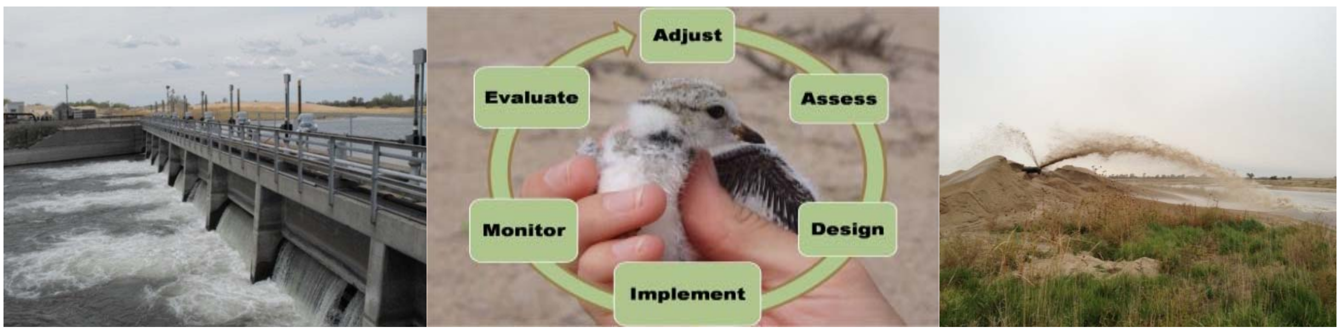
Adaptive Management on the Platte River



09/01/2015

Platte River Recovery Implementation Program
Adaptive Management Plan (AMP)

2014 State of the Platte Report

(updated primarily with 2013-2014 data)

PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

2

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PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2014 State of the Platte Report

The Platte River Recovery Implementation Program's ("Program" or "PRRIP") Executive Director's Office (EDO) developed this annual 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 2 below, followed by detailed assessment write-up for each Big Question. Each detailed assessment includes information noting any updates or changes from the 2013 version. This document contains a large number of endnotes as a way 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.

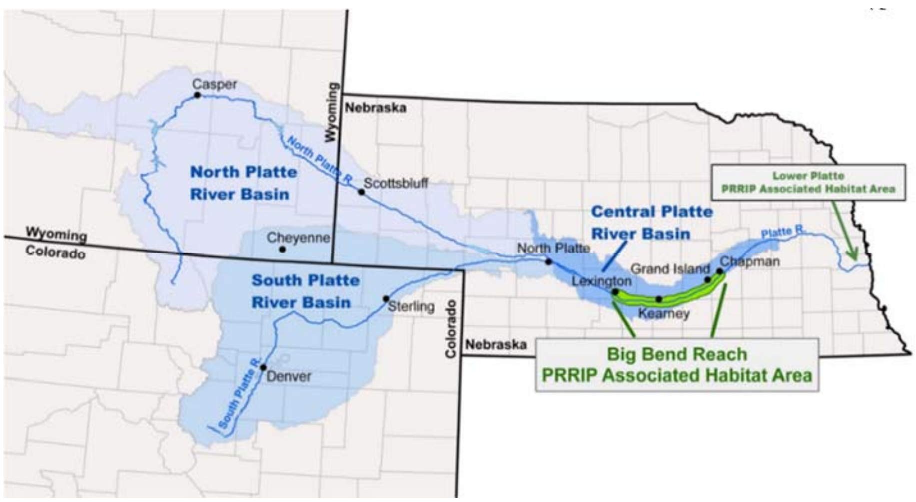

Figure 1. Map depicting Program area, including the Associated Habitat Reaches on the central and lower Platte River.

The 2014 State of the Platte Report includes assessments incorporating Program data from years 2007-2014. **The highlight of this year's report is a conclusive assessment for both Big Questions #1 and #9.** The EDO considers these questions answered conclusively based on peer-reviewed reports and data syntheses previously discussed with and accepted by the GC. In both instances, the conclusive assessment affords the GC an opportunity to consider alternative management choices that will lead the PRRIP through the "Adjust" phase of adaptive management and thus a full loop of the six-step adaptive management cycle. This is a significant accomplishment for the PRRIP given there is no other documented case of a large-scale adaptive management program in the United States proceeding through a full loop of the adaptive management cycle.

This report was discussed with and reviewed by the Program's Technical Advisory Committee (TAC) and the Program's Independent Scientific Advisory Committee (ISAC) several times during 2014 and 2015. As noted in **Appendix A**, the ISAC generally agreed with the 2014 Big Question assessments. Feedback from the TAC on the 2014 Big Question assessments is included in **Appendix B**. The map below details the Program's Associated Habitat Area in the central Platte River, highlighting Program habitat complexes in the western half of the 90-mile reach (top map) and the eastern half (bottom map). Program implementation, data collection, and analysis described in the 2014 assessments of the Big Questions largely center on management actions taken at Program habitat complexes.

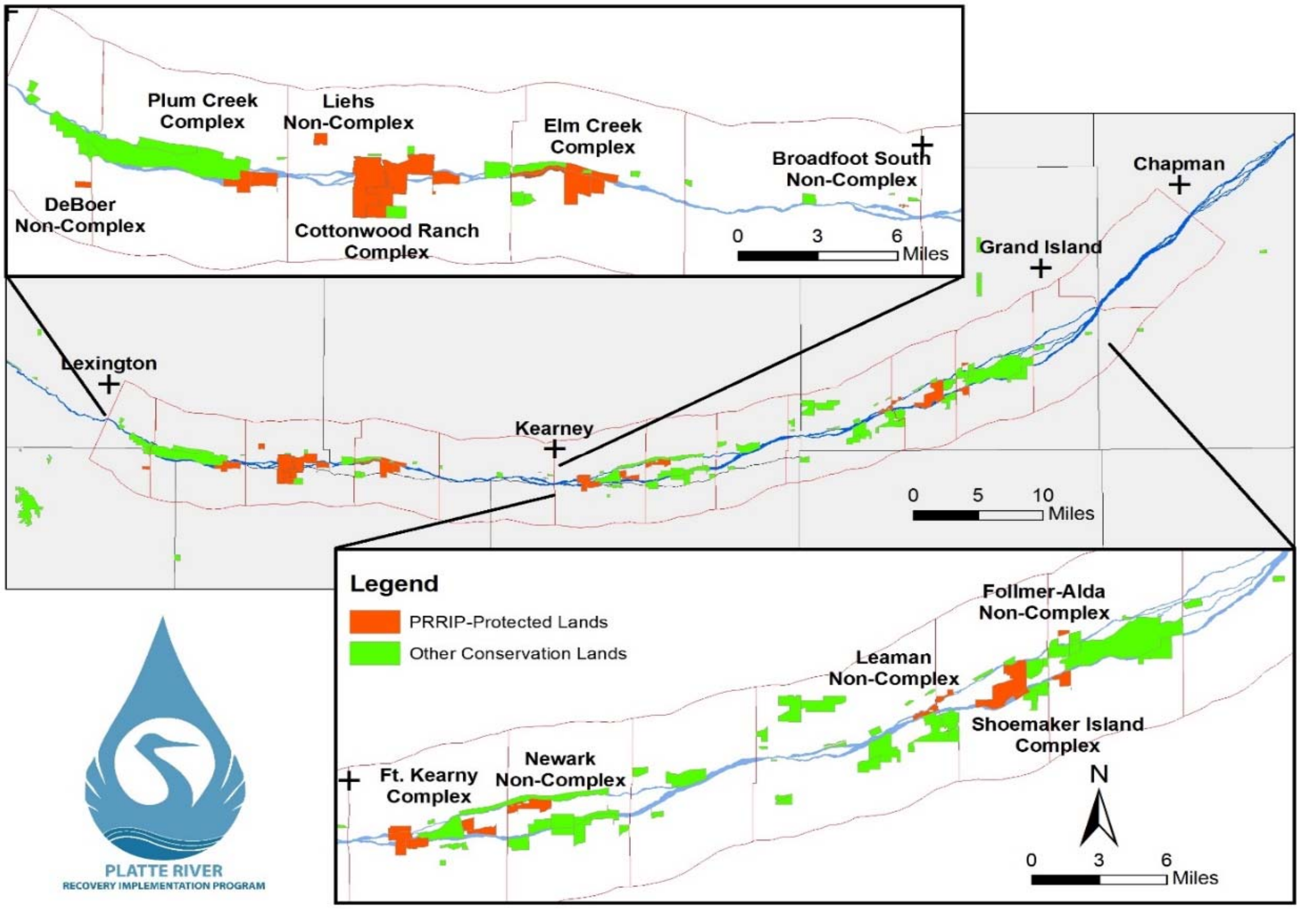

Figure 2. Program habitat complexes in the Associated Habitat Reach.

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Acronyms

Acronyms are provided for reference only and do not constitute official positions of the Platte River Recovery Implementation Program.

1. AM Adaptive management
2. AMP Adaptive Management Plan
3. AHR Associated Habitat Reach
4. CIR Color infrared
5. CPR Central Platte River
6. CNPPID Central Nebraska Public Power and Irrigation District
7. DEM Digital elevation model
8. DWU Downstream Water Users
9. EDO Executive Director's Office
10. FEIS Final Environmental Impact Statement
11. FSM Flow-Sediment-Mechanical
12. GC Governance Committee
13. ISAC Independent Scientific Advisory Committee
14. LAC Land Advisory Committee
15. LiDAR Light Detection and Ranging
16. LTPP Least tern (LT) and piping plover (PP)
17. MCM Mechanical Creation and Maintenance
18. NGPC Nebraska Game and Parks Commission
19. OCSW Off-channel sand and water
20. PRRIP Platte River Recovery Implementation Program (or "Program")
21. PS Pallid sturgeon
22. PVWMA Platte Valley Weed Management Association
23. SDHF Short-Duration High Flow
24. TAC Technical Advisory Committee
25. USACE United States Corps of Engineers
26. USFWS United States Fish and Wildlife Service
27. WAC Water Advisory Committee
28. WC Whooping crane

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Quick Reference Guide

To assist the GC with quickly evaluating the 2014 Big Question assessments, the icons below 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.

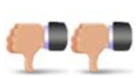
Icon	Trend or Answer Explained by Icon
	• Big Question and underlying hypotheses **answered conclusively** in the **affirmative** • Foundational documents, analysis, and other references on which this assessment is based have undergone peer review through the PRRIP peer review process and/or publication 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

Table 1. Quick reference table explaining icons used to assess PRRIP Big Questions.

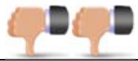
PRRIP Big Question	2014 Assessment	Basis for assessment
<u>Implementation</u> – Program Management Actions and Habitat		
1. Will implementation of SDHF produce suitable tern and plover riverine nesting habitat on an annual or near-annual basis?		Peer-reviewed Program synthesis concludes that SDHF will not produce suitable nesting sandbars.
2. Will implementation of SDHF produce and/or maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis?		Trending negative; Program synthesis chapters now in development will be discussed with the TAC and ISAC and peer reviewed in 2015; those synthesis chapters and published manuscripts related to the Program's vegetation and lateral erosion research will likely support a "two thumbs down" assessment in the 2015 State of the Platte Report.
3. Is sediment augmentation necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?		Trending positive; certainty about the sediment deficit; uncertainty about the role of that deficit in habitat creation and maintenance.
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; planform management manuscript now in development will be published and will likely support a "two thumbs up" assessment in the 2015 State of the Platte Report.
<u>Effectiveness</u> – Habitat and Target Species Response		
5. Do whooping cranes select suitable riverine roosting habitat in proportions equal to its availability?		A definitive assessment is expected by 2017 once peer review of data analyses (monitoring, telemetry, stopover study data, habitat availability assessments, IGERT research) is complete.
6. Does availability of suitable nesting habitat limit tern and plover use and reproductive success on the central Platte River?		Trending positive; three documents now in development will be peer reviewed and/or published and will likely support a "two thumbs up" assessment in the 2015 State of the Platte Report.
7. Are both suitable in-channel and off-channel nesting habitats required to maintain central Platte River tern and plover populations?		Trending negative; three documents now in development will be peer reviewed and/or published and will likely support a "two thumbs down" assessment in the 2015 State of the Platte Report.
8. Does forage availability limit tern and plover productivity on the central Platte River?		Trending negative; synthesis document related to tern forage (fish) will be peer reviewed that, in combination with the results of the Foraging Habits Study, will likely support a "two thumbs down" assessment in the 2015 State of the Platte Report.
9. Do Program flow management actions in the central Platte River avoid adverse impacts to pallid sturgeon in the lower Platte River?		Peer-reviewed Program stage change study concludes Program flow management actions will avoid adverse impacts.
<u>Larger Scale Issues</u> – Application of Learning		
10. Do Program management actions in the central Platte River contribute to least tern, piping plover, and whooping crane recovery?		By definition, implementation of the Program contributes to recovery of the target species. A definitive answer for this question can only be obtained by a broader analysis of the contribution of the central Platte to range-wide recovery.
11. What uncertainties exist at the end of the First Increment, and how might the Program address those uncertainties?		This question is a "parking lot" for uncertainties that could be addressed through adaptive management in an extended First Increment or new Second Increment.

Table 2. 2014 Big Questions table.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2014 State of the Platte Report
Big Question Assessments

1. Will implementation of SDHF produce suitable tern and plover riverine nesting habitat on an annual or near-annual basis?

How does this Big Question relate to Program priority hypotheses?

Based upon the SedVeg model and associated assumptions in the FSM management strategy, it is hypothesized that under a balanced sediment budget, flows of 5,000 to 8,000 cfs magnitude for three days (SDHF) will build sandbars to an elevation that is suitable for tern and plover nesting. The Program's minimum height suitability criterion is 1.5 ft above the 1,200 cfs stage and represents the minimum height thought necessary for nest initiation.[1]

2014 Assessment for BQ #1:

- 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 that exceed the PRRIP's minimum height suitability criterion.
- Sandbars created by SDHF releases will be inundated during the nesting season in most years.
- Regardless of peak flow magnitude or duration, AHR sandbars will generally be much smaller than those used by the species in other regional river segments. This due to significant differences in bed material grain size and the mode of sediment transport. These differences are likely intractable.

What the science says:

The programmatic Environmental Impact Statement (EIS) analyses of the potential benefits of SDHF assumed that sandbars build to the water surface during peak flow events in areas of sediment balance. Consequently, the modeled increase in Q1.5 stage of 30% to 50% from existing conditions was used as an indicator that SDHF releases would increase maximum sandbar heights by 30% to 50% in reaches with a balanced sediment budget. The EIS stressed the fact that the Q1.5 stage was used solely as an index of sandbar height and was not linked directly to actual sandbars or nests sites. Accordingly, the EIS called for the development of a monitoring program to evaluate the ability of flows to build sandbars to a suitable height.

The Program has monitored sandbar heights following three peak flow events (2010, 2011 & 2013) that exceeded SDHF magnitude and duration. Mean sandbar height following the 2010 event was 1.5 ft below peak flow stage. Sandbar heights following the 2011 event were lower than the 2010 event and the 2013 event was not of sufficient magnitude/duration to mobilize and rework bedforms in most of the reach. Sandbars formed during the 2010, 2011 and 2013 events did not exceed the Program's minimum sandbar height suitability criterion.

A total of one plover nest was initiated on a sandbar that was disked during fall of 2010 and was overtopped by the 2011 high-flow event (2012 nesting season). Similarly, two tern nests were initiated on a sandbar that was disked during the fall of 2013 and was subsequently overtopped by the 2013 high-flow event (2014 nesting season). None of these nests were on habitat that conformed to the Program's minimum suitability criteria.

The proposed species recovery objective for piping plover the Associated Habitat Reach (AHR) is 79 adults or 0.9 adults per river mile. The proposed objective for least tern is 189 adults or 2.1 adults/mi. A regional analysis of species occurrence indicates that the only river system in this area that supports adult densities approximating proposed AHR recovery objectives is the Niobrara. Peak flow magnitudes on the Niobrara River are similar to the AHR. The mean annual peak discharge on the Niobrara is 5,655 cfs and the mean peak in the AHR is 6,095 cfs. However, the large sandbars used by the species in the Niobrara (mean = 27.9 ac) are absent from the AHR. This is likely due to differences in sediment transport associated with the much coarser (0.96 mm) bed material grain size in the AHR than the Niobrara (0.24 mm).

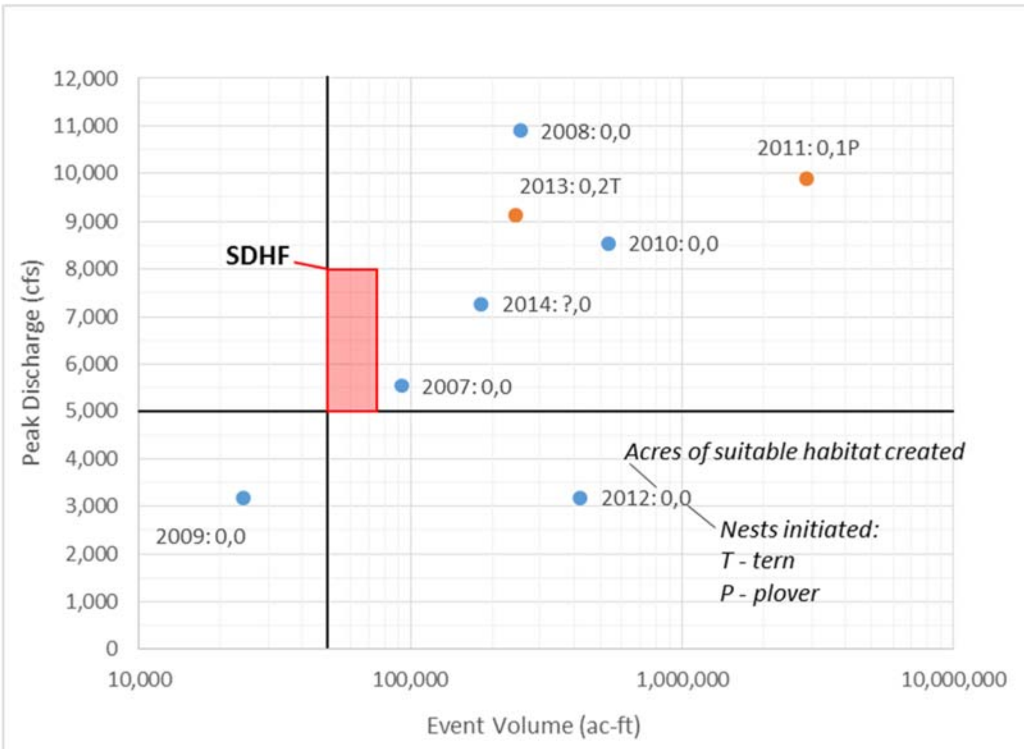


Figure 1. First Increment peak flow event magnitudes and volumes in relation to SDHF. Acres of suitable habitat created and species response (nest incidence) are provided for each event.

