at 799 cfs or tern production is limited by summer flows of <50 cfs.	#8	Districts' forage fish monitoring protocol, USGS foraging habits study, EDO analyses		Pending publication of manuscript in 2016 will result in conclusive answer for this hypothesis.	OK with "Notes".
T2a	Flow rates influence the number and species diversity in tern prey base (fish).	Tern productivity not affected by fish community species diversity.	N/A	N/A			If the flow rate cannot be tied to productivity per the paper referenced in T2 then this hypothesis can be rejected or the alternative accepted.
P1	Additional bare sand habitat will increase the number of adult piping plovers.	Bare sand is not currently limiting number of adults.	#6	PRRIP tern/plover monitoring protocol, EDO analyses, tern/plover habitat synthesis chapters		*2015 State of the Platte* – monitoring and analyses indicate there is a strong positive correlation between Program-defined suitable ***nesting*** habitat and tern and plover breeding pair counts within the AHR.	See comment under T1.
P2	Plover productivity is related to the number of suitable macroinverts and macroinverts limit plover production below 800 cfs from May-Sept.	Macroinverts do not limit plover production at 799 cfs or plover production is limited by summer flows of <50 cfs.	#8	Districts' forage fish monitoring protocol, USGS foraging habits study, EDO analyses		Tern productivity/flow conclusions generally apply to plovers but need to complete separate analysis and manuscript in 2016-2017.	Since plovers continue to be almost exclusively on sandpits how would we tie flow to chick survival (i.e. production)? It should just be noted that plover do not nest on islands in sufficient numbers to matter.

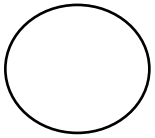
X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
TP 1	Interaction of river and sandpit habitat.	LT and PP show no preference for the river over sandpits.	#7	PRRIP tern/plover monitoring protocol, EDO analyses		*2015 State of the Platte* – monitoring and analyses indicate both in-channel and off-channel ***nesting*** habitats are not necessary to maintain the central Platte River population of terns and plovers. However, the river is a valuable source of ***forage*** for both species as forage availability is lower on off-channel habitats.	This was a hypothesis of if birds selected islands over sandpits. The conclusion needs to reflect the hypothesis answered birds do not and all management will be sandpits and a 10-acre moving complex.
TP 2	The central Platte River may act as a source or sink for terns and plovers.	Currently not a sink.	N/A	PRRIP tern/plover monitoring protocol, EDO analyses		Given population growth within the AHR and fledge ratios that exceed all numbers hypothesized to result in population growth, the hypothesis is almost certainly rejected.	The conclusion should be based on the fledge ratio only. Population growth could be due to immigration. Density dependent factors may increase with increased use, this hypothesis should be continually evaluated.
TP 4d	Correlation between river island habitat and flow.		N/A	Tern/plover habitat synthesis chapters		No need to test as sandbars are not suitably high for nesting.	The X-Y graph narrative should note that bars created by anything except the highest flows are inundated at 1,200 cfs or at least are not 1.5 feet above 1,200 cfs. It also raises the question of is 1.5 feet the right number.
TP 5	Use of riverine islands by least terns and piping plovers will increase with active channel width.	Use will not increase with channel width.	#1	Tern/plover habitat synthesis chapters		Hypothesis affirmed in tern/plover synthesis chapter 4.	The hypothesis is supported by data from other rivers in Chapter 4. However, if you are going to base that on data from the Niobrara you would need to examine the need to be 1.5 feet above some flow. NO islands are that high on the Niobrara. This hypothesis is moot given the SDM outcome.

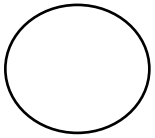
X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
Whooping Cranes							
WC 1	Whooping crane use will increase as function of Program land and water management activities.	Whooping crane use will not increase as function of Program land and water management activities.	N/A	WEST habitat selection report, whooping crane habitat synthesis chapters		Evidence points to accepting this hypothesis. Peer review of key documents is underway and this will change to a conclusive answer in the *2016 State of the Platte*.	OK with "Notes".
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 (preferred depth?) and channel width (define as wetted width, open width, other?).	WC use of areas is not directly linked to FWS habitat suitability values.	#5	WEST habitat selection report, whooping crane habitat synthesis chapters		Evidence points to rejecting this hypothesis. Peer review of key documents is underway and this will change to a conclusive answer in the *2016 State of the Platte*.	OK with "Notes". See Service comments related to this hypothesis on Page 8.
WC 4	Whooping crane use of the central Platte River study area will increase proportionally to an increase in wet meadows.	WC do not use wet meadows currently and are unlikely to respond to increases in wet meadow area.	N/A	N/A		Evidence points to rejecting this hypothesis. Peer review of key documents will likely result in a conclusive answer in a future *State of the Platte Report*.	Have there been any whooping crane sightings in restored wet meadows? Were birds on the Johns Tract ever seen out of water? Accept the alternative hypothesis. Service – Restored wet meadow use is certainly not on par with the two pristine wet meadows that have had a lot of repeat use (Mormon Island and Binfield). The Anderson tract, John's tract, and Speidel all have had use in "wet meadow-ish" conditions. They were all either forest or corn and are now grass/wetland. The jury is still out on this one and more time is needed to assess this.
WC 5	Whooping cranes are adversely affected by nocturnal disturbances that lead to flushing (walking or flying) which could lead to potential mortality.	WC are not negatively impacted by nocturnal disturbances.	N/A	N/A			