We estimate with confidence that:

Given observed AHR sandbar heights and stage-discharge relationships, sandbars created by a full SDHF magnitude of 8,000 cfs would be 0.5 – 1.0 ft lower than the Program's minimum height criterion of 1.5 ft above 1,200 cfs stage and would be inundated at flows experienced in the AHR during most nesting seasons. Flow magnitudes of 11,000 – 15,000 cfs would likely be necessary to produce sandbars meeting the minimum height suitability criterion.

Even at discharge magnitudes approaching 15,000 cfs, suitably-high sandbars would likely be small in size and total suitable sandbar area would be well below the AMP objective of 10 acres per river mile given that the largest sandbars observed in the AHR have been on the order of 1 acre in size. In contrast, the mean area of sandbars with nest records in the Niobrara is on the order of 30 ac. The lack of large sandbars in the AHR is likely related to bed material grain size (0.24 mm in Niobrara vs. 0.96 mm in AHR) and the associated mode of sediment transport. Given that sediments finer than 0.2mm comprise only 10% of AHR sub-surface alluvium by weight, the supply of fine sediment in the AHR is not sufficient to shift grain size down into the range observed in the Niobrara.

What do we still need to know?

The duration/volume of recent natural high flow events have exceeded SDHF. For example, the total volume of the fall 2013 event was on the order of 250,000 acre-ft, approximately five times greater than the full SDHF volume of 50,000 to 75,000 acre-ft. Observations in many stretches of the river indicate the 2013 event did not mobilize the channel bed. Consequently, it is not known if, or under what conditions, SDHF volume of 50,000 to 75,000 acre-ft would be sufficient to mobilize the channel bed and create sandbars. Addressing this uncertainty would likely strengthen the existing assessment.

The hypotheses associated with Big Question #1 include the concept of sediment balance or a balanced sediment budget. It is difficult to identify the portion of the AHR that is in sediment balance in any given year. In general, the weight of evidence suggests that approximately the downstream half of the AHR is in sediment balance over the long term. Accordingly, sandbar height analyses have been confined that that portion of the AHR. Addressing this uncertainty would likely have little effect on the existing assessment given that no evidence for a relationship between sediment balance and sandbar height could be found in the existing body of geomorphic literature.

The sensitivity of sandbar height and area to bed material grain size is also not well understood. The existing body of geomorphic literature indicates that sandbar height potential generally increases with increasing sediment grain size but this relationship has not been validated for the AHR. Addressing this uncertainty would likely have little effect on the existing assessment given that the Program does not have the ability to substantively shift bed material grain size in the AHR.

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 and have been used to develop the 2014 assessment. Accordingly, Program staff consider Big Question #1 to be answered with a definitive "two thumbs down" and recommend that the Governance Committee move into the final "Adjust" stage of adaptive management.

In what ways might the Program adjust?

Given that SDHF is not sufficient to create suitable tern and plover habitat, Program decision makers may elect to adapt in several ways. The EDO offers the following suggestions for consideration and to spark discussion but they have not been vetted through the Program's Advisory Committee review process:

1) The Program could develop and evaluate alternative peak flow management actions to create and maintain in-channel tern and plover habitat. Analyses to date indicate that flow magnitudes would likely need to be on the order of 11,000 – 15,000 cfs to create sandbars meeting the minimum height criterion. There are currently substantial technical and institutional barriers to implementation of peak flow releases of this magnitude. The potential for successful species outcomes is also somewhat limited given that sandbars at the minimum height criterion are still vulnerable to flooding and would have been inundated at least once during the nesting season in four of the last eight years.

2) The Program could elect to abandon peak flow releases in favor of mechanically creating and maintaining in-channel tern and plover nesting habitat. The Program currently maintains constructed in-channel habitat at three habitat complexes. The potential for successful species outcomes is currently not known as use and productivity on constructed in-channel habitat have been limited to date.

3) Third, the Program could elect to abandon on-channel habitat in favor of creating and maintaining off-channel nesting habitat. The Program currently maintains off-channel nesting habitat at five locations. There is a high potential for successful species outcomes given that productivity at off-channel sites currently exceeds proposed species recovery objectives for the AHR.

NOTE: All species recovery objectives referenced in this assessment were proposed by the U.S. Fish and Wildlife Service and have not been agreed to or adopted by the Platte River Recovery Implementation Program.

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?

How does this Big Question relate to Program priority hypotheses?

Based upon the SedVeg model and associated assumptions in the FSM management strategy, it is hypothesized that under a balanced sediment budget flows of 5,000 to 8,000 cfs magnitude for three days on an annual or near annual basis (SDHF) will increase the average width of the vegetation-free channel to a width that is suitable for whooping crane roosting. Various unvegetated width metrics have been proposed including a minimum suitability criterion of 280 ft and width targets of 750 and 1,150 ft. Most recently, an analysis of whooping crane use data indicates that the probability of use is maximized when unobstructed channel widths are on the order of 600 ft.

2014 Assessment for BQ #2:

- Phragmites has been a "surprise" that was not contemplated when SDHF was hypothesized to be competent to increase the width of the vegetation-free channel.
- SDHF flow depths and velocities are not capable of eroding mature phragmites plants or plant patches. Therefore, SDHF will not increase or maintain the width of the vegetation-free channel in absence of active phragmites control efforts.
- In absence of phragmites, flow releases during the germination season would likely be the most effective in maintaining unvegetated channel width.

What the science says:

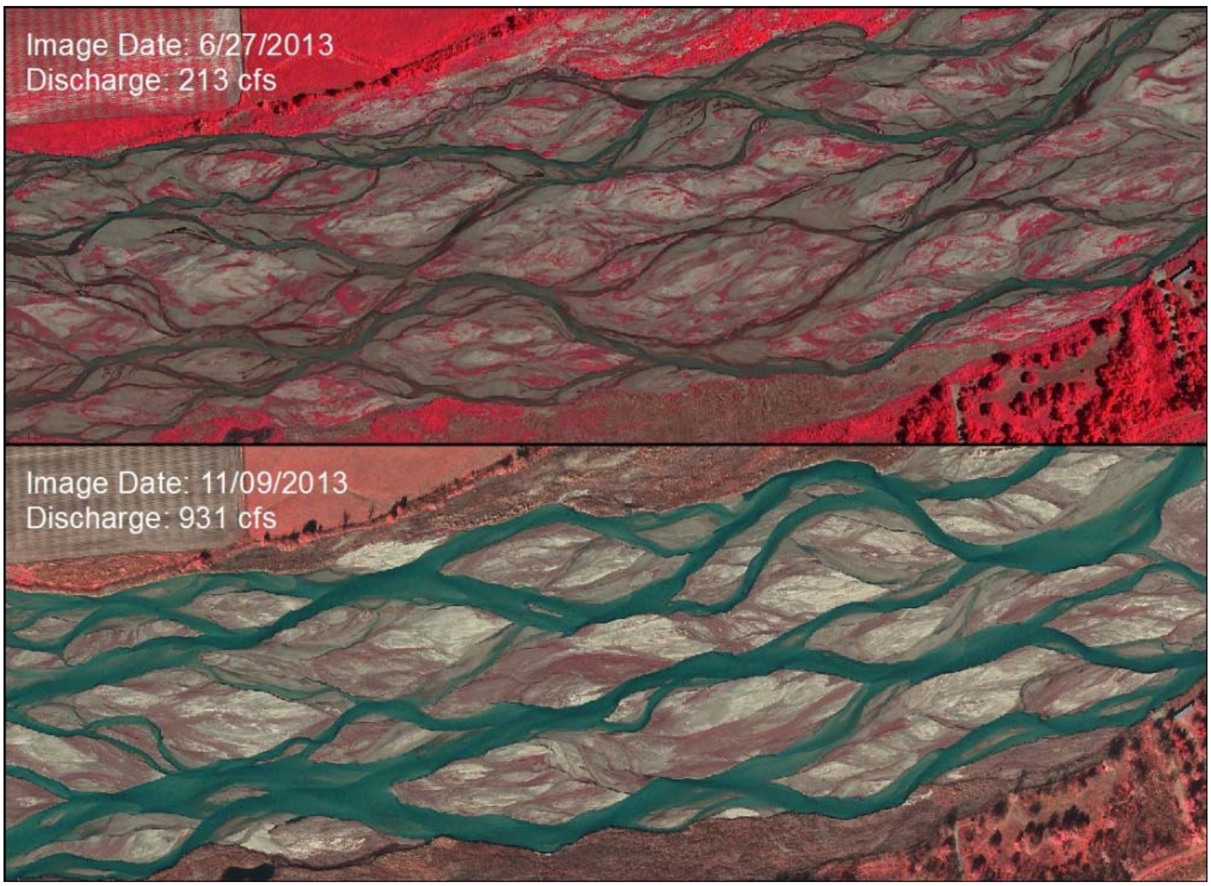
The original analysis of SDHF performance based on the Bureau of Reclamation SedVeg model included four vegetation species: cottonwood, willow, spike rush, and cord grass. In the SedVeg model, all plants below the maximum water surface elevation were removed by a peak flow when mean flow velocity exceeded a pre-defined maximum scour velocity. The maximum scour velocities for 1-year old plants were 2.5 ft/sec for cottonwoods, 2.1 ft/sec for willows, 1.8 ft/sec for spike rush, and 1.5 ft/sec for cord grass.

The Program conducted directed general vegetation scour research to evaluate the appropriateness of the scour velocity for cottonwoods and develop scour velocities for the exotic strain of phragmites that was primarily responsible for channel narrowing during the drought of 2001-2007. That research indicated that velocities on the order of 6 ft/sec were necessary to achieve a 50% probability of scouring 1-year old cottonwood seedlings. Phragmites, which is extremely scour resistant, has a very low probability of scour (<5%) across the range of flow velocities that occur in the AHR. Subsequent lateral erosion research indicated that little erosion, be it hydraulic or geotechnical, can occur once rhizomes have grown throughout the depth of a bar or bank. The study concluded that phragmites could only be removed through mechanical intervention.

A large-scale Phragmites control program was initiated by the Platte Valley Weed Management Area (PVWMA) in 2008. That effort consisted of aerial and land-based herbicide application and limited above-ground biomass removal. System-scale vegetation monitoring documented a decline in Phragmites occurrence in the AHR from 12% of plots in 2009 to less than 4% of plots in 2012. Phragmites occurrence increased slightly in 2013 to approximately 5% of plots. At a plot scale, the reduction was positively correlated with herbicide application. It was not correlated with inundation depth or inundation duration during high flow events.

Overall, mean total channel width in the AHR did not change significantly during the period of 2009-2013. Mean unvegetated channel width increased significantly from 410 ft in 2009 to 630 ft in 2011 and declined back to only 310 ft in 2013. Monitoring indicates that both green line elevation (GLE) and unvegetated channel width are responsive to the magnitude of preceding flows, with the strongest correlation between GLE and mean discharge during the germination season.

In October of 2013, after system-scale monitoring, a historic precipitation event in the South Platte basin resulted in peak flow event with a magnitude exceeding 9,000 cfs and total runoff volume of approximately 250,000 acre-ft. River discharge was low during the growing season in 2012 and 2013 and much of the channel bed was occupied by annual species and cottonwood seedlings that germinated in 2012. In vegetated areas, the fall 2013 event did not appear to effectively scour vegetation and rework the bed. Instead, unvegetated portions of the bed incised and sediment was deposited on vegetated bedforms (see figure).



Comparison of channel bedforms at River Mile 205 prior to and immediately after the October 2013 high flow event. Note the persistence of vegetation (red color) and bedforms following the high flow event.

We estimate with confidence that:

Phragmites persists at somewhat lowered occurrence throughout the AHR. In absence of ongoing active phragmites control efforts, Phragmites will recolonize channel banks and sandbars, especially during periods of drought when discharges are low and asexual propagation via stolons is unhindered by actively-flowing water. The vegetation scour research and lack of a correlation between reductions in Phragmites and flow depth or inundation duration during peak flow events in 2010 and 2011 are strong indicators that SDHF will not remove Phragmites once it expands into previously unvegetated channel areas. Instead, peak flow releases would potentially exacerbate channel incision and vertical accretion of vegetated bar forms.

Phragmites control efforts are expected to cost on the order of $500,000 annually in the reach extending from approximately Chapman upstream to North Platte.

In the absence of baseline assumptions about the frequency and efficacy of future Phragmites control efforts, it is difficult to assess the potential for SDHF to maintain suitably-wide unvegetated channel widths. However, the lack of vegetation scour and bed mobility during the October 2013 event is an indication that SDHF may not be of sufficient magnitude and duration to scour vegetation that has persisted for at least one full growing season. We are currently unable to assess the potential effectiveness of annual flow releases during the germination season although, similar to findings of Johnson (1994), system-scale monitoring results suggest that channel inundation that prevents new vegetation from colonizing the channel is the key factor in maintaining unvegetated channel width.

What do we still need to know?

Baseline assumptions about the frequency and efficacy of future Phragmites control efforts are currently lacking. Funds for the initial large-scale control efforts have largely been expended and efforts to secure funding for ongoing control have not been successful to date. If the larger ongoing efforts cease, the Program will continue to control Phragmites on Program lands but will not be able to address loss of habitat and flow conveyance in the 80% of the AHR not controlled by the Program.

The duration and volume of natural high flow events during the First Increment of the Program have greatly exceeded SDHF. Given that lack of bed mobilization in the fall of 2013, it is not known if SDHF duration is sufficient to mobilize existing bedforms, even if they are only lightly vegetated. This brings into question the ability to manage unvegetated channel width through SDHF during drought periods when annual peak flow releases would not be possible due to water supply constraints.

The use of flow during the germination season to prevent plant establishment and/or cause inundation mortality have not been well explored to date. Johnson (1994) recommended a discharge target of 2,600 – 3,000 cfs during the month of June to prevent seedling germination. It is unknown if sufficient water supply would be available to sustain germination season discharges over the long term. The median daily discharge in June during dry hydrologic years is approximately 400 cfs. Accordingly, annual augmentation volumes on the order of 150,000 acre-ft could be necessary during drought periods to maintain channel width.

Answering BQ #2 during the First Increment:

The Program's directed scour research, now in manuscript development, will serve as the best source for synthesized reference data for this question. Once those studies are published, Program staff expect Big Question #2 to be answered with a definitive "two thumbs down" in 2015. The Governance Committee will then be presented with information suggesting that this Big Question be revised to reflect the ongoing necessity of some level of mechanical/herbicide control of Phragmites and possibly other scour-resistant vegetation.

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

How does this Big Question relate to Program priority hypotheses?

Based on the SedVeg model and associated assumptions in the FSM management strategy, it is hypothesized that eliminating the existing sediment deficit through sediment augmentation is necessary to reduce channel narrowing and incision, contribute to channel widening, and increase the sustainability of a braided channel morphology.

2014 Assessment for BQ #3:

- Monitoring strongly indicates the reach upstream of Kearney is degradational with an average annual sand deficit on the order of 100,000 tons. However, there appears to be a high degree of variability within the reach including short segments, like the Cottonwood Ranch reach, that are aggradational.
- Sand augmentation is necessary in degradational areas to reduce channel narrowing and incision and increase the sustainability of braided channel morphology.
- Sand augmentation at one or two locations at the upstream end of the degradational reach will not bring the entire reach into balance given the high variability in channel characteristics and sediment transport capacity.
- Sand augmentation in absence of mechanical vegetation removal may not contribute to channel widening and could increase the rate at which vegetated bar forms accrete into islands.

What the science says:

System-scale geomorphology and sediment transport monitoring strongly indicate that portions of the AHR upstream of Kearney are degradational with a model-estimated average annual sand deficit on the order of 100,000 tons. The portion of the reach downstream of Kearney is most likely stable to slightly aggradational but this conclusion is only weakly supported by the available data. However, annual sand transport, which is driven by flow magnitude and duration, is highly variable. Accordingly, the AHR may be aggradational during dry periods and degradational during wet periods. System-scale monitoring indicates that the AHR, overall, was degradational during the period of 2009-2011 and aggradational during the period of 2011-2013. Sediment transport modeling also indicates that the majority of degradation occurs during very high discharge years.

The Program augmented approximately 180,000 tons of sand in 2012-2013 to evaluate augmentation means and methods. Sand was augmented through mechanical island leveling and channel widening at the Cottonwood Ranch Complex and via overbank sand mining and pumping at the Plum Creek Complex. Sand pump augmentation cost was approximately $6.50 per ton. Approximately half of the sand pumping cost was associated with sorting of the mined material prior to placement and redistribution of the pumped material within the channel due to a lack of mobilization by river flow. Overall, sand pumping was much less time and cost efficient than mechanical augmentation which cost $1.76 a ton. However, sand pump augmentation does disturb a much smaller area and significantly increase augmentation material supply because alluvium can be mined to a depth of approximately 60 ft.

Sediment transport modeling and monitoring associated with the augmentation project also indicated several challenges that need to be assessed prior to implementation of full-scale augmentation operations. First, sediment transport capacity in the south channel downstream of the J-2 return is not sufficient to augment enough material to overcome the entire sediment deficit. Accordingly, multiple augmentation locations would be necessary. Second, mechanically-widened reaches like the Cottonwood Ranch Complex have a lower sediment transport capacity resulting in a tendency toward aggradation. As a consequence, sediment augmented upstream becomes “trapped” in managed reaches which can cause downstream reaches to become more strongly degradational. Third, sediment transport capacity and the associated sand deficit vary widely between years and augmentation of the average deficit volume may not have the desired effect. During dry periods, augmentation volume would significantly exceed sediment transport capacity and sediment could not be augmented in sufficient quantities to offset the deficit during high flow years.

Example of mechanical augmentation (left) and sand pumping augmentation (right). Mechanical augmentation provides the ability to distribute sediment evenly across the channel. Point-source sand

pumping produces limited capacity to entrain augmented material.