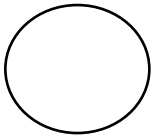
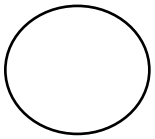
X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
Pallid Sturgeon							
PS-1	Program flow/sediment management will result in a positive species response by the pallid sturgeon in the lower Platte River.	Program flow/sediment management will result in no increase in species use/occurrence by the plaid sturgeon in the lower Platte River.	N/A	N/A			
PS-2	Program water management will result in measurable changes on flow in the lower Platte River.	Program water management will result in statistically insignificant changes on flow in the lower Platte River.	#9	Stage change study		*2012 State of the Platte* – Stage change study analyses concluded relative change in habitat due to Program water management activities would be small to undetectable and should not provide additional stress to the pallid sturgeon population. Impacts can be avoided through development of operational rules that prohibit Program diversions when lower Platte River discharges fall below 4,000 cfs.	The Service notes inconsistencies with study conclusions and peer reviewer conclusions regarding detection of Program water. Specifically, three peer reviewers answered "yes" in that Program flow can be detected (Guy, Helsel, and Weber). One of the five peer reviewers stated that Program activities cannot be detected (Wilson). One peer reviewer answered "no" because a better evaluation of gaging errors is needed (Gaeuman). The above referenced peer review comments add great uncertainty when it comes to concluding PS-2 with great confidence. The geographic scope of PS-2 is for the "lower Platte River" versus the associated habitat reach, and thus, the Service has concerns about the application of the stage change study for portions of the lower Platte River upstream of the Elkhorn River confluence. Given the above reasons, the Service suggests a yellow color for PS-2.

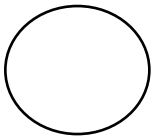
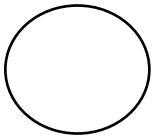
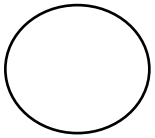
X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
PS-4	Flows in the lower Platte will affect pallid sturgeon habitat suitability.	Flows in the lower Platte River will have no effect on pallid sturgeon habitat suitability.	N/A	N/A			
PS-5	Pallid sturgeon habitat suitability is maximized between water temperatures of X and Y in the lower Platte River.	Pallid sturgeon use is independent of river water temperature.	N/A	N/A			
PS-6	Increasing flow in the lower Platte will affect pallid sturgeon habitat availability.	Increasing flow in the lower Platte River will have no effect on pallid sturgeon habitat availability.	N/A	N/A			
PS-7	Increasing habitat availability in the lower Platte will increase pallid sturgeon use.	Pallid sturgeon use is independent of lower Platte River habitat availability.	N/A	N/A			

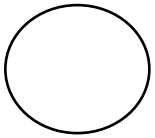
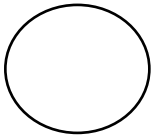
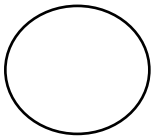
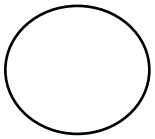
X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
PS-9	Increasing Program flow releases will decrease water temperatures in the lower Platte River.	River water temperature is independent of flow rate in the lower Platte River Increases in program flow releases will increase water temperatures on the lower Platte River.	N/A	N/A			
PS-11	Non-Program actions (e.g. harvest, stocking, Missouri River conditions) determine the occurrence of pallid sturgeon in the lower Platte River.	Program actions will affect the rate of occurrence of pallid sturgeon in the lower Platte River such that use is disproportionate to external factors (e.g., stocking, harvest, local conditions) relative to local population.	N/A	N/A			
Physical Processes – Flow							
Flow #1	Increasing the variation between river stage at peak (indexed by Q1.5 flow at Overton) and average flows (1,200 cfs index flow), by increasing the stage of the peak (1.5-yr) flow through Program flows, will increase the height of sand bars between Overton and Chapman by 30% to 50% from existing conditions.	Flow magnitudes and channel compilations are insufficient to generate bars high enough to provide habitat for LT and PP. Bars may quickly vegetate making them poor habitat for target species. Bars can be created/maintained by mechanical/other means.	#1	Geomorphology and vegetation monitoring, tern/plover monitoring, tern/plover habitat synthesis chapters		*2014 State of the Platte* – Full SDHF magnitude of 8,000 cfs is not sufficient to create sandbars exceeding the PRRIP's minimum height suitability criterion. Sandbars created by SDHF releases will be inundated during the nesting season in most years.	The hypothesis and alternate hypothesis are not quite the same. Agree with the note on accepting the alternative hypothesis but not sure we can reject the original hypothesis of increasing bar height by 30-50%.