We estimate with confidence that:

Observed planform adjustments like narrowing and incision in the south channel downstream of the J-2 Return are strong indicators that it will be difficult to sustain a wide, braided channel morphology in degradational reaches over time in absence of augmentation. However, augmentation of the average sand deficit at one or two locations near the upstream end of the AHR will likely not have the intended beneficial effect of bringing the entire AHR into sediment balance. This due to the high degree of temporal variability sediment transport and associated deficit and the spatial variability in sediment transport capacity within the AHR.

The AMP hypothesizes that the channel will respond to augmentation by widening. Program vegetation scour research indicates that the presence of scour-resistant vegetation like Phragmites severely limits the potential for the channel to adjust laterally in response to augmentation. Instead, sediment would likely be deposited on vegetated islands, accelerating the rate at which they accrete to permanent islands.

What do we still need to know?

Annual sediment deficits in the AHR may range from 0 tons in drought years to 400,000 tons in high-discharge years. Accordingly, annual augmentation of the mean deficit of 100,000 would commonly result in a mismatch between augmentation supply and sediment transport capacity. The effects of oversupply of sediment in dry years on channel capacity are not known. It is also not known if it is feasible to attempt to offset the entire deficit during high flow years.

The spatial variability in sediment transport capacity through the AHR will negatively affect the Program’s ability to produce reach-wide benefits through augmentation at one or two locations at the upstream end of the reach. In addition, the speed and magnitude of channel response to augmentation is still unknown. Additional work is needed to identify the number, location, and magnitude of augmentation operations and to develop a better understanding of the likely magnitude of channel response.

Answering BQ #3 during the First Increment:

This topic will be a major discussion point at the summer 2015 Independent Science Advisory Committee meeting. Depending on the outcome of that meeting, the Program will begin preparation of a full-scale sediment augmentation design. Augmentation operations and response monitoring could begin in 2016.

4. Are mechanical channel alterations necessary for the creation and/or maintenance of suitable riverine tern, plover and whooping crane habitat?

How does this Big Question relate to Program priority hypotheses?

Based on the SedVeg model and associated assumptions in the FSM management strategy, it is hypothesized that designed mechanical channel alterations like mechanical clearing and leveling of islands, channel widening, vegetation clearing from banks are needed to accelerate the creation of, and/or to maintain suitable riverine habitat.

2014 Assessment for BQ #4:

- Peak flows in the AHR are not competent 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.
- Flow and sediment management actions will likely not increase total and/or unvegetated channel width in portions of the AHR that are not mechanically treated prior to flow releases.

What the science says:

The AHR has historically episodically narrowed during drought events as a result of woody riparian vegetation encroachment into the formally active channel. However, the channel has historically not substantially re-widened in response to increased discharge and stream power following episodes of narrowing during drought periods (see graphic). This has been attributed to the vegetation “ratchet” effect. Woody vegetation, primarily cottonwoods, have historically been the controlling factor in the AHR ratchet.

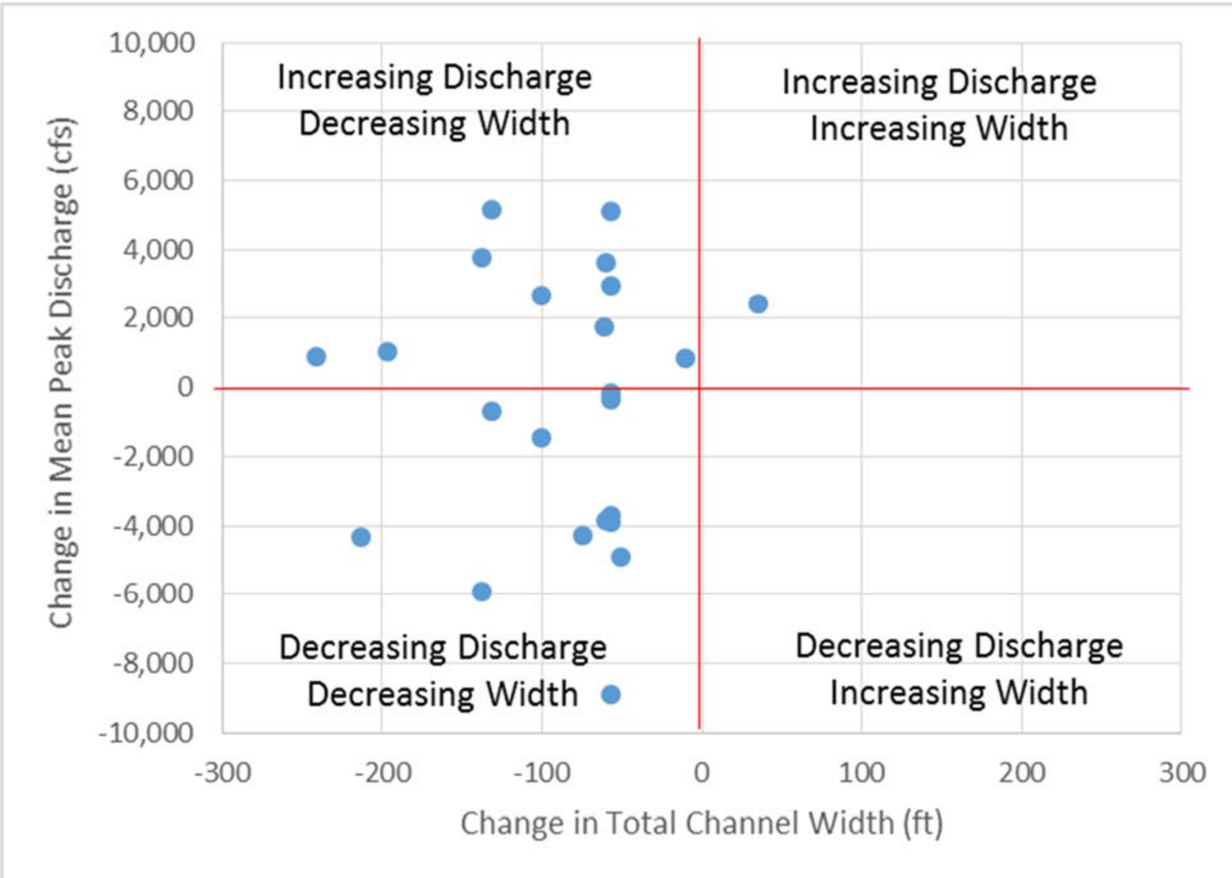
Program vegetation scour research indicates that cottonwood seedlings are vulnerable to general and lateral scour during the year of seed germination but the potential for scouring decreases dramatically in the year following seed germination. Once cottonwoods are established for several years, they are very erosion-resident. Phragmites is even more erosion-resistant with SDHF flow depths and velocities only sufficient to scour the very weakest individual plants.

We estimate with confidence that:

The persistence of scour-resistant vegetation and the lack of re-widening following previous narrowing events are strong indicators that mechanical clearing and leveling will be necessary to create unvegetated channels of suitable width. The PRRIP controls approximately 20% of the main channel length of the AHR. Conservation organizations control another 20%. PRRIP flow and sediment management will likely have little beneficial effect in increasing total and/or unvegetated channel width in the 60% to 80% of the AHR that currently cannot be mechanically managed.

What do we still need to know?

Baseline assumptions about the frequency and efficacy of future Phragmites control efforts are currently lacking. Funds for the initial large-scale control efforts have largely been expended and efforts to secure funding for ongoing control have not been successful to date. If the larger ongoing efforts cease, the Program will continue to control Phragmites on Program lands but will not be able to address loss of habitat and flow conveyance in the 80% of the AHR not controlled by the Program.



Relationship between change in 5-year mean peak discharge magnitude and total channel width in the Shelton to Wood River bridge segment 1940-2010 in five year intervals.

The frequency of mechanical intervention that will be necessary to maintain unvegetated channel widths under various hydrologic conditions and/or flow management actions has not been evaluated. The Program disked the majority of in-channel area at Program habitat complexes in 2013 and 2014. Other areas that have historically been mechanically managed were not disked during that period. Comparative analyses of unvegetated width in these areas may be useful in assessing the importance of mechanical disturbance in maintaining unvegetated width.

Answering BQ #4 during the First Increment:
The Program is developing a manuscript focusing on planform management that will serve as the best source for synthesized reference data for this question. Once this manuscript is peer reviewed, Program staff expect Big Question #4 to be answered with a definitive "two thumbs up" in 2016.

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

How does this Big Question relate to Program priority hypotheses?

It is hypothesized that when whooping crane roosting habitat availability increases, the proportion of the whooping crane population using the central Platte River and the length of those stays will increase (i.e., roosting habitat is limiting). The Program established minimum habitat criteria to assess habitat availability and continues to monitor use of the central Platte River to evaluate the relationship between whooping crane use and Program defined habitat availability.[2]

2014 Assessment for BQ #5:

- We observed a record number of whooping cranes within the AHR during the spring 2014 migration season.
- Long-term monitoring and data analyses indicate whooping crane use of the AHR has increased during the spring and been constant or decreased slightly during the fall migration season.

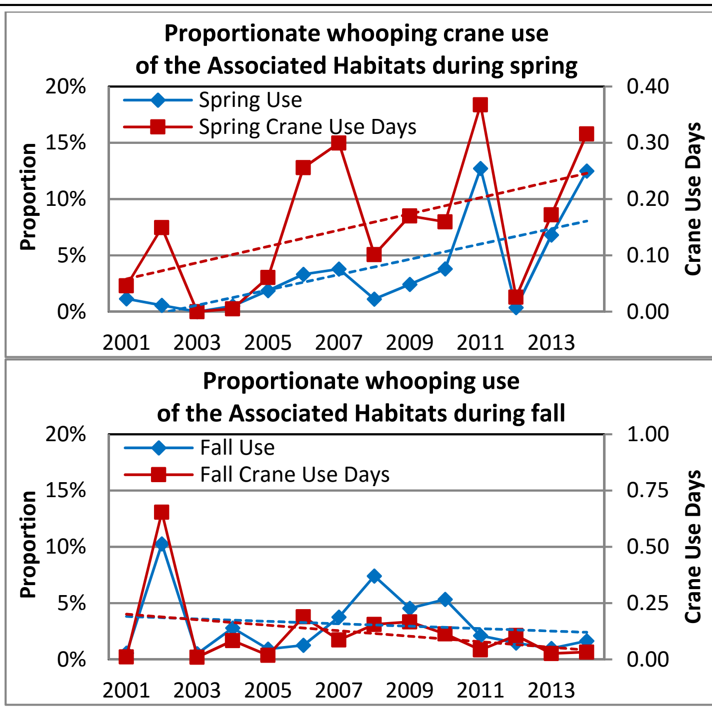


Figure 1. Program whooping crane monitoring data indicate the proportion of the whooping crane population that utilized the Associated Habitats (blue) and crane use days (red) within the Associated Habitats/bird in the population may be increasing during spring (top) and decreasing during fall (bottom), but the trends are not significant (p<0.05). Both figures account for changes in the whooping crane population size, 2001-2014. Whooping cranes not detected by the Program's systematic monitoring efforts are not included.

What the science says:

- In spring 2014, a record number of individuals (41) including four radio-marked whooping cranes were documented using the Platte River, both of which represent 12.5% of the population.[1]

- Though variable, the proportion of the whooping crane population documented within the AHR during the spring migration has increased over the past 14 years.

- Fall use of the Platte River has been constant to declining over the past 14 years.[2]

Program whooping crane monitoring data collected to date indicate the proportion of the whooping crane population observed using the central Platte River and number of crane use days (weighted by population size) on an annual basis appear to be increasing during the spring and decreasing during the fall; though neither trend is significant. However, use is still being evaluated against habitat availability.

[1] PRRIP Spring 2014 Whooping Crane Monitoring Report.
[2] PRRIP Fall 2014 Whooping Crane Monitoring Report.

We estimate with confidence that:

Program habitat management efforts have been implemented to increase whooping cranes use of the Program Associated Habitat Area. The Program continues to acquire and manage land and water resources along the central Platte River for the benefit of whooping cranes. Such management actions have included tree removal, bank line and channel disking and widening, flow releases, sediment augmentation and wet meadow creation and maintenance. The Program continues to assess in- and off-channel habitat availability. Recent assessment are pending so results are not shown.

What do we still need to know?

- If current levels of roosting and foraging habitat limit whooping crane use of the Associated Habitats.
- If whooping cranes select or avoid wet meadow habitat, palustrine wetlands, specific channel characteristics, habitat complexes as described in Table 1 of the Program's Land Plan, or flow.
- If and what Program management activities influence whooping crane use of the Program Associated Habitat Area.
- If the Program can collect enough of the right data to evaluate all Program priority hypotheses with statistical certainty.
- The Program's contributions for an IGERT student's (Trevor Hefley) analysis of the long-term database that has been maintained by the Fish and Wildlife Service Grand Island Field Office is now complete. Results of that assessment indicate the Associated Habitat Area is the most highly selected area by whooping cranes within Nebraska. Additional analyses at the scale of the habitat complexes will be conducted to predict whooping crane response to management actions.

The Program has collected 14 years of data through the implementation of a systematic monitoring protocol for the central Platte River. Detailed whooping crane habitat selection analyses are underway and are expected to be completed in early 2015. Additional data collection efforts are ongoing. We are now nearing the end of the whooping crane telemetry partnership. In depth analyses of the telemetry study data are forthcoming and results of those assessments should be available in 2016 and 2017. The telemetry study will provide a great deal of information regarding in-channel and off-channel selection of habitat. The Program is also entering the final year of the whooping crane stopover study. Detailed results of this project will also provide valuable information for assessing whooping habitat selection within the Program Associated Habitat Area as well as within other sandbed river systems that are similar to the Platte River.

Answering BQ #5 during the First Increment:

- Addressing remaining uncertainties will change BQ assessment.
- Habitat selection analyses will be complete in 2015-2017 and should provide evidence to change the assessment of this Big Question.
- Peer review or publication of data analyses (monitoring, telemetry, and stopover study data) and habitat availability assessments should provide information for a definitive assessment by 2017.
- The Governance Committee will be presented information suggesting decision-making should progress to the final "Adjust" stage of the adaptive management cycle be reached.

Once completed, results of all of these analyses will be used directly or in a weight of evidence approach to evaluate the appropriateness of the Program's minimum habitat criteria and to evaluate hypothesized relationships between whooping crane use and suitable roosting habitat articulated in the Program's Big Question and associated hypotheses.

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

How does this Big Question relate to Program priority hypotheses?

It is hypothesized that when in-channel (sandbars) and off-channel (sandpits) nesting habitat availability increase, tern and plover use and productivity will increase (i.e., habitat is limiting). The Program established minimum habitat criteria to assess habitat availability and continues to monitor tern and plover use of the Program Associated Habitat Area to evaluate the relationship between breeding pair counts and Program defined habitat availability.[3]

2014 Assessment for BQ #6:

- 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.
- Nearly all successful nesting prior to and during the Program's First Increment occurred on off-channel sandpits making for a thin comparison with on-channel island nesting.

What the science says:

- Off-channel nesting habitat availability has increased.
- Tern and plover breeding pair counts have increased at a similar rate as habitat availability.
- The 2007-2014 increase in numbers of tern and plover breeding pairs is significant.
- In-channel nesting habitat availability and tern and plover use and productivity decreased from 2007-2010 and in-channel habitat availability increased in 2013 and 2014.

Constructed on-channel habitat availability has been variable and somewhat limited during the First Increment of the Program (Table 1). Approximately 24 acres of constructed habitat were present in the AHR in 2007 as the result of efforts by other conservation organizations. That habitat was subsequently lost over the course of several years due to erosion during natural high flow events. The Program began large-scale on-channel habitat construction efforts at the Elm Creek complex in the fall of 2012 and was also able to create on-channel habitat at the Cottonwood Ranch and Plum Creek complexes as part of sediment augmentation activities. Much of that habitat was lost during a natural high flow event in the fall of 2013 (Table 1). On-channel island construction began at the Shoemaker Island complex following the fall 2013 event. A high flow event in June of 2014 eroded a portion of the habitat constructed in the fall of 2013 but the Program was able to construct a total of 28 acres of on-channel habitat during the fall of 2014 at the Elm Creek and Shoemaker Island complexes. It is not known how much of that habitat will remain at the start of the 2015 nesting season. On-channel habitat construction by other conservation organizations has been very limited since the first year of the First Increment.

Approximately 48 acres of managed off-channel nesting habitat were present in the AHR at the beginning of the First Increment (Table 1). The Program began acquiring and restoring off-channel sites in 2009. Total off-channel habitat in the AHR increased to 128 acres during the period of 2009-2014 as the Program constructed and/or restored 80 acres of habitat. The Program will likely acquire one additional off-channel site prior to the end of the First Increment and one existing off-channel site (Follmer Alda) has not yet been modified to create suitable habitat. Construction at that site will be completed prior to the 2015 nesting season, increasing the total off-channel sand nesting habitat area to approximately 138 acres.

Table 1. Constructed on- and off-channel habitat in the Associated Habitat Reach by year, 2007-2014.

Year	On-Channel Habitat			Off-Channel Habitat		
	PRRIP	Others	**Total**	PRRIP	Others	**Total**
2007	0	24	**24**	0	48	**48**
2008	0	21	**21**	0	48	**48**
2009	0	15	**15**	0	48	**48**
2010	0	5	**5**	32	48	**80**
2011	0	5	**5**	60	48	**108**
2012	0	0	**0**	72	48	**120**
2013	55	0	**55**	72	48	**120**
2014	19	0	**19**	80	48	**128**
Mean	**9.3**	**8.8**	**18.0**	**39.5**	**48.0**	**87.5**

The total number of breeding pairs has increased for both species during the First Increment of the Program (Table 2). In 2014, a total of 98 breeding pairs of terns and 30 breeding pairs of plovers were observed in the AHR. Most of the nesting in the AHR during the First Increment of the Program has occurred on managed off-channel habitats (Tables 3 and 4). The limited amount of on-channel nesting observed at the beginning of the First Increment declined as on-channel habitat was lost during high flow events (Tables 1 and 3). The species have generally not responded to subsequent Program habitat construction efforts in 2013 and 2014 (Table 3). Off-channel habitat accounts for most of the nesting in the AHR and the number of breeding pairs has generally increased over the course of the First Increment as the Program has constructed additional off-channel habitats (Tables 1 and 4). Overall, the Program has observed a species response to off-channel habitat construction but not to on-channel habitat construction.

Table 2. Least tern and piping plover nesting incidence by year, 2007-2014.

Year	Least Tern					Piping Plover				
	Br. Pair	Nests	Succ. Nests	Fledglings	Fledglings Per Pair	Br. Pairs	Nests	Succ. Nests	Fledglings	Fledglings Per Pair
2007	42	53	22	40	0.95	21	27	15	25	1.19
2008	39	64	27	44	1.13	14	21	8	10	0.71
2009	43	60	36	46	1.07	12	15	9	12	1.00
2010	51	80	44	64	1.25	22	33	22	46	2.09
2011	62	90	53	89	1.44	28	34	27	45	1.61
2012	66	88	63	84	1.27	30	46	32	59	1.97
2013	63	95	51	64	1.02	27	31	23	28	1.04
2014	98	145	54	91	0.93	30	43	25	59	1.97
Mean	**58.**	**84.4**	**43.8**	**65.3**	**1.13**	**23.0**	**31.3**	**20.1**	**35.5**	**1.40**

Table 3. Least tern and piping plover on-channel nesting incidence and productivity by year, 2007-2014.

Year	Least Tern				Piping Plover			
	Breeding Pairs	Nests	Successful Nests	Fledglings	Breeding Pairs	Nests	Successful Nests	Fledglings
2007	11	13	2	2	1	4	2	7
2008	10	20	7	9	3	5	1	3
2009	3	8	5	4	2	2	1	1
2010	0	0	0	0	4	11	4	10
2011	0	0	0	0	0	0	0	0
2012	0	0	0	0	1	1	1	4
2013	0	0	0	0	0	0	0	0
2014	0	2	0	0	1	2	1	4
Mean	**3.0**	**5.4**	**1.8**	**1.9**	**1.5**	**3.1**	**1.3**	**3.6**

Table 4. Least tern and piping plover off-channel nesting incidence and productivity by year, 2007-2014.

Year	Least Tern					Piping Plover				
	Br. Pairs	Nests	Succ. Nests	Fledglings	Fledglings Per Pair	Br. Pairs	Nests	Succ. Nests	Fledglings	Fledglings Per Pair
2007	31	40	20	38	1.23	20	23	13	18	0.90
2008	29	44	20	35	1.21	11	16	7	7	0.64
2009	40	52	31	42	1.05	10	13	8	11	1.10
2010	51	80	44	64	1.25	18	22	18	36	2.00
2011	62	90	53	89	1.44	28	34	27	45	1.61
2012	66	88	63	84	1.27	29	45	31	55	1.90
2013	63	95	51	64	1.02	27	31	23	28	1.04
2014	98	143	54	91	0.93	29	41	24	55	1.90
Mean	**55.0**	**79.0**	**42.0**	**63.4**	**1.17**	**21.5**	**28.1**	**18.9**	**31.9**	**1.38**

We estimate with confidence that:

- There is a strong, positive correlation between tern and plover breeding pair counts and habitat availability.
- Increases in off-channel habitat resulted in an increase in breeding pairs within the Associated Habitat Reach.
- Increases in breeding pairs are the result of high use and productivity within the Program Associated Habitat Area.
- Habitat availability was limiting plover, and possibly tern, use and productivity within the Associated Habitat Area.

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. As availability of Program defined suitable habitat increases, tern and plover use (Table 2; Figure 1) and productivity increase. Nearly all successful nesting during the First Increment occurred on off-channel sandpits making for a thin comparison with on-channel island nesting.

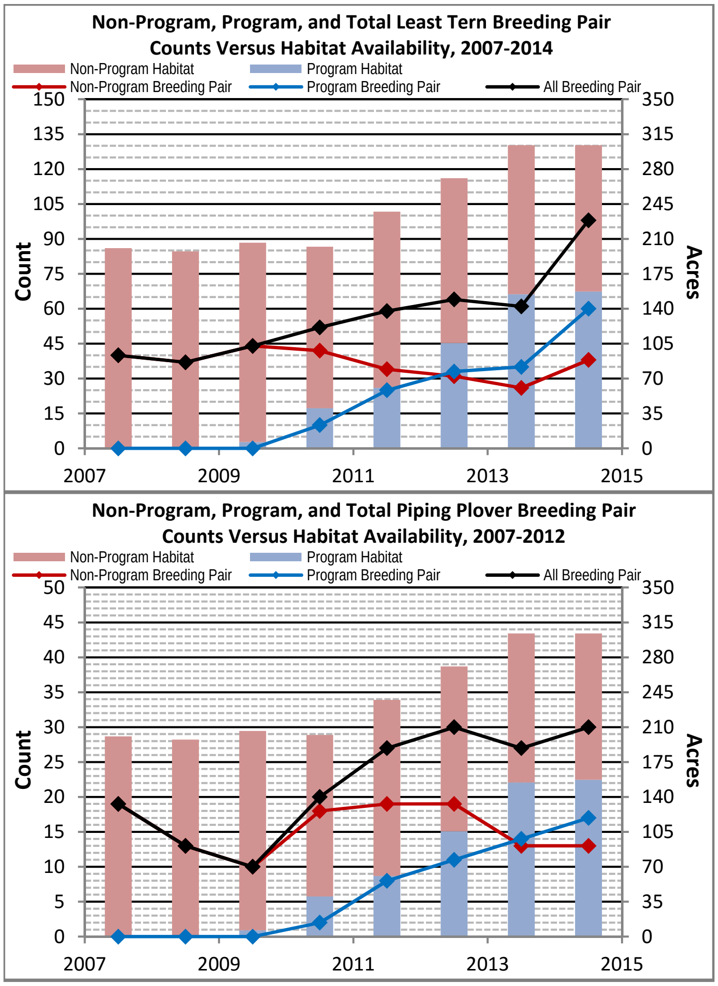


Figure 1. Relationships between availability of Program-defined suitable nesting habitat owned by the Program (blue bars) and non-Program entities (red bars) and tern (top plot) and plover (bottom plot) Program (blue line), non-Program (red line) and combined (black line) breeding pair counts, 2007–2014.

What do we still need to know?

- If current levels of off-channel nesting habitat limit further growth and expansion of the plover population within the Associated Habitat Reach.
- How many tern breeding pair current levels of off-channel nesting habitat can support.
- If in-channel nesting habitat can support similar breeding pair densities and productivity levels as off-channel nesting habitat has.

It is unclear if current levels of off-channel habitat availability limit further growth of the plover population. As of late, we have observed a fairly even distribution of approximately 1 plover breeding pair per 2.5 acres of off-channel habitat which is similar to reports from other systems; although some densities have been higher. Though tern breeding pair numbers have increased since Program implementation, given tern densities have ranged from 0-1.5 breeding pair/acre we do not believe the increase is related to habitat availability, but rather high productivity. However, increased densities of terns at off-channel sites appears to be resulting in slightly lower productivity than had been observed in the past (2001-2006).

Marginal changes in habitat availability (Table 1) and high year-to-year variability in fledge ratios (Tables 2), however, reduces the certainty of whether or not habitat availability currently limits tern and plover productivity on the central Platte River.

Answering BQ #6 during the First Increment:

- Remaining uncertainties are not likely to change BQ assessment.
- Peer review or publication of the tern and plover breeding pair manuscript, productivity manuscript, and habitat availability assessment results will serve as the best source of information for this BQ.
- Once peer review is complete, Program staff expect Big Question #6 will be answered with a definitive “2-thumbs up” in 2016 and the GC will be presented information suggesting decision-making should progress to the final “Adjust” stage of the adaptive management cycle.

NOTE: Further work is required at the technical level of the Program in 2015 to determine species targets for terns and plovers within the Associated Habitats. Once established, we can determine how much additional nesting habitat is needed to meet the targets.

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

How does this Big Question relate to Program priority hypotheses?

It is hypothesized that ephemeral, in-channel nesting islands (sandbars) are needed for long-term nesting success of terns and plovers on the central Platte and when available, terns and plovers will select sandbars over sandpits for nesting. It is also hypothesized that tern and plover nesting is more successful on in-channel than off-channel habitat which could eliminate the need to maintain off-channel habitat.[4]

2014 Assessment for BQ #7:

- Long-term monitoring and data analyses indicate off-channel ***nesting habitat*** is adequate for maintaining the central Platte River population of terns and plovers.
- In-channel ***nesting habitat*** is not needed to maintain terns and plovers in the Associated Habitat Reach
- The persistence of, and increases in tern and plover populations on the central Platte River is the result of long-term availability of off-channel nesting habitat.
- Observational data indicate the river serves a valuable function as it provides an abundance of forage for both species which likely contributes to high levels of productivity on off-channel nesting sites.

What the science says:

- Since 2007, off-channel nesting habitat has resulted in consistent use and productivity.
- Off-channel nesting habitat supported 659 tern and 253 plover breeding pair and resulted in 652 and 251 fledglings, respectively.
- Tern breeding pairs have increased nearly 5-fold (21 to 98) while plover breeding pairs have tripled (10 to 30) since 2007.
- Since 2007, in-channel habitat availability and tern and plover nesting have been sporadic.
- In-channel nesting habitat supported 22 tern and 12 plover breeding pair which resulted in 15 and 21 fledglings, respectively.

Detailed tern and plover habitat availability assessments (2007-2014) will soon be underway and are expected to be completed for the Program in 2015. Once completed, habitat availability assessment results will be paired with tern and plover use data collected by the Program to evaluate tern and plover selection of Program-defined suitable nesting habitat.

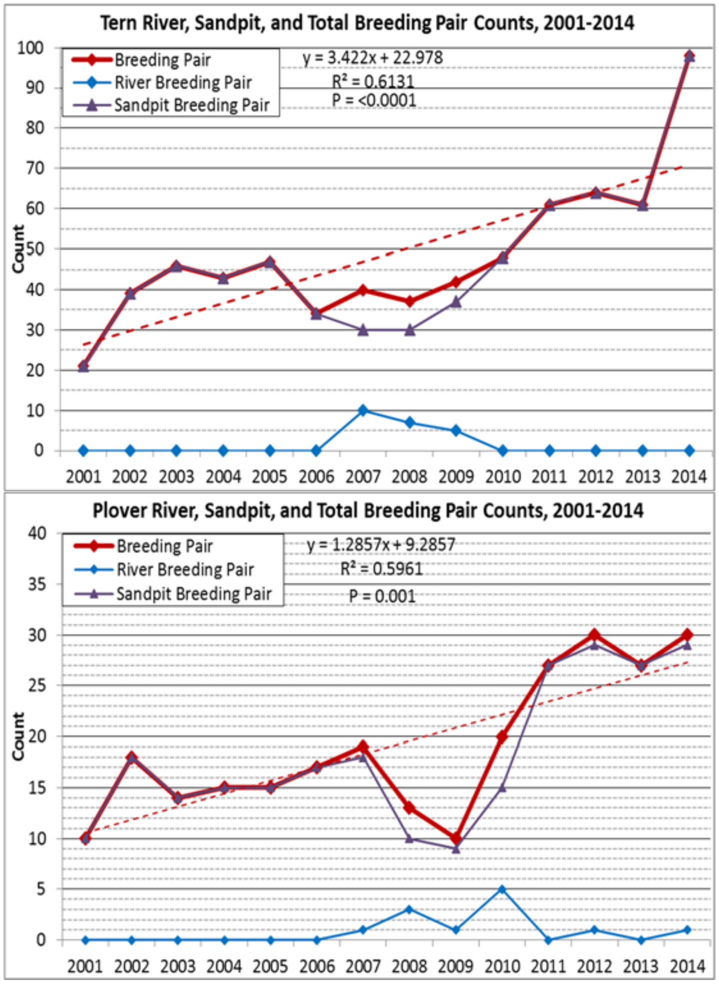


Figure 1. Annual tern (left plot) and plover (right plot) total, riverine, and sandpit breeding pair counts, 2001-2014. Trend lines (dashed lines) represent significant increases in tern and plover breeding pair counts during 2001-2014 with the most substantial increases occurring since inception of the Program.

We estimate with confidence that:

- The Program can maintain off-channel nesting habitat in the Associated Habitat Reach that terns and plovers use.
- Tern and plover populations can be maintained at elevated levels with current numbers of acres of off-channel nesting habitat.
- Constructing and maintaining in-channel nesting habitat is difficult.
- In-channel habitat has not resulted in adequate levels of use and productivity to maintain tern and plover populations.
- The river plays and important role in providing an adequate source of forage for terns and plovers.
- Similar increases have not been observed throughout the species range.

Based on Program monitoring data and minimum suitable tern and plover nesting habitat criteria, in-channel habitat and use have declined since 2007 while off-channel habitat availability and use have increased[5]. Though variable, tern and plover productivity numbers (fledge ratios) have been at levels believed to result in population growth since 2007[6]. Much of the productivity observed to date has been at off-channel sites where productivity is hypothesized to be lower than in-channel sites. We observed higher densities of tern and plover breeding pairs on in-channel nesting habitat (Figure 1); however, we generally observed lower fledge ratios at in-channel sites and observed no tern nests on river islands, 2010-2013 and no plover nests on the river during 2011 or 2013. Despite the Program's ongoing efforts to create and maintain in-channel nesting habitat on an annual basis, availability of Program-defined suitable in-channel nesting habitat has been low during the first eight years of the Program. The decline in sandbar habitat and shortage of sandbar nesting leaves open the question of whether both habitat types are necessary to maintain tern and plover populations on the central Platte River.

What do we still need to know?

- Whether or not in-channel nesting habitat could result in similar levels of tern and plover use and productivity.
- If the Platte River is critical foraging habitat for survival and productivity of terns and plovers within the Associated Habitat Reach.
- Persistence of off-channel nesting habitat if Program management actions were to cease.

Answering BQ #7 during the First Increment:

- Remaining uncertainties are not likely to change the BQ assessment.
- Peer review or publication of the tern and plover breeding pair manuscript, productivity manuscript, and tern and plover chapters will serve as the best source of evidence for this question.
- Once peer review and/or publication is complete, Program staff expect Big Question #7 will be answered with a definitive "2-thumbs down" in 2016.
- The Governance Committee will be presented information suggesting decision-making should progress to the final "Adjust" stage of the adaptive management cycle.

NOTE: Further work is required at the technical level of the Program in 2015 to address the true intent of Priority Hypothesis TP1 and to figure out how best to analyze Program data to evaluate the relationship between in-channel and off-channel habitat selection and use by terns and plovers.

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

How does this Big Question relate to Program priority hypotheses?

Priority hypotheses T2 and P2 states that flows less than 800 cfs from May – September limit the number of prey fish for least terns and invertebrates for piping plovers. As a result of limited forage availability, population productivity of terns and plovers would be constrained.[7]

2014 Assessment for BQ #8:

- Least tern and piping plover productivity has been high over the period 2001-2014.
- This high level of productivity has been sustained even in years of extremely low flow.
- During the time period 2001–2013, over 78% of least tern chicks fledged when flows were <800cfs.
- Most nest failures and chick mortalities can be attributed to predation, adverse weather and high-flow events.
- Results of regression analyses relating flow to forage fish abundance indicate forage fish abundance increases as flows decrease.
- We found weak evidence that tern foraging success increases with flow. However, the effect size was not very large and higher flows had similar negative influences on capture success as lower flows.
- We estimate that at flows of 1,766cfs and 200cfs, the tern forage base in the CPR could support 2 to 9 times the number of breeding pairs observed in the CPR, respectively.

What the science says:

- If forage availability limited productivity, we would expect this would impact least tern chicks most severely.
- Intensive monitoring data collect from 2001–2013 shows that of 471 broods monitored, 362 broods fledged at least one chick, 48 resulted in an unknown status and 61 failed. Of these 61 broods that failed, 34 had an unknown cause of failure, 8 failed due to weather, and 19 failed due to predation. Of the 423 (362 + 61) broods that had a known fate (i.e., 'fledged' or 'failed'), 419 included records of the number of chicks that hatched and fledged. These 419 broods produced 947 chicks, of which 738 [78%] chicks fledged. Of 419 broods, 315 had fates determined when the flow was <800 cfs. These 315 broods produced 703 chicks, of which 550 [78%] chicks fledged.
- There is a weak or no relationship between flow and tern foraging success.
- We estimate the central Platte River could sustain >9 times the numbers of tern family units as has been observed to date.

Despite several years of data collection and the availability of a rather large set of data, we have been unable to establish a relationship between forage fish abundance and discharge. Similar to Chadwick and Associates (1992), a vast majority (>80%) of fish captured in open channel areas where least terns forage were deemed suitable forage for least terns.[8] Average forage fish density across all samples, sites and years was 2,438 fish/acre which is similar to what was reported in the Program's Foraging Habits Study.[9] The Foraging Habits Study found abundance and diversity of forage fish and tern foraging success was higher at riverine than sandpit sites which would indicate the river likely is an important forage source for least terns. The study also revealed that forage fish abundance at least tern foraging sites and random locations were similar which would indicate forage abundance was similarly high throughout the river channel. The Foraging Habits Study also revealed least terns frequently traveled distances of 6 miles to forage which would make a wide range of habitats, water conditions, and a large quantity of forage fish available to least terns while foraging.

In 2015, the EDO analyzed the Water Districts' forage fish data in conjunction with USGS flow data, the Program's tern/plover foraging habits study data, and the Program's productivity data to provide insight on relationships between flow, forage fish availability and tern foraging success and productivity.[10] We also used the Districts' forage fish data and a review of literature to develop a bioenergetics approach to estimate numbers of least tern family units (2 adults and 3 chicks) the AHR could support at various flows. We used a weight of evidence approach, several sources of data, and multiple lines of evidence and found:

- we found no evidenced least tern productivity was negatively influenced by low flow events (Figure 1), and
- forage fish abundance decreases as mean daily flows increases (Figure 2),
- we were unable to establish any strong relationships between fish density and flow and tern plunge and fish capture rates,
- the number of family units the forage fish population in AHR could potentially support was maximized at 200cfs with an estimated 903 family units supported, which is >9 times the maximum number of breeding pair observed to date (Figure 3).

As such, our results indicate one should reject priority hypothesis T2 and sub-hypothesis T2a as well as the notion least tern productivity is negatively influenced by flows below 800cfs articulated in the Program's associated Big Question.

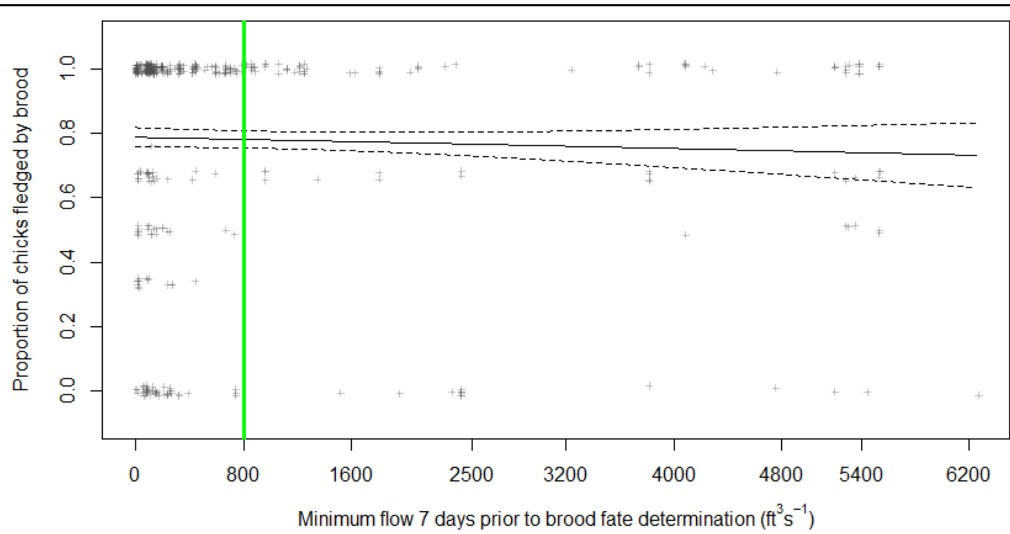


Figure 1. Results from data analysis showing the relationship between flow and tern productivity. Note the grey "+" signs show the proportion of chicks that fledged for each brood (i.e., number of fledglings/number of eggs that hatched). Note the green line shows that 315/419 (75%) successful broods experienced flows less than 800 cfs in the 7 days before they fledged or failed.

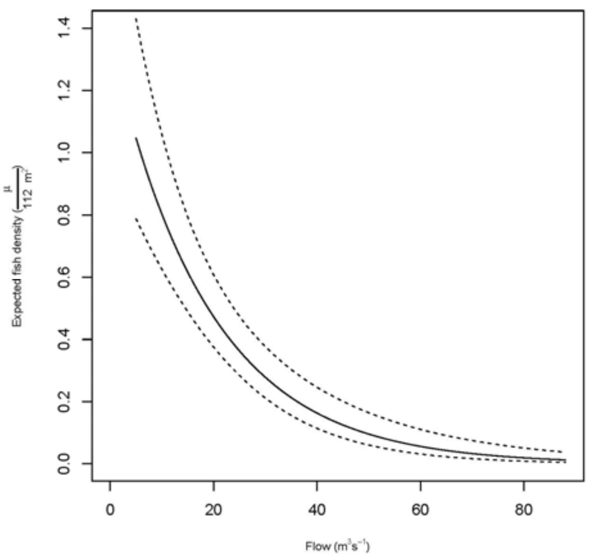


Figure 2. Regression model (Eq. 3.1–3.2) showing the relationship between expected forage fish density ($\mu/112.5\ m^2$) and average daily flow the day seining occurred (posterior median = solid black line; 95% CIs = dashed black lines).

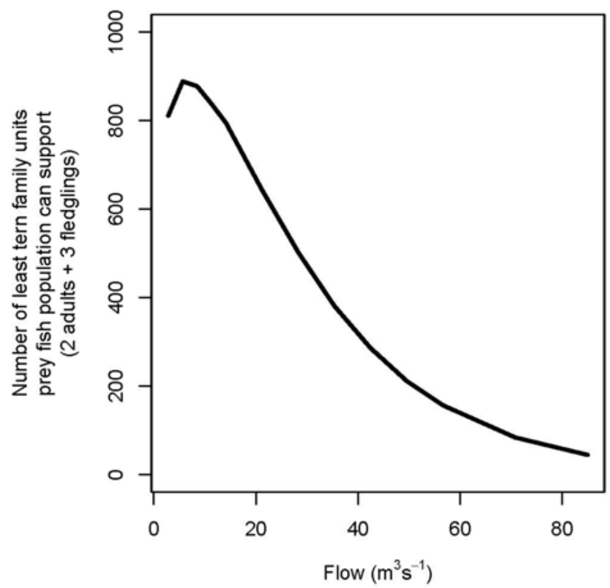


Figure 3. Numbers of least tern family units (defined as 2 adults + 3 chicks) the prey fish population in the Program Associated Habitat Area could potentially support.

We estimate with confidence that:

- Productivity, as measure by the percentage of chicks that fledge is high within the AHR.
- Most mortality of least tern chicks can be attributed to predation and adverse weather or high-flow events.
- There is no causal link between flow and invertebrate forage populations for piping plovers. Productivity of piping plovers is also high.
- If forage availability does become limiting, intensive nest and brood monitoring being implemented during the first increment should detect increased rates of unknown causes of confirmed (dead chick) mortality which may indicate a need to revisit BQ #8.

Given observed least tern productivity numbers[11], forage fish abundance numbers, foraging success rates, and our bioenergetics approach for evaluating the hypothesis, there currently is no evidence that abundance of forage fish within the central Platte River limits least tern productivity so long as there is at least some flow, albeit <200cfs, in the channel. During years when 0 cfs flows are recorded at gaging stations downstream of NPPD's Kearney Canal Diversion, forage fish populations above the diversion and in other river segments with a consistent supply of water from canal return flows appear to allow the central Platte forage fish populations to rebound quickly once flows return to the river.

What do we still need to know?

- Invertebrate densities within habitats occupied by plover chicks.
- Plover population levels the invertebrate forage base can support in the AHR. This would involve answering the question: At what population size would plovers be limited by forage availability?
- How central Platte River tern and plover growth rates compare to other systems.

The Program has collected invertebrate samples at in-channel and off-channel sites during 2009, 2010, and 2012-2014. Preliminary indications are that small and large invertebrates are more abundant on sandbars than sandpit sites. Final analyses and results of these efforts will be reported in 2015. However, based on observed plover productivity numbers[12] and invertebrate data collected to date, there is no evidence that invertebrate abundance within the central Platte River currently limits plover productivity.

While we feel it could be beneficial to continue to continue baseline monitoring of invertebrate and forage fish abundance and diversity in the central Platte River as has been done in the past, at this time there is no evidence to warrant implementing system-wide monitoring protocols. In order to test our assumptions and fully evaluate tern and plover response to forage abundance throughout the Program Associated Habitat Area, additional protocols and a systematic approach, such as sampling at Program anchor points, would be needed. Sampling efforts would also need to be expanded to include the wide range of discharges observed during the May-September time period to provide a larger data set of forage abundance at different river discharges and to capture a broader forage response to discharge related to both forage recruitment and availability as tern and plover forage. Evaluating tern and plover response to forage abundance would also require capturing and weighing chicks on multiple occasions to establish the relationship between growth rates and forage fish abundance. At this time, Program participants have agreed these additional expenses, efforts, and risk of injury to chicks are not warranted as it appears forage abundance is adequately high to support the central Platte population of terns and plovers.

Answering BQ #8 during the First Increment:

- Remaining uncertainties are not likely to change the tern assessment for BQ #8; the plover assessment is forthcoming.
- A report has been prepared that examines relationships between flow and forage fish abundance and tern foraging success and productivity within the AHR. A similar report will be developed in 2015 for plovers.
- Once peer reviews are complete, Program staff expect Big Question #8 to be answered with a definitive “two thumbs down”.
- The Governance Committee will be presented information suggesting decision-making should move into the final stage of adaptive management, “Adjust”.

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

How does this Big Question relate to Program priority hypotheses?

It is hypothesized that Program water management actions, such as diverting excess 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.[13]

2014 Assessment for BQ #9:

- Stage change study analyses concluded relative change in habitat due to Program water management activities would be very small to undetectable and thus these changes should not provide additional stress to the pallid sturgeon population.
- The greatest potential for negative habitat impacts would occur when lower Platte River discharges are low (4,000 – 6,000 cfs) but central Platte River discharges are high enough that flow could be diverted into storage for retiming. Since 1954, these conditions occurred one time during the spring for two consecutive days and 37 times during the fall with 26 of the instances lasting three consecutive days or less. Impacts can be avoided through development of operational rules that prohibit Program diversions when lower Platte River discharges fall below 4,000 cfs.

What the science says:

The stage change study scale was the lower Platte River from the Elkhorn River confluence to the Missouri River confluence, as defined in the Program document. Intensive fieldwork and modeling were conducted on a smaller study reach from the Highway 50 Bridge to the reclaimed Pedestrian Bridge near Louisville, Nebraska. Data collection and modeling began in September 2008 and concluded in October 2009. Performance measures evaluated during the study are provided in the table below.

Performance Measure	Range of Conditions Evaluated
Water depth and velocity	between 3,700 – 40,000 cfs
% of Program water	reaching Louisville
Changes in habitat classifications (slackwater, flat, riffle, run, isolated pool, plunge)	between 3,700 – 40,000 cfs
Number of days	below 4,000 cfs @ Louisville (Dry Conditions Analysis)
Range of flows	below 4,000 cfs @ Louisville (Dry Conditions Analysis)
Number of consecutive days	below 4,000 cfs @ Louisville (Dry Conditions Analysis)

Given the influence of the Loup and Elkhorn Rivers on lower Platte flows, water management activities in the lower Platte, flow attenuation, and their size and timing, the study concluded Program water management activities would not have a statistically significant impact on lower Platte flows or on the type or availability of pallid sturgeon habitat (as defined only by the study's habitat classifications).[14] Stage change study analysis of historic reach gains and losses showed that not all flow reaching Grand Island is translated downstream to Louisville and that predicted changes in discharge due to Program water management activities is likely within the range of gage uncertainty.

We estimate with confidence that:

At the request of Program participants, the study authors conducted a Dry Conditions Analysis as a kind of "worst case scenario" to determine how the stage change study tool might be used to evaluate Program water management activities at a time of excess flow in the central Platte but low flow in the lower Platte.[15]

The gage period of record (1954 to current) was analyzed during the spring and fall to identify incidences when flows were above target at Grand Island, the Program could divert some portion of that excess, and flows were simultaneously in the 4,000-6,000 cfs range at Louisville. Assuming habitat connectivity is important for pallid sturgeon and that connectivity declines below 4,000 cfs, this analysis identified one incidence during the spring and 37 incidences during the fall when flows were low in the lower Platte but high enough to divert flow in the central Platte. The duration of these conditions ranged from two to fourteen days with 27 of the incidences lasting three days or less.[16] If the Program determines that short-term impacts to connectivity could be problematic, operational rules for Program water projects could prohibit diversions when lower Platte River discharges fall below some minimum threshold.

What do we still need to know?

The general conclusion of the stage change study is that Program water management will not result in measurable changes on flow in the lower Platte River and thus little change to the amount of habitat available to pallid sturgeon.[17] 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[18] above 4,000 cfs, the study tool 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. Use of the tool for this purpose would be greatly enhanced if additional data were collected and analyzed regarding what defines pallid sturgeon habitat in the lower Platte and how that habitat is being utilized.

Answering BQ #9 during the First Increment:

The Program's stage change study serves as the best source for synthesized reference data for this question. The final stage change study report was peer reviewed and accepted by the Governance Committee and was used to develop the 2014 assessment. Accordingly, Program staff consider Big Question #9 to be answered with a definitive "two thumbs up" and recommend the Governance Committee move into the final "Adjust" stage of adaptive management for this question.

In what ways might the Program adjust?

1) The stage change study is a technical tool that can now be used by the Program to evaluate the potential impacts of Program water management actions on stage in the lower Platte. For example, the stage change study can be used to evaluate different operational scenarios for the J-2 re-regulating reservoir.

2) Further Program actions for the pallid sturgeon (for example, pallid sturgeon habitat use/selection research[19]) are a policy decision that is the sole discretion of the Governance Committee. The U.S. Fish and Wildlife Service maintains the GC needs to address, at the policy level, perceived disagreement between the AMP management objective of "avoid adverse impacts from Program actions on pallid sturgeon populations" and the stated Program goal of "testing the assumption that managing flow in the central Platte River also improves the pallid sturgeon's lower Platte River habitat."[20]

10. Do Program management actions in the central Platte River contribute to least tern, piping plover, and whooping crane recovery?

How does this Big Question relate to Program priority hypotheses?

It is hypothesized that restoring land into five habitat complexes of roughly 2,000 acres each and applying Program management actions that influence those complexes will result in positive effects on the target bird species that will help lead to recovery.[21]

2014 Assessment for BQ #10:

- Program implementation is considered a contribution to the recovery of the target species. A clearer picture of the magnitude of that contribution to the overall health of the populations of the three target bird species will emerge closer to the end of the First Increment.

What the science says:

Since 2007, the Program implemented its Land Plan, Water Plan, and Adaptive Management Plan components. The Program is the Reasonable and Prudent Alternative for the U.S. Fish and Wildlife Service's Final Biological Opinion on the Platte River and is being implemented to secure "defined benefits for the target species and their associated habitat to assist in their conservation and recovery".[22] Thus, implementation of Program management actions itself is considered a contribution toward recovery of the target species. Highlights of successful implementation thus far include:

- Acquisition of over 10,000 of the Program's First Increment Land Objective of 10,000 acres. This acreage objective is considered a "floor" so additional acquisition may occur over time.
- Habitat restoration including channel widening, in- and off-channel tern/plover nesting habitat construction and management, vegetation management, and other related activities at five Program habitat complexes.
- Implementation of FSM "Proof of Concept" activities at the Elm Creek and Shoemaker Island Complexes.
- Sediment augmentation pilot-scale management actions at the Plum Creek and Cottonwood Ranch Complexes.
- Flow consolidation management action at the Cottonwood Ranch Complex.

Additionally, the Program is engaging with entities working with the three target bird species in other river systems and locations to develop a strategy for assessing the significance of Program management actions and the resulting bird response on the overall populations of all three species. Activities include:

- Serving as a "Core Partner" in the Whooping Crane Tracking Partnership, a migratory range-wide telemetry study of whooping cranes.
- Serving as a member of the Working Group for development of an Interior Least Tern Metapopulation Model.
- Participating in range-wide meetings on the status of the piping plover.
- Urging development of life-history based Conceptual Ecological Models (CEM) for all three bird species, and contributing to the development of those CEMs.

What do we still need to know?

Data collection related to the larger-scale items above is only in the early stages, and any analysis of data such as that collected through the whooping crane telemetry project will produce speculative conclusions.

Analyzing data relative to this Big Question will only prove fruitful toward the end of the First Increment, so Program involvement in data collection and developing CEMs for the target bird species will continue until enough data is collected and analysis procedures are specified in a way that will shed more objective light on this question and the associated hypothesis.

In 2013 the ISAC recommend updating the wording of this Big Question to read “How do Program management actions in the central Platte River **cumulatively** contribute to least tern, piping plover, and whooping crane recovery?” to provide a more direct link to priority hypothesis S-1 in the AMP. This will be addressed in a future State of the Platte Report.

Answering BQ #10 during the First Increment:
What constitutes recovery of the interior least tern, piping plover, and whooping crane?
Addressing this question by developing objective, quantifiable performance measures will continue to be a priority during the First Increment.

What contribution does the central Platte make to overall recovery of the three target bird species?
As above, developing objective, quantifiable performance measures to address this question remains a First Increment priority. However, as per the Final Program Document, implementation of the Program is itself considered a contribution toward recovery of the target species.

11. What uncertainties exist at the end of the First Increment, and how might the Program address those uncertainties?

How does this Big Question relate to Program priority hypotheses?

The intent of this Big Question is to serve as "parking lot" for major scientific and technical uncertainties that remain unanswered toward the end of the First Increment. These "unanswered questions" may be Big Questions that still remain unanswered, or secondary uncertainties that were not sequenced as priorities during the First Increment, or they may be new questions revealed during the course of implementation of the AMP during the First Increment.

2014 Assessment for BQ #11:

- A list of existing and/or new unanswered questions will be maintained throughout the First Increment to set the stage for evaluation during the Second Increment.

What the science says:

No major scientific or technical uncertainties were added to this list as a result of Program implementation and associated data collection and analysis in 2014. Consideration will be given to adding uncertainties to the list in 2015 if necessary. A sample list of existing priority hypotheses not intended, at this point, to be addressed during the First Increment is presented in the table below as a placeholder for potential Second Increment uncertainties to be logged as they are identified. This list will continue to change and grow during the course of the First Increment.

Broad Hypotheses & Other Potential Second Increment "Big Questions"	Priority Hypotheses
Implementation – Program Management Actions and Habitat	
PP-4: Higher water surface elevations resulting from raised river bed elevations can generate measurable increases in the elevation, extent, frequency, and/or duration of growing-season high water tables in wet meadows within 3,000 feet of the river.	WM-2, 3, 4, 8a
Effectiveness – Habitat and Target Species Response	
WC-2: Whooping cranes prefer palustrine wetlands to river channel, based on known migratory stopover habitats. Whooping crane use of the central Platte River study area during migration seasons will increase proportionately to an increase in palustrine wetlands.	WC3
PS-3: Non-Program actions (e.g. harvest, stocking, Missouri River conditions) determine the occurrence of pallid sturgeon in the lower Platte River.	PS-11
Larger Scale Issues – Application of Learning	
What uncertainties exist at the end of the Second Increment, and how might the Program address those uncertainties?	N/A

Potential Second Increment Big Questions, including existing broad and priority hypotheses from the AMP that could serve as the foundation for additional questions in the Second Increment.

Answering BQ #11 during the First Increment:

This question is directed back at the GC to ensure there is open communication between the GC and the technical representatives of the Program. The purpose of this Big Question is to keep a running list of scientific and technical questions the GC needs to have addressed to inform management decision-making.

APPENDIX A

Independent Scientific Advisory Committee (ISAC) Comments and Executive Director's Office (EDO) Responses

Independent Science Advisory Committee (ISAC)

Responses to Questions Posed by the Platte River Recovery Implementation Program (PRRIP) in July 2015

Sand deposited below the Kearney Canal Diversion; July 14, 2015.

Submitted to
PRRIP Governance Committee

C/o Dr. Jerry Kenny, Executive Director,
Platte River Recovery Implementation Program
Headwaters Corporation
4111 4th Avenue, Suite 6
Kearney, Nebraska 68845

Prepared by

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August 21, 2015

The Platte River Recovery Implementation Program (PRRIP or Program) requested written input from the ISAC on five questions. These questions were the focus of discussions during the ISAC meeting in Kearney, NE, held on July 13-15, 2015. To enable the Program to easily extract ISAC recommendations from our overall discussion of the questions posed to us, we have put our recommendations in **blue** text. These recommendations are contained within the context of the overall discussion of each question so that our rationale is clear.

2014 State of the Platte Report

1) Is the "two thumbs up" assessment for Big Question #9 in the 2014 State of the Platte Report logical based on your understanding of Program data and consistent with what you have learned during your involvement with the Program?

Reference Documents – 2014 State of the Platte Report

Big Question #9 (BQ 9) asks: "Do Program flow management actions in the central Platte River avoid adverse impacts to pallid sturgeon in the lower Platte River?" The relevant Program flow management actions which could potentially affect flows in lower Platte River include diversions of Platte River water for the J2 reservoir or for groundwater recharge (a much smaller volume than J2 diversions). The Program associated habitat reach for pallid is from the Elkhorn River to the Missouri confluence (pg. 30, AM Plan 2006). The area examined in the stage change study was the reach between the Nebraska Highway 50 Bridge and the reclaimed Chicago Rock Island and Pacific Railroad (pedestrian) Bridge (pg. 1-2, HDR et al. 2009).

The ISAC provided inputs on BQ 9 in our October 2013 report (pg. 10, lines 413-431):

> "The current conclusion is one thumb up, which is reasonable. The peer-reviewed stage change study confirms that answer to BQ 9 is at least one thumb up. If there are minimal predicted effects on water physical and chemical conditions below the Elkhorn River from Program flow management actions (as determined in the peer-reviewed stage change study), then it is unlikely that sturgeon below the Elkhorn River are exposed to any effects from Program flow management actions, either positively or negatively. If evidence were provided which redefined the area of concern to include areas above Elkhorn River (i.e., from ongoing studies by USGS and the Nebraska Game and Parks Commission), then it would be necessary to repeat the stage change study for areas further upstream. The ISAC recommends publishing the results of the stage-change study in a journal, and using the tool developed in the stage-change study to examine the effects of the proposed operations of the J2 re-regulating reservoir.
>
> While a one thumb up conclusion is justified, we do not support a conclusion of two-thumbs up at this time. The water part of the peer-reviewed stage change study is robust. However, the connection to sturgeon habitat is less certain because we don't know if the area modeled for sturgeon habitat suitability was sufficient given the true distribution of sturgeon, as discussed above. We recommend that the Program uses the stage-change tool to adjust Program water operations to further minimize downstream effects during low-water conditions, and then re-evaluate the evidence for BQ 9."

What has been learned since the 2013 ISAC report? Hamel et al. (2014; their Figure 3) reported one pallid sturgeon at multiple locations in the 107 km of the Lower Platte River between the Elkhorn and Loup Rivers (rkm 52-159). Additionally, Delonay et al. (in press) and Delonay (personal communication, 14 August 2015; Appendix A) stated it is highly suggestive pallid sturgeon spawned in the Lower Platte River, Nebraska from 2011 through 2014 under widely differing flow conditions. They also tracked a spawning ready female above the Elkhorn River. Specific locations and habitats where pallids have spawned in the Lower Platte River and whether larvae were produced remain unknown.

The stage change study was restricted to a representative reach of the segment below the Elkhorn to mouth (rkm 52-0). Thus there is pallid sturgeon use of the river above the Program's associated habitat reach in the Lower Platte River area, upstream from the additional flow contributed by the Elkhorn River. **To address the new information on pallid sturgeon we recommend that the Program repeat its "Alternative Analysis of Program Activities" (Appendix G in HDR et al. 2009) to determine if Program flow management actions also yield minimal predicted effects on water physical and chemical conditions in the Elkhorn to Loup segment of the Lower Platte River.**

The 2014 State of the Platte Report (pg. 28) mentions the idea of an operational rule:

> "Impacts can be avoided through development of operational rules that prohibit Program diversions when lower Platte River discharges fall below 4,000 cfs"

The ISAC recommends that the Program formulate an operational rule that would be applied to the operation of the J2 reservoir. Provided that such a rule is put in place by the Program to protect the habitat of pallid sturgeon, then the ISAC supports the conclusion of two thumbs up on Big Question #9.

The operational rule might be of the following form:

> *If flows are < X in Lower Platte at gage Y, and if extraction of flows from the Platter River (for any purpose) in the Central Platte River could cause detectable, adverse changes in river stage in the area used by pallid sturgeon, then do not extract water to J2 for Short Duration High Flows (SDHF). This rule is based on the HDR et al. 2009 stage change study and supplementary analyses for the Elkhorn to Loup reach.*

The draft 2014 State of the Platte report (pg. 29, lines 881-885) has the following statement:

> "The U.S. Fish and Wildlife Service maintains the GC needs to address, at the policy level, perceived disagreement between the AMP management objective of "avoid adverse impacts from Program actions on pallid sturgeon populations" and the stated Program goal of "testing the assumption that managing flow in the central Platte River also improves the pallid sturgeon's lower Platte River habitat."

The ISAC agrees that the GC needs to address this perceived disagreement.

2) In June 2015 the GC accepted the "two thumbs down" assessment for Big Question #1 in the 2014 State of the Platte Report. The GC asked the EDO to work with the ISAC and the TAC to provide guidance on how to adjust management in response to Program learning. Do you concur with the EDO recommendation to utilize a Structured Decision Making process to assist the GC with the adjust step of adaptive management and if so what guidance do you have to help make the process successful?

Reference Documents – 2014 State of the Platte Report; SDM White Paper; Tern and Plover Habitat Synthesis Chapters (final peer review package)

The ISAC accepts the evidence against Big Question #1, as described in the 2014 State of the Platte Report and referenced materials. The ISAC is also satisfied with the peer reviews of the Tern and Plover Habitat Synthesis chapters, and the responses of Program scientists to recommendations made by the peer reviewers. **We recommend that the Program add a requirement for documentation of responses to peer reviews in the policy related to the PRRIP peer review process.**

The ISAC has previously recommended that the Program apply modelling and Structured Decision Making– see ISAC 2014a (points 10 and 11 on pages 4-5) and ISAC 2014b (point 8 on page 15; also found on page 49 of the 2014 State of the Platte Report). Natural resource management decisions involve synthesizing both science and human values. Examples of Platte River decisions which involve this kind of synthesis include the kinds of habitats that are required to achieve plover and tern objectives (e.g., off-channel only vs. off-channel and in-channel) and the optimal allocation of water and funding resources across whooping cranes, plovers and terns. Now that the Program has collected ample ecological evidence to address some basic questions, it is time to move forward with an analysis of future management options, bringing together ecological evidence, economics, and human values. This analysis must be conducted in such a manner that all stakeholders clearly understand the process for formulating and evaluating alternative management actions to be applied in the future, including adaptive management alternatives. A common understanding of the process will facilitate the selection of alternative(s) for implementation, and the documentation of the rationale for that selection. Structured Decision Making provides a formal method for rigorously combining scientific evidence and modelling tools with stakeholder values to converge on management alternatives which best meet ecological, economic and other objectives (Hammond et al. 1999, Gregory et al. 2012). We recommend that this process be applied on a trial basis on a single question concerning the Platte River as a means to evaluate its future utility for the larger program.

We concur with the EDO recommendation to use Structured Decision Making to assist the GC with the adjust step of the AM cycle for Big Question #1. A key benefit of this process is that it will provide a structured integration of the learning that has occurred during the last 8 years into a form which provides insights on the implications of decisions for various objectives, and the implications of differing weights on objectives for choices. It's prudent to do a test application of this approach on part of the Program (i.e., Big Question #1) rather than tackling all issues related to an extension of the First Increment or Second Increment. In the test application to Big Question #1 for terns and plovers proposed by the EDO, it's important to ensure that the objectives and performance measures PMs include potential impacts to whooping cranes and pallid sturgeon (i.e., that tradeoffs in the use of water are fully considered).

We have the following other responses and recommendations on this topic (not bolded for ease of reading)**:**

- The ISAC endorses the EDO's proposed process, use of outside experts and schedule;
- It's a good idea to have a test application of this structured process on Big Question #1, to figure out the process of adjustment in the AM cycle, and inform the GC on how this process works, recognizing that decisions on allocation of water and other resources for one big question could affect decisions on other big questions
- It's critical that the GC be involved in reviewing existing Program objectives and performance measures, adding other metrics as required related to human values, and that the GC be involved in proposing management alternatives, as well as in evaluating those alternatives (see recommended roles Figure 1).
- In developing the tools that help the GC to evaluate alternatives, it's important that:
    - the models used in the process be kept as simple as possible (but not too simple) recognizing that the key filter for deciding whether or not to include a hypothesis or process in a particular model is whether or not it would help distinguish among alternatives (determined by sensitivity analysis);

- the models should recognize uncertainty with respect to various functional relationships that are still being explored, such as alternative hypotheses related to the effects of flow on erosion of islands (for examples of decision analyses incorporating alternative hypotheses see Peters et al. 2001 and Alexander et al. 2006);
- the models' assumptions be well documented, and reviewed by both the TAC and ISAC;
- the EDO should work with a subset of TAC members who have the time to 'dig deep', and become thoroughly familiar with the models used in this process; and
- the EDO, TAC and outside experts develop simple ways to summarize for the GC the relationships in the models, and the consequences of the alternatives.

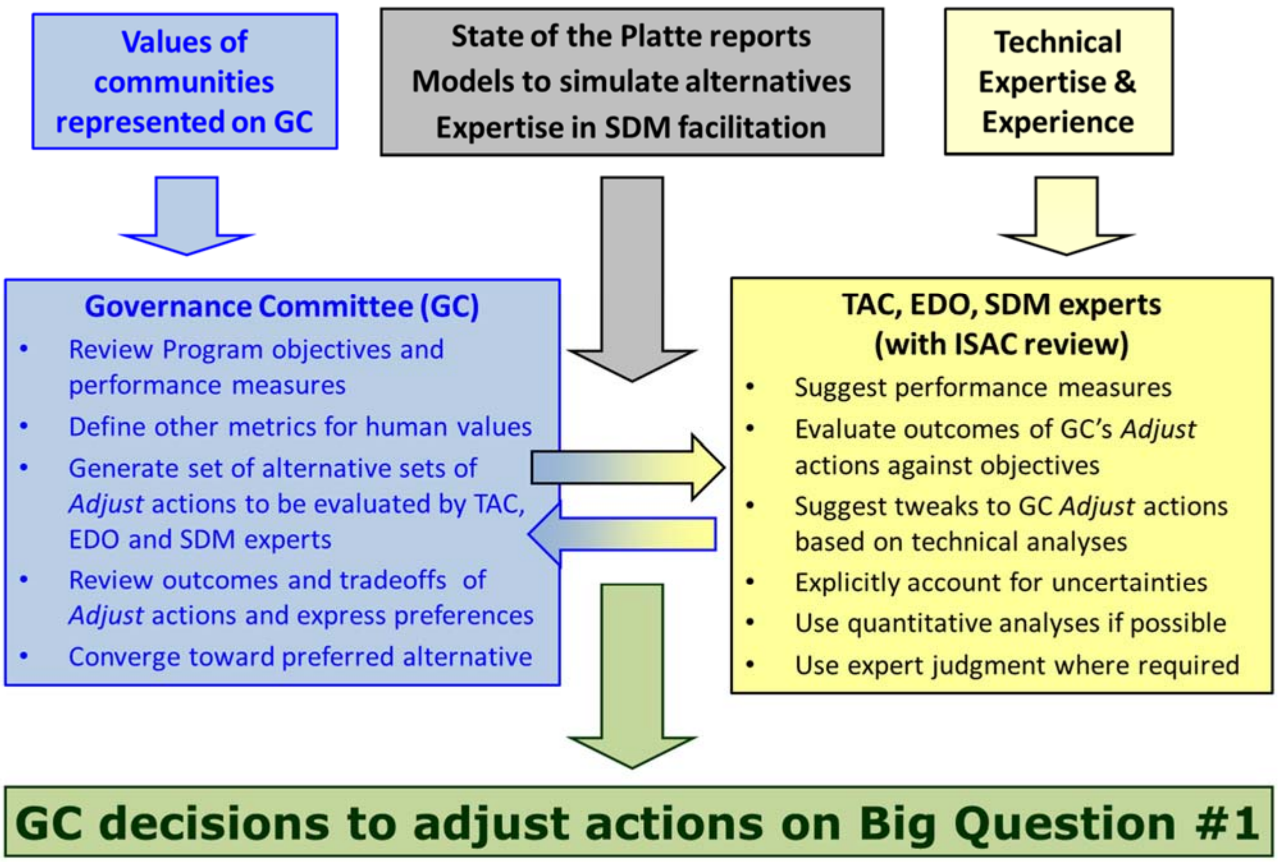

Figure 1. ISAC view of how Structured Decision Making can be applied to the adjust phase for Big Question #1 and the respective roles of the GC, TAC, EDO and outside experts.

Sediment Augmentation

3) What guidance can the ISAC provide regarding future sediment augmentation management actions on the central Platte River?

Reference Documents – Sediment Augmentation & Sediment Deficit Memo

The November 2014 ISAC report provided several recommendations on sediment augmentation, which can be found in the 2014 State of Platte Report on pages 37 (response to Big Question 3), and page 50 (ISAC other suggestions). The key points made by the ISAC in November 2014 were to focus sediment augmentation on a smaller spatial scale, and to perform more intensive monitoring to detect the effects of this action. At the July 2015 meeting, the ISAC added the following observations:

- Within the uncertainty of existing information, most of the Central Platte River appears to be in balance. Except for the area upstream of Overton, there does not appear to be a sediment deficit.
- A reach scale sediment deficit will most likely lead to both river channel degradation and narrowing, which will then decrease the number and area of exposed, unvegetated sand bars. Channel incision would also reduce the Program's ability to use Flow-Sediment-Mechanical approaches to affect floodplain vegetation and channel width.
- The Program needs to address two questions: "Is sediment balance necessary to achieve suitable habitat?", and "Is sediment augmentation necessary to achieve sediment balance?". As we indicated in the ISAC's November 2014 report, it's best to first address these two questions in one intensively monitored area with greater experimental control. The large amount of spatial and temporal variability in sediment transport and deposition demands both greater experimental control, and also using performance measures that can be monitored very thoroughly and reliably. A third related question is: "How close to balance do you need to be to maintain channel width?"
- Sediment balance or aggradation is likely *necessary* but not *sufficient* for creating and maintaining suitable habitat by Flow-Sediment-Mechanical or Mechanical Creation and Maintenance. Sediment balance is not sufficient because it's also necessary to remove *Phragmites* and other vegetation.
- **The ISAC recommends focusing all appropriate actions for creating habitat (i.e., vegetation removal, sediment augmentation, flow management) in the south channel upstream of Overton and intensively monitoring responses to these actions, in particular determining if sediment augmentation maintains or increases channel width.** If the intensive monitoring does not demonstrate benefits of these actions in the south channel below the J2 return, then it's unlikely that benefits will be observed anywhere else.
- **We recommend that the Program base sediment augmentation decisions on thoroughly measured, multiple lines of evidence that have first been proven in an intensively monitored area (i.e., south channel below the J2 return; see Q4). We recommend using the following highest priority lines of evidence:**
  - **apply geomorphic change detection techniques (GCD) to green LIDAR, using methods developed by Dr. Joseph Wheaton of the USGS and colleagues[3];**
  - **analyze trends in transects, cross-sections, and other geomorphic metrics of interest derived from planform maps;**
  - **assess the magnitude of change in the longitudinal profile; and**

[3] https://sites.google.com/a/joewheaton.org/www/Home/research/projects-1/morphological-sediment-budgeting

  - **specific gage analysis, reporting confidence intervals for changes in slope.**
- **For each of these lines of evidence, we recommend that the Program:**
  - **review statistical power analyses conducted in other rivers to assess the risks of type 1 and type 2 error (e.g., falsely detecting a sediment deficit that does not exist, and not detecting a sediment deficit that does exist); and then**
  - **conduct statistical power analyses with data collected from the Platte (so as to best characterize spatial and temporal variability with local data)**
- The ISAC considered two additional lines of evidence, but assigned them a lower priority at this time:
  - analyzing trends in sediment transport from high frequency sampling - assigned a lower priority due to major challenges in measuring bed load in the Platte River; and
  - HEC-6T modelling, which is useful for integrating the various lines of evidence, but is ultimately dependent on high quality data for model calibration and validation (the high priority types of data mentioned above)

Geomorphology/In-Channel Vegetation Monitoring

4) Can the Program collect the necessary geomorphology and vegetation monitoring data to assist with evaluation of the Big Questions and related hypotheses through acquisition of imagery (e.g., LiDAR, aerial photos)? If so, what considerations are important before the Program moves to this monitoring effort?

Reference Documents – Channel Width Analysis Manuscript

The ISAC's previous recommendations on geomorphic and vegetation monitoring (ISAC 2014b) are worthy of review, and can be found on pages 50-51 of the 2014 State of the Platte report. Table 1 summarizes the ISAC's recommendations on geomorphic and vegetation monitoring from the July 2015 meeting, which are generally consistent with our previous recommendations, but more specific.

Our recommendations are based on the following considerations and observations:

- the need for coarse measures of geomorphic and vegetation condition on a system wide scale;
- the need for detailed measures of geomorphic and vegetation condition on an intensive scale to assess the effects of sediment augmentation;
- current geomorphic and vegetation monitoring is spread too thin over space and time to detect what is a relatively small signal from sediment augmentation (relative to the annual sediment load);
- the need to focus on a smaller area and test out methods first before applying them on a system wide scale;
- the time of year at which it is most critical for whooping cranes to have sufficient *unobstructed vegetation width* (March/April and October/November);
- the implications of whooping crane habitat requirements for the *timing* of geomorphology and vegetation monitoring (monitor in Oct/Nov and use the information for the following spring);
- the finding that fall LIDAR imagery provides estimates of channel widths that are very similar to transect measurements (Channel Width Analysis);

- the types of vegetation data of interest for assessing whooping crane habitat (*unobstructed vegetation width*);
- the quantitative description of vegetation required as inputs to geomorphological analyses (*unvegetated channel width*), focusing on plants which have geomorphic influence (e.g., annual weed species (cockleburs, red top), cheat grass, cottonwoods, willows, reed-canary grass, *Phragmites*); and
- the observation that the strongest correlation with the green line is the average flow during the germination season, which apparently keeps annual plants from establishing.

Table 1. ISAC recommendations on geomorphic and vegetation monitoring.

Spatial Scale and Type of Monitoring	What should be measured?	Why do these measurements?
Coarse Monitoring at system wide scale (Lexington to Chapman) including all habitat complexes	• highest priority: current 0.5' CIR aerial imagery across entire system <u>during fall period</u>, ideally at a consistent flow (may not always be possible)	• provide system- wide estimate of changes in unvegetated channel width, which is more useful than measurements just at transects
	• if green LIDAR can provide the desired information (see 'Why' column), then use a subset of current transects to ground truth green LIDAR and continue these through time to provide long term trend • if green LIDAR doesn't work, then the program needs to carefully rethink the current set of transects based on intensive studies, ensuring that there is some continuity of the trend anchor points, while making the reaches longer	• maintain existing time series to detect large scale, long term geomorphic change (more likely due to natural events than PRRIP actions)
Intensive Monitoring (S. Platte River below J2 return and above Overton)	• *assuming that the Program continues to remove vegetation and adds appreciable volumes of sediment at Dyer Property above Overton (pushing sediment in from banks) then it's worth:* • applying green LIDAR between Lexington and Overton in fall, and compare to transects that were done in July / Aug, accounting for flow differences • doing more detailed transect spatial density above Overton, which can then be subsampled to help inform decisions on system scale sampling (e.g., 1 transect every channel width for a reach of about 10 channel widths) – provides backup if green LIDAR doesn't work and also provides ground truthing of green LIDAR	• test out whether intensive vegetation removal and sediment augmentation can produce detectable changes in sediment balance and unvegetated channel widths above Overton using higher priority lines of evidence described under Big Question3 • test out whether green LIDAR provides reliable channel topography with which to evaluate, channel aggradation / degradation • use green LIDAR to filter out effects of flow on estimates of unvegetated (or perhaps unobstructed) channel width • if green LIDAR does not work, then consider more temporally intensive sediment transport measurements at Overton • use traditional aerial photography to estimate: a) green line; b) unobstructed channel width; and c) unvegetated channel width

With respect to field monitoring at transects, the ISAC further recommends:

- **Carefully examining (with ISAC assistance if desired) the ~30 or so vegetation and geomorphic metrics that are now being measured at each transect and decide what's really needed for whooping crane and geomorphic analyses (i.e., considering the fidelity of metrics as surrogates for processes that affect changes over time in the channel, possible redundancies in metrics, cost, value of along the causal chain within the conceptual ecological model, ease of measurement).**
- **Re-evaluating the benefit of the rotating panel sites. At present, 50% of the sites are done every year at trend sites, and one quarter of the remaining sites are sampled every year as rotating panel sites. The original intent of the rotating panel sites was to get a better estimate of system-wide status, but the magnitude of spatial and temporal variability appears to be such that the density of transects (including both fixed and rotating panel sites) is insufficient to detect changes on a system wide scale.**

The ISAC has the following recommendations on presentation and statistical issues in the Channel Width Analysis manuscript, as well as other statistical and geomorphic recommendations which have been communicated directly to scientists at the EDO.

- Add an abstract to the manuscript.
- Redo the boxplots in Figures 3 to 5 to remove the extraneous diagonal lines.
- Digitize polygons (areas) and dividing them by length to get a quick but more accurate estimate of reach- averaged width.
- Evaluate whether considering only the middle transect will provide most or perhaps all, of the information obtained by the more complicated approach used in the current draft of the manuscript. The simpler analysis is preferred if the results are similar.
- Most importantly, remove the ANOVAs (which were computed using the *lm* command in the statistical program R to fit a linear model- without the intercept) and replace them with individual t-tests so that the standard errors are computed correctly. If you only have one set for each year (3 tests total), then you won't need to worry about a multiple-comparison problem.
- It is not accurate to call the differences in June 'errors'. One would expect that the exposed width is smaller when water levels are higher. Remove the 'error' language (e.g., line 178 in Channel Width Analysis). Similarly, for Figure 4 in the Channel Width Analysis, call these "differences" instead of "errors".

5) Are the assumptions, methods, results, and conclusions in the SDHF and Lateral Erosion manuscripts reasonable?

Reference Document – SDHF and Lateral Erosion manuscripts

The conclusions of the ISAC's review of these two manuscripts were that: a) their assumptions, methods, results, and conclusions are reasonable; and b) that these manuscripts make a very important contribution to the Program.

The response to Big Question #2 in the 2014 State of the Platte Report could be improved. The response to Big Question #2 currently focuses too much on the *why* before giving the reader the *what*:

- *What:* Repeated high flow events equal to or exceeding SDHF under a balanced sediment budget (i.e. below Overton) have not produced or maintained suitable WC roosting habitat on an annual or near-annual basis
- *Why?* Statements in present draft (e.g., *Phragmites* / reed canary grass). Other factors?

The Program should place a high priority on completing the analyses that will help to better define 'suitable habitat' for whooping cranes.

References Cited

Alexander, C.A.D., C.N. Peters, D.R. Marmorek and P. Higgins. 2006. A decision analysis of flow management experiments for Columbia River mountain whitefish management. Can. J. Fish. Aquat. Sci. 63: 1142-1156.

Delonay, A.J., Jacobson, R.B., Chojnacki, K.A., Braaten, P.J., Bulliner, E.A., Elliott, C.M., Erwin, S.O., Fuller, D.B., Haas, J.D., Ladd, H.L.A., Mestl, G.E., Papoulias, D.M., and Wildhaber, M.L., in press, Ecological requirements for pallid sturgeon reproduction and recruitment in the Missouri River-a synthesis of science, 2005-2012: U.S. Geological Survey Scientific Investigations Report 2015-XXXX, 162 p

Gregory, R., L. Failing, M. Harstone, G. Long, T. McDaniels, and D. Ohlson. 2012. Structured Decision Making: A Practical Guide to Environmental Management Choices. Wiley-Blackwell. 312 pp.

Hamel, M. J., J. J. Spurgeon, M. A. Pegg, J. J. Hammen, and M. L. Rugg. 2014. Hydrologic variability influences local probability of pallid sturgeon occurrence in a Missouri River tributary. *River Research and Applications.* DOI: 10.1002/rra.2850.

Hammond, J.S., R.L. Keeney, and H. Raiffa. 1999. Smart Choices: A Practical Guide to Making Better Decisions. Harvard Business Review Press. 256 pp.

HDR, Mussetter Engineering, The Flatwater Group and M.A. Pegg 2009. Lower Platte River Stage Change Study Final Protocol Implementation Report.

ISAC 2014a. Responses to Questions Posed by the Platte River Recovery Implementation Program (PRRIP) in April 2014. 10 pp.

ISAC 2014b. Responses to Questions Posed by the Platte River Recovery Implementation Program (PRRIP) in October 2014. 18 pp.

Peters, C.N. and D.R. Marmorek. 2001. Application of decision analysis to evaluate recovery actions for threatened Snake River spring and summer chinook salmon (Oncorhynchus tshawytscha). Can. J. Fish. Aquat. Sci. 58(12): 2431-2446.

PRRIP 2006. Attachment 3. Adaptive Management Plan. 254 pp.

APPENDIX A

Summary of Evidence Suggestive of Pallid Sturgeon Spawning in the Platte River

Email from Aaron Delonay to David Galat, Fri 8/14/2015 4:15 PM (with minor formatting improvements)

David,

I have prepared a summary of what we have learned about pallid sturgeon spawning in the Platte River to date based upon USGS studies. I believe that Dr. Peters also had a reproductive female that was tagged in the Platte River in early studies that may have also spawned in the Platte River, but it moved rapidly downstream after tagging and was not recaptured to verify that it did spawn.

For some rapid background information on the use of tributaries by these species---we have observed shovelnose sturgeon in reproductive condition migrate upstream and explore the Big Sioux River for a short time (days) before exiting and subsequently spawning in the mainstem Missouri River. But we also have shovelnose sturgeon that did stay and spawn in the Big Sioux. We believe we had a similar instance of short-term tributary use (days) by a reproductive pallid sturgeon in the James River in 2011, which then most likely exited and spawned in the Missouri River. By contrast, the pallid sturgeon documented below migrated into the Platte River and stayed in the Platte for several weeks to more than a month during the spawning period. Some were recaptured nearly immediately as they exited the Platte River (NGPC boats searched the Missouri near the confluence almost daily), while other were recaptured weeks later, and one several months later. Successfully spawned females can be evaluated months after the event to determine if the eggs were shed successfully or reabsorbed. Recently initiated laboratory studies indicate that females that do ovulate cannot shed their eggs without going through spawning behavior.

2011 -- First indication of spawning in Platte River. Three probable wild pallid sturgeon females (PLS11-015, PLS11-016, and PLS11-020) known to be in spawning condition were tagged and released. They were not located during the spawning period using telemetry. They were recaptured later and determined to have spawned in the spring of 2011. Spawning location was inferred from data storage tag records of temperature matching the temperature profile of the Platte River, Nebr. (markedly different from mainstem Missouri River). See Delonay et al (2014) Annual Report.

2012 -- One probable wild female pallid sturgeon (PLS10-029) not evaluated prior to spawning during the spring, but was recaptured in post-spawn condition with few remaining free, viable oocytes in 2012 as it left the Platte River (suggesting a very recent spawn event). Repeated searches of the Missouri River did not locate the fish in the Missouri River during the spawning period. The fish was determined to have spawned in the spring of 2012. The fish was not located during the spawning period using telemetry. Spawning location was inferred from data storage tag records of temperature matching the temperature profile of the Platte River, Nebr. See 2012 Synthesis Report (final review)

2013 -- Two probable wild pallid sturgeon females that were previously believed to be Platte River spawners in 2011 (PLS11-016 and PLS11-020) return to Platte River to spawn. Both fish were evaluated prior to spawning and were gravid. The fish were not located during the spawning period using telemetry. Spawning location was inferred from data storage tag records of temperature matching the temperature profile of the Platte River, Nebr. See 2013 Annual Report (in final review)

Larval sampling for sturgeon and paddlefish in the Platte River in 2013, just upstream of the mouth, detected small numbers of drifting shovelnose sturgeon free embryos showing that shovelnose sturgeon are finding suitable spawning substrate and are successfully spawning in the Platte River. Interestingly, no paddlefish free embryos were collected. Paddlefish and shovelnose sturgeon free embryos are far more abundant in the Missouri River, and over a longer time period than in the Platte River. No free embryo pallid sturgeon were collected in the Platte River. See 2013 Annual Report (in final review)

2014 -- Two probable wild pallid sturgeon females (PLS11-015 and PLS10-029), both believed to be Platte River spawners in 2011 (PLS11-015) and 2012 (PLS10-029), returned to the Platte River to spawn. The location of both fish in the Platte River was verified using telemetry during the spawning period by USGS and NGPC, with PLS11-015 swimming upstream in the Platte River at least as far as the Elkhorn River confluence. It was relocated as it was passing the confluence and moving upstream. Both fish were recovered and were been determined to have spawned completely. See 2014 Annual Report (in review)

Larval sampling for sturgeon and paddlefish in the Platte River in 2014, just upstream of the mouth, detected small numbers of drifting shovelnose sturgeon free embryos showing that shovelnose sturgeon again found suitable spawning substrate and successfully spawned in the Platte River. Interestingly, again no paddlefish free embryos were collected. Paddlefish and shovelnose sturgeon free embryos are far more abundant in the Missouri River, and over a longer time period than in the Platte River. No free embryo pallid sturgeon were collected in the Platte River. Three free embryo pallid sturgeon were collected in the mainstem Missouri immediately upstream of the confluence with the Platte River. See 2014 Annual Report (in review)

2015 -- No known tagged, reproductive fish were detected or suspected of using the Platte River in 2015. No sampling for free embryos or larvae was conducted in the Platte River.

Significance--
The preponderance of the data is highly suggestive of pallid sturgeon spawning in the Platte River, Nebraska. Our data has not determined the location of spawning within the Platte River, nor has it measured the success of spawning attempts. Spawning aggregations of sturgeon were not documented, but numbers of tagged, known spawning adults in the Platte was low, tracking efforts were absent or minimal, and the transmitter used (acoustic only) did not allow rapid and effective tracking of pallid sturgeon in the Platte River. Few free embryo or larval shovelnose sturgeon were collected, but no pallid sturgeon embryos or larvae were collected. The relative importance of the Platte River to pallid sturgeon reproduction in the Lower Missouri River basin was not determined by our studies.

Data shows --

- Value of long-term data sets with individual fish.
- Critical need for recapture and reproductive assessment
- Exponential return on investment of implanted sensor technology and instrumentation of the river (gage data / temperature loggers)
- Spawning fidelity of 4 females (8 spawning events, by 4 females, over four years, with each female using the Platte during consecutive spawning cycles) to the Platte River across very different water years (indicates use is may not be opportunistic, but suggests selection or preference for the Platte River). The basis of fidelity is unknown (e.g., past experience, imprinting, or social cues from conspecifics).

- Spawning frequency of females is 2 to 3 years, though may be influenced by increased growth due to the flood of 2011, or growth enhancement during short time spent in hatchery by fish tagged and released in 2011.
- Advance knowledge of spawning destination or spawning sites (though limited) would be of great value in monitoring programs to assess management actions.
- Importance of genetics. These are probable wild fish (Probable because detection of hatchery progeny is not 100% reliable as of this memo). It is unknown whether the fish using the Platte are different than other wild fish, or stocked fish. There is currently no evidence to suggest that they are.
- Use of the Platte River for spawning opens possibility for the use of the Platte River as another comparative model for spawning habitat and natural flow experiments for the species--similar to the Yellowstone River.

A publication is in the preliminary stages of preparation, but the release date has not been determined.

Please contact me with any questions.

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References

DeLonay, A.J., Jacobson, R.B., Chojnacki, K.A., Annis, M.L., Braaten, P.J., Elliott, C.M., Fuller, D.B., Haas, J.D., Haddix, T.M., Ladd, H.L.A., McElroy, B.J., Mestl, G.E., Papoulias, D.M., Rhoten, J.C., and Wildhaber, M.L., 2014, Ecological requirements for pallid sturgeon reproduction and recruitment in the Missouri River—Annual report 2011: U.S. Geological Survey Open-File Report 2014–1106, 96 p., http://dx.doi.org/10.3133/ofr20141106.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

Reponses of Platte River Recovery Implementation Program (PRRIP or Program) to August 2015 Independent Scientific Advisory Committee (ISAC) Recommendations

What is this document?

This document provides official responses from the Program to ISAC recommendations from August 2015. The ISAC recommendations are contained in the August 21, 2015 ISAC report to the Governance Committee (GC). That report contains written responses from the ISAC to the GC regarding a set of five questions posed to the ISAC that served as the focus of discussions during the July 13-15, 2015 ISAC meeting in Kearney, NE. Responses were drafted by the Executive Director's Office (EDO).

Format for responses:

ISAC recommendations are reported below in the same blue text and numerical order as contained in the August 21, 2015 ISAC report. Some ISAC responses to the Program questions in that report did not contain recommendations, thus the inconsistent numbering seen below. Each recommendation is listed under the Program question to which it pertains. An official Program response follows each comment.

ISAC Question #1 – Is the "two thumbs up" assessment for Big Question #9 in the 2014 State of the Platte Report logical based on your understanding of Program data and consistent with what you have learned during your involvement with the Program?
1. To address the new information on pallid sturgeon we recommend that the Program repeat its "Alternative Analysis of Program Activities" (Appendix G in HDR et al. 2009) to determine if Program flow management actions also yield minimal predicted effects on water physical and chemical conditions in the Elkhorn to Loup segment of the Lower Platte River.
Program response: The lower Platte River Associated Habitat Reach is defined as being from the mouth of the Elkhorn River down to the mouth of the Platte River where it joins the Missouri River near Plattsmouth, NE. Any Program activity above the mouth of the Elkhorn River would have to be directed by the Governance Committee.
2. The ISAC recommends that the Program formulate an operational rule that would be applied to the operation of the J2 reservoir. Provided that such a rule is put in place by the Program to protect the habitat of pallid sturgeon, then the ISAC supports the conclusion of two thumbs up on Big Question #9.
Program response: The EDO will continue to work with the WAC and others to formalize this operational rule for the proposed J2 reservoir or any other similar Program water projects.
3. The draft 2014 State of the Platte report (pg. 29, lines 881-885) has the following statement: "The U.S. Fish and Wildlife Service maintains the GC needs to address, at the policy level, perceived disagreement between the AMP management objective of "avoid adverse impacts from Program actions on pallid sturgeon populations" and the stated Program goal of "testing the assumption that managing flow in the central Platte River also improves the pallid sturgeon's lower Platte River habitat." The ISAC agrees that the GC needs to address this perceived disagreement.
Program response: The GC will have to provide further direction on this issue.

ISAC Question #2 – In June 2015 the GC accepted the "two thumbs down" assessment for Big Question #1 in the 2014 State of the Platte Report. The GC asked the EDO to work with the ISAC and the TAC to provide guidance on how to adjust management in response to Program learning. Do you concur with the EDO recommendation to utilize a Structured Decision Making process to assist the GC with the adjust step of adaptive management and if so what guidance do you have to help make the process successful?
4. We recommend that the Program add a requirement for documentation of responses to peer reviews in the policy related to the PRRIP peer review process.
Program response: The EDO will draft revised PRRIP peer review process language for the GC to consider adopting as part of the Final Program Document.
5. We concur with the EDO recommendation to use Structured Decision Making to assist the GC with the adjust step of the AM cycle for Big Question #1. **6. We have the following other responses and recommendations on this topic** (not bolded for ease of reading)**:** • The ISAC endorses the EDO's proposed process, use of outside experts and schedule; • It's a good idea to have a test application of this structured process on Big Question #1, to figure out the process of adjustment in the AM cycle, and inform the GC on how this process works, recognizing that decisions on allocation of water and other resources for one big question could affect decisions on other big questions • It's critical that the GC be involved in reviewing existing Program objectives and performance measures, adding other metrics as required related to human values, and that the GC be involved in proposing management alternatives, as well as in evaluating those alternatives (see recommended roles Figure 1). • In developing the tools that help the GC to evaluate alternatives, it's important that: i. the models used in the process be kept as simple as possible (but not too simple) recognizing that the key filter for deciding whether or not to include a hypothesis or process in a particular model is whether or not it would help distinguish among alternatives (determined by sensitivity analysis); ii. the models should recognize uncertainty with respect to various functional relationships that are still being explored, such as alternative hypotheses related to the effects of flow on erosion of islands (for examples of decision analyses incorporating alternative hypotheses see Peters et al. 2001 and Alexander et al. 2006); iii. the models' assumptions be well documented, and reviewed by both the TAC and ISAC; iv. the EDO should work with a subset of TAC members who have the time to 'dig deep', and become thoroughly familiar with the models used in this process; and v. the EDO, TAC and outside experts develop simple ways to summarize for the GC the relationships in the models, and the consequences of the alternatives.
Program response: This will be discussed with the GC during the September 8-9, 2015 GC meeting.

1

ISAC Question #3 – What guidance can the ISAC provide regarding future sediment augmentation management actions on the central Platte River?

7. The ISAC recommends focusing all appropriate actions for creating habitat (i.e., vegetation removal, sediment augmentation, flow management) in the south channel upstream of Overton and intensively monitoring responses to these actions, in particular determining if sediment augmentation maintains or increases channel width.
8. We recommend that the Program base sediment augmentation decisions on thoroughly measured, multiple lines of evidence that have first been proven in an intensively monitored area (i.e., south channel below the J2 return; see Q4). We recommend using the following highest priority lines of evidence:
   - apply geomorphic change detection techniques (GCD) to green LIDAR, using methods developed by Dr. Joseph Wheaton of the USGS and colleagues[4];
   - analyze trends in transects, cross-sections, and other geomorphic metrics of interest derived from planform maps;
   - assess the magnitude of change in the longitudinal profile; and
   - specific gage analysis, reporting confidence intervals for changes in slope.
9. For each of these lines of evidence, we recommend that the Program:
   - review statistical power analyses conducted in other rivers to assess the risks of type 1 and type 2 error (e.g., falsely detecting a sediment deficit that does not exist, and not detecting a sediment deficit that does exist); and then
   - conduct statistical power analyses with data collected from the Platte (so as to best characterize spatial and temporal variability with local data).

Program response:
This will be discussed at the 2015 AMP Reporting Session, as part of development of the PRRIP FY16 budget, and as part of implementation planning for 2016 and beyond.

1

ISAC Question #4 – Can the Program collect the necessary geomorphology and vegetation monitoring data to assist with evaluation of the Big Questions and related hypotheses through acquisition of imagery (e.g., LiDAR, aerial photos)? If so, what considerations are important before the Program moves to this monitoring effort?

10. The ISAC's previous recommendations on geomorphic and vegetation monitoring (ISAC 2014b) are worthy of review, and can be found on pages 50-51 of the 2014 State of the Platte report. Table 1 summarizes the ISAC's recommendations on geomorphic and vegetation monitoring from the July 2015 meeting, which are generally consistent with our previous recommendations, but more specific.
11. Table 1. ISAC recommendations on geomorphic and vegetation monitoring.
12. Carefully examining (with ISAC assistance if desired) the ~30 or so vegetation and geomorphic metrics that are now being measured at each transect and decide what's really needed for whooping crane and geomorphic analyses (i.e., considering the fidelity of metrics as surrogates for processes that affect changes over time in the channel, possible redundancies in metrics, cost, value of along the causal chain within the conceptual ecological model, ease of measurement).
13. Re-evaluating the benefit of the rotating panel sites. At present, 50% of the sites are done every year at trend sites, and one quarter of the remaining sites are sampled every year as

[4] https://sites.google.com/a/joewheaton.org/www/Home/research/projects-1/morphological-sediment-budgeting

rotating panel sites. The original intent of the rotating panel sites was to get a better estimate of system-wide status, but the magnitude of spatial and temporal variability appears to be such that the density of transects (including both fixed and rotating panel sites) is insufficient to detect changes on a system wide scale.

Program response:
This will be discussed at the 2015 AMP Reporting Session, as part of development of the PRRIP FY16 budget, and as part of implementation planning for 2016 and beyond.

14. The ISAC has the following recommendations on presentation and statistical issues in the Channel Width Analysis manuscript, as well as other statistical and geomorphic recommendations which have been communicated directly to scientists at the EDO.

- Add an abstract to the manuscript.
- Redo the boxplots in Figures 3 to 5 to remove the extraneous diagonal lines.
- Digitize polygons (areas) and dividing them by length to get a quick but more accurate estimate of reach- averaged width.
- Evaluate whether considering only the middle transect will provide most or perhaps all, of the information obtained by the more complicated approach used in the current draft of the manuscript. The simpler analysis is preferred if the results are similar.
- Most importantly, remove the ANOVAs (which were computed using the *lm* command in the statistical program R to fit a linear model- without the intercept) and replace them with individual t-tests so that the standard errors are computed correctly. If you only have one set for each year (3 tests total), then you won't need to worry about a multiple-comparison problem.
- It is not accurate to call the differences in June 'errors'. One would expect that the exposed width is smaller when water levels are higher. Remove the 'error' language (e.g., line 178 in Channel Width Analysis). Similarly, for Figure 4 in the Channel Width Analysis, call these "differences" instead of "errors".

Program response:
The EDO will consider edits to the Channel Width Analysis manuscript as discussed above.

General ISAC Recommendation

15. The response to Big Question #2 in the 2014 State of the Platte Report could be improved.
The response to Big Question #2 currently focuses too much on the *why* before giving the reader the *what*:
What: Repeated high flow events equal to or exceeding SDHF under a balanced sediment budget (i.e. below Overton) have not produced or maintained suitable WC roosting habitat on an annual or near-annual basis
Why? Statements in present draft (e.g., *Phragmites* / reed canary grass). Other factors?

16. The Program should place a high priority on completing the analyses that will help to better define 'suitable habitat' for whooping cranes.

Program response:
The whooping crane habitat synthesis chapters, now in development by the EDO, will address whooping crane suitability through time and other aspects of the "what" question.

Independent Science Advisory Committee (ISAC)

Responses to Questions Posed by the Platte River Recovery Implementation Program (PRRIP) in October 2014

Islands in Platte River near Elm Creek during high flows, Oct 2, 2013.

Submitted to
PRRIP Governance Committee

C/o Dr. Jerry Kenny, Executive Director,
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November 16, 2014

The Platte River Recovery Implementation Program (PRRIP or Program) requested written input from the Independent Science Advisory Committee (ISAC) on six questions. These questions were the focus of discussions during the ISAC meeting on October 16, 2014 in Omaha, NE, which immediately followed the Adaptive Management Plan (AMP) Reporting Session on October 14-15, 2014. To enable the Program to easily extract ISAC recommendations from our overall discussion of the questions posed to us, we have put our most important recommendations in **blue bolded** text. These recommendations are contained within the context of the overall discussion of each question so that our rationale is clear.

General Questions

1) Are the 2014 Big Question assessments logical based on your understanding of Program data and consistent with what you have learned during your involvement with the Program?
Reference Document – 2014 State of the Platte Report Cards

We have the following high level comments and recommendations on the Big Question (BQ) assessments:

- In general, the ISAC likes the new format, and adds the following recommendations:
    - **the graphic is very important and will be main piece read by the Governance Committee, so making this graphic scientifically correct and easily understood is essential**
    - **slider bars should have the key metrics related to each big question (e.g., habitat for BQ 1, not # nests on third bar)**
    - **include more explanation in assessment caption for slider bars (e.g., relationship to objectives; showing Short-Duration High Flows (SDHF) on bars, meaning of red and green)**
    - **you may not need green on some bars, just red (more not always better)**
    - **include report cards at the front of State of the Platte Report so that previous lines of evidence are not lost, with updates to the State of the Platte report included in the main report**
- With respect to the text included in the report cards (and the overall State of the Platte report) **we recommend that the Program use phrases which distinguish among different levels of evidence, such as:**
    - We're certain of the following…
    - We estimate with confidence that…
    - Current models predict…
    - Remaining uncertainties include…
    - Our judgment is that…
    - Our predictive ability would be enhanced if…

The ISAC has the following specific comments on individual assessments of the Big Questions:

- BQ #1 - Will implementation of Short-Duration High Flow releases produce suitable tern and plover riverine nesting habitat on an annual or near-annual basis?
    - *Current rating in 2014 report card:* One thumb down now, possibly two thumbs down after peer review of 6 tern / plover synthesis chapters
    - *ISAC comments and recommendations:*

- ISAC agrees with 2014 report card conclusions on BQ #1.
- **Figure 1 should list the amount of suitable in-river habitat created next to each point, not the number of nests.**
- **Including cost on Figure 1 (top x axis) is misleading, since many of the high flow events were natural, and such high volumes would not have been purchased; the cost of water can and should be discussed in the text.**

- BQ #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?
  - *Current rating in 2014 report card:* Scratchy head; uncertain
  - *ISAC comments and recommendations:*
    - Without effective spraying and mechanical actions, SDHF could make things worse by causing an incised channel and depositing vegetation on existing bar forms.
    - SDHF on its own (as stated in BQ #2) will not be able to <u>produce</u> sufficient channel widths and suitable roosting habitat for whooping cranes in the Central Platte River. SDHF *may* be able to <u>maintain</u> sufficient channel widths, if (and only if) such flows follow *Phragmites* control and mechanical actions to remove vegetation, and SDHF are applied during the germination season.
    - We support the Program's proposal to adjust the current rating to 1 thumb down based on the above comments and the weight of evidence.
    - **In 2015, the Program should consider revising BQ #2 to BQ #2a: "*If applied after herbicide and mechanical actions to remove vegetation, will SDHF during the vegetation germination season be able to <u>maintain</u> suitable whooping crane riverine roosting habitat on an annual or near-annual basis?*"**
    - The USGS telemetry data presented by Aaron Pearse is very relevant to BQ#2. The report card should describe the 10^{th} percentile and median channel widths used by satellite-tracked whooping cranes, since these data help to inform the definition of "suitable" in BQ#2. These values could be included on the slider diagram.
    - **The Program should describe a process and timeline for revising habitat suitability criteria for whooping cranes.** First, the Program should communicate a process and timeline for how they will use telemetry data results, (e.g., slides 35-43 from Aaron Pearse's PowerPoint) to evaluate and possibly refine their minimum habitat use criteria for whooping cranes. Second, the program needs to refine its understanding of the relationship between channel width and suitable habitat. At this point in time, it isn't clear whether the cranes select for channel width or for habitat that meets the use criteria identified by the Program. Note that developing habitat that meets the habitat use criteria may be a consequence of channel width, but could also be achieved by other means. There may be a mismatch between SDHF creating a 750' minimum channel width and the Program's minimum habitat criteria for cranes. None of the minimum habitat criteria include channel width (see pg. 76 in 2014 State of the Platte Report). The implied assumption of the Program is that creating a 750' wide unvegetated channel width will yield all or most of the minimum habitat criteria. Is this valid? Is it being tested?

- Further ISAC suggestions on vegetation monitoring and habitat suitability are found at the end of this report in parts d and e (respectively) of section **9) other ISAC Suggestions**.
- The caption for Figure 2 should indicate that pink areas are vegetated.

- BQ #3 – Is sediment augmentation necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?

  - *Current rating in 2014 report card:* One thumb up. Various complexities noted.

  - *ISAC comments and recommendations:*
    - ISAC generally agrees with 2014 report card assessment of BQ #3, but we think that sediment augmentation needs to be thought through more carefully. It appears that sediment augmentation is necessary upstream of Kearney, an area which is definitely in sediment deficit. The PRRIP plan was to add sediment near J2 and make the whole Associated Habitat Reach come to sediment balance. Unfortunately, it appears that large flow events create degradation, which then requires much more sediment.
    - Based on the modelling work by Tetra Tech presented by Bob Mussetter in Omaha on Oct. 14, it's challenging to determine whether or not the river is in balance in other areas (i.e., lots of samples required, uncertainty as to whether survey locations are representative of the overall reach and adequately cover spatial variability). If a reach were in sediment balance, then by the original definition of Flow-Sediment-Mechanical treatments (FSM) you would not need sediment augmentation to create / maintain habitat. Using green LIDAR to assess changes in channel geometry and aggradation / degradation over time (see ISAC comment in section 9) should provide better spatial coverage, even though it’s less precise than data from cross-sections.

    - **We recommend addressing sediment augmentation on a small scale rather than on a 90-mile scale (e.g., in 5 miles below J2 reservoir, using finer sediment grain size; or at Shoemaker Island). This will be a much more tractable adaptive management experiment, with stronger spatial and temporal contrasts, that can be intensively monitored to accurately determine changes in sediment transport and storage as well as bar formation.**

- BQ #4 – Are mechanical channel alterations necessary for the creation and/or maintenance of suitable riverine tern, plover and whooping crane habitat?

  - *Current rating in 2014 report card:* One thumb up

  - *ISAC comments and recommendations:*
    - In general, we concur with the conclusion on BQ #4 – mechanical channel alterations are necessary. However, there are some subtleties which need to be discussed in either the report card or the State of the Platte report, as outlined below.

- The required *frequency* of channel maintenance may be somewhat different for whooping crane (WC) vs piping plover (PP) and least tern (LT) habitats. Whooping crane habitat was apparently maintained at Rowe Sanctuary, but it appears to be much more difficult to maintain piping plover and least tern nesting islands.
- Is there a "Goldilocks bar height" of mechanically created islands for piping plovers and least terns– not so high that turtles colonize them, yet high enough to not be frequently washed away during the nesting season, and low enough to remain islands (rather than peninsulas) so that birds use them? Or is that difficult to achieve in most of the Central Platte reaches for reasons outlined in the synthesis chapters, including flow timing / nesting conflicts, resulting in the need to apply mechanical treatments annually? What is the persistence of "Goldilocks" bars?
- If there is no such "Goldilocks bar height" for some reaches, then **the answer to BQ #4 will need to elaborate on the frequency of mechanical channel alterations required to create and maintain in-river piping plover and least tern habitat on a sustainable basis in these reaches.**
- Minor comments:
  - In the section "Answering BQ #4 in the First Increment" the phrase "if published in a peer-reviewed journal" should be changed to "if successfully peer-reviewed according to the Program's peer review process" (see ISAC 2013 report on the PRRIP).
  - The second y-axis in Figure 4 should have units of Watts/m^2. This is a very important figure.
  - The caption on Figure 5 states that Rowe Sanctuary retained "high habitat suitability". Please clarify whether this is for whooping cranes only or also for terns and plovers

- BQ #5: Do whooping cranes select riverine roosting habitat in proportions equal to its availability?

  - *Current rating in 2014 report card:* Uncertain – scratchy head

  - *ISAC comments and recommendations:*
    - We understand that the habitat selection study is not yet complete, and so this conclusion is reasonable at this time. The assessment should include inferences from both USGS telemetered birds and local data.
    - Once the present crane telemetry results are evaluated, it should be determined how useful local and telemetry monitoring has been in addressing crane-related Program Big Questions and if each form of monitoring should be continued, reactivated, redesigned, or discontinued (if past data are sufficient).
    - As stated, the phrasing of BQ #5 apparently refers to the *proportion of the total area* that is made up of riverine roosting habitat (i.e., a spatial comparison). This is subtly different than hypothesis WC-1, which states: "Whooping cranes that use the central Platte River study area during migration seasons prefer habitat complexes (Land Plan Table 1) and <u>use will increase proportionately to an increase in habitat complexes</u>" [emphasis added]. WC-1 hypothesizes that both the area of

Program habitat complexes and whooping crane use will increase *over time*. BQ #5 and WC-1 imply different kinds of data analyses. **The Program should clarify which question they really want to answer – WC-1 or BQ #5 (or both).**

- The Program should first define a criterion for what constitutes selection (e.g., biologically and statistically significant differences between use and availability). If such differences are observed, the Program might reconsider their current ranking. For example, if managed lands make up 20% of the area, but have 40% of the cranes and this mean use is statistically different than availability then the birds are not selecting Program habitats in proportion to their availability.
- It will be important to explain to the Governance Committee that a 1-thumb down answer to this BQ (with birds selecting managed lands over other lands) actually means that the Program efforts to create habitat are effective (a confusing outcome). Are there other options like rephrasing the question (e.g., *Do whooping cranes select suitable habitat in proportions greater than its availability?*) The percent of the total whooping crane population using the Platte is a very useful secondary indicator of the suitability of roosting habitats for whooping cranes in the Central Platte (Figure 6).
- It is important that the Program not equate 'use' with 'preference'. For example, if managed lands make up 20% $\pm$ a confidence interval (CI) of available area, but cranes use managed lands 40% $\pm$ CI of the time or 40% + CI of the cranes were recorded on managed lands, it is incorrect to conclude that they 'prefer' managed lands over other habitats along the central Platte. 'Preference' implies selection of a particular habitat (i.e., any potentially limiting resource like food, habitat, mates) when ALL suitable habitats are available to choose from. It is unlikely that all suitable habitats for migrating cranes are present within the Central Platte Program Area, thus *preference* cannot be determined. In the above example cranes are '*selecting'* managed lands, perhaps because they are the most suitable of the options present within the Program, although they might prefer some other conditions. One benefit of the telemetry study is that it provides a larger sample of available habitats for the cranes to select from and thereby provide the Program with a more accurate measure of selection.
- Further suggestions on data analyses for BQ #5 are found at the end of this report in part e of section **9) Other ISAC Suggestions**.

- BQ #6 – Does availability of suitable nesting habitat limit tern and plover use and reproductive success on the central Platte River?
  - *Current rating in 2014 report card:* One thumb up

  - *ISAC comments and recommendations:*
    - Patterns of change in the Central Platte River are consistent with the hypothesis that more habitat leads to more birds, but there are alternative explanations which should be acknowledged and addressed.
    - The above point was discussed in both the October 2013 and May 2014 ISAC reports, and was presented by the ISAC to the Governance Committee in June 2014 (Figure 1). As stated in the May 2014 ISAC report (page 3, point 6):

> "As described in previous ISAC comments (PRRIP 2013 State of the Platte Report, pg. 46), there are other alternative mechanisms which might explain the observed patterns of increased nests and breeding pairs, including: increases in the overall meta-population; decreases in other habitats (e.g., Lake McConaughy) has caused birds to move to the Central Platte; improved predator control in off channel sand and water (OCSW) habitats (rather than increased habitat area) has resulted in improved survival