X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
Flow #3	Increasing 1.5-yr Q with Program flows will increase local boundary shear stress and frequency of inundation at existing green line (elevation at which riparian vegetation can establish). These changes will increase riparian plant mortality along margins of channel, raising elevation of green line. Raised green line = more exposed sandbar area and wider unvegetated main channel.	Insufficient Program flows to adequately increase shear stress on banks. Plant mortality can be achieved by other means.	#2	Directed scour research, whooping crane habitat synthesis chapters		Evidence points to rejecting this hypothesis. Peer review and publication of key documents is underway and this will change to a conclusive answer in the *2016 State of the Platte*.	Should this change to red with Natasha's publication?
Flow #4	Annual riparian seedling mortality greater than 90% is required to prevent riparian encroachment on exposed bars, thereby increasing (maintaining at least 10 acres/mile) exposed bars between Overton and Grand Island that are usable as LT and PP habitat.	Riparian seedling mortality greater than 90% is needed to increase exposed bar area. Other factors drive exposed bar area instead of seedling mortality. Plant mortality can be achieved by other means.	N/A	N/A			Should this change to red with Natasha's publication?
Flow #5	Increasing magnitude and duration of a 1.5-yr flow will increase riparian plant mortality along the margins of the river. There will be different relations (graphs) for different species.	Insufficient Program flows to maintain required flow durations. Plant mortality can be achieved by other means.	#2	Directed scour research, whooping crane habitat synthesis chapters		Evidence points to rejecting this hypothesis. Peer review and publication of key documents is underway and this will change to a conclusive answer in the *2016 State of the Platte*.	Should this change to red with Natasha's publication?

X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
Physical Processes – Sediment							
Sediment #1	Average sediment augmentation at Overton of 185,000 tons/yr. under existing flow regime and 225,000 tons/yr. under Governance Committee proposed flow regime achieves a sediment balance to Kearney.	Augmentation greater than or less than 225,000 tons/year is needed to balance the sediment budget and increase exposed bar area. There is no sediment imbalance. Exposed bar area or occurrence of braiding will not be affected by increased sediment. Sediment balance is insignificant except in local instances. Satisfactory bar areas can be created and maintained through strictly mechanical actions.	#3	Sediment transport modeling, results of sediment augmentation Proof of Concept experimental implementation		Augmentation of sediment in the south channel is necessary to slow incision and narrowing and prevent degradation from progressing downstream past the Overton bridge. It will be challenging to measure the effectiveness of augmentation given that the desired beneficial effect is slowing and ultimately halting of a long-term trend.	Is the issue with measuring natural variability? Does the hypothesis need to change?
Sediment #2	A balanced sediment budget (sediment augmentation of 225,000 tons/year near Overton under proposed Governance Committee flows) when implemented with mechanical actions (channel consolidation & widening) in anastomosed reaches will promote braided channel morphology with an average braiding index in the main channel of greater than 3.	Flows and sediment augmentation are insufficient to achieve desired braiding index.	N/A	N/A			

X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
Sediment #3	Increasing the average braiding index of the main channel by achieving a balanced sediment budget, increases the active unvegetated width of the main channel at an index flow of 2,000 cfs (at Overton).	Width will not change with increasing braiding index.	N/A	N/A			
Sediment #4	Increasing the average braiding index to greater than 3 for the main channel in the sediment deficient reach near Overton will increase and maintain exposed bar area greater than 1.5 acres in the reach between Overton and Kearney at an index flow of 1,200 cfs (at Overton).	There is no relationship between braiding index and area of exposed bars. Exposed bars may be created (maintained) through mechanical means without need to change braiding index.	N/A	N/A			
Physical Processes – Mechanical							
Mechanical #2	Increasing the Q1.5 in the main channel by consolidating 85% of the flow, and aided by Program flow and a sediment balance, flows will exceed stream power thresholds that will convert main channel from meander morphology in anastomosed reaches, to braided morphology with an average braiding index > 3.	Higher stream power (higher 1.5 yr. Q and/or more consolidation of side channels) needed to convert channel to braided morphology. Lower stream power will convert channel to braided morphology.	#4	Directed scour research, whooping crane habitat synthesis chapters		Evidence points to affirming this hypothesis. Peer review and publication of key documents is underway and this will change to a conclusive answer in the *2016 State of the Platte*.	Where have we consolidated flow?

X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
Mechanical #3	Reducing the number of channels in a transect to 3 or less under balanced sediment budget will convert anastomosed reaches of the Platte River between Overton and Chapman to a braided channel morphology. With proposed flow regime, should occur with greater number of channels.	Reducing the number of channels in a transect to 1 or 2 is necessary to achieve an average braiding index in the main channel of greater than 3.	N/A	N/A			
Mechanical #4	Increasing the average braiding index to greater than 3 in the main channel by channel manipulation will promote in the Platte River at the mechanically changed sites a total main channel wetted width exceeding 500 to 750 ft at an index flow of 1,700 cfs (at Overton).	A braiding index greater than 4 is needed to achieve a width greater than 500 ft. There is no relation between braiding index and channel width.	N/A	N/A			
Mechanical #5	Increasing the average braiding index to greater than 3 for the main channel by mechanical channel manipulation, will increase and maintain exposed bar area greater than 1.5 acres at mechanical changed sites at an index flow of 1,200 cfs (at Overton).	Mechanically consolidating flows will have no effect on areal extent of bars.	N/A	N/A			

X-Y Graph Number	Description of hypothesis	Description of alternative/competing hypotheses	Link to PRRIP Big Questions	Data Source(s)	Hypothesis Test Results [i]	Notes	Comments from TAC/AMWG
Wet Meadows							
WM-2	Wet meadows producing the optimum productivity and diversity of macro-invertebrates potentially consumed by WC exhibit certain characteristic combinations of soils, hydrology, size and location. Mormon Island and adjacent to Rowe Sanctuary have some of best existing combinations	There are too many possible combinations of site characteristics to allow for a meaningful characterization of "desirable" conditions.	N/A	N/A			
WM-3	Shallow surface water and groundwater in March and April support high productivity and diversity of macroinvertebrates as potential food sources to WC in wet meadows.		N/A	N/A			
WM-4	A predominance of organic-rich soils supports the productivity and diversity of macro-invertebrates as potential WC food sources in bottomland grasslands.	Wet meadows and their soils are too complex and variable to allow this individual factor to be effectively assessed.	N/A	N/A			
WM-8a	As the spring depth to groundwater increases, surface soils stay frozen longer. Where groundwater is closer to the surface soils thaw sooner.		N/A	N/A			

[i] Hypothesis Test Results are indicated as one of the following categories:

 Hypothesis answered conclusively – affirmed.

 Hypothesis answered conclusively – rejected.

 Hypothesis not yet answered – ongoing implementation, analysis, and synthesis.

 Not currently being addressed through implementation of the AMP and related data analysis and synthesis.

ENDNOTES

[1] Program. 2016. Analysis of sandbar height distributions following First Increment peak flow events. Prepared for the Platte River Recovery Implementation Program.
[2] Program. 2015. Least tern and piping plover habitat synthesis chapters. Prepared for the Platte River Recovery Implementation Program.
[3] Pollen-Bankhead, R. Thomas, and A. Simon. 2012. Can short duration high flows be used to remove vegetation from bars in the central Platte River? Prepared for the Platte River Recovery Implementation Program.
[4] Tetra Tech Inc. 2015. 2014 Final Data Analysis Report Platte River Geomorphology and In-Channel Vegetation. Prepared for the Platte River Recovery Implication Program
[5] Program. 2016. Whooping Crane Data Synthesis Chapters. Prepared for the Platte River Recovery Implementation Program.
[6] Tetra Tech Inc. 2015. Model Results, Platte River Sediment-transport Modeling, South Channel at Jeffery Island. Prepared for the Platte River Recovery Implementation Program.
[7] Program. 2016. Proof-of-Concept Sediment Augmentation Implementation and Effectiveness Analyses Methods. Prepared for the Platte River Recovery Implementation Program.
[8] Pollen-Bankhead et al. 2012. Can Short Duration High Flows be used to Remove Vegetation from Bars in the Central Platte River. Prepared for the Platte River Recovery Implementation Program.
[9] See WEST Report titled Correlates of Whooping Crane Habitat Selection and Trends in Use in the Central Platte River 02-16-16.
[10] See the Whooping Crane Synthesis Chapters 2 and 3.
[11] See PRRIP 2015 Tern and Plover Monitoring Report.
[12] Baasch et al. 2015. A comparison of breeding population estimators using nest and brood monitoring data.
[13] PRRIP 2015 Tern and Plover Monitoring Report.
[14] Sherfy et al. 2012. Foraging Ecology of Least Terns and Piping Plovers Nesting on Central Platte River Sandpits and Sandbars.
[15] Baasch et al. 2017. Interior Least Tern Productivity in Relation to Flow in the Central Platte River.
[16] PRRIP Final Stage Change Study.
[17] See Pallid Sturgeon Process Memo.
[18] See Page 1 of the Final Program Document, Program Purposes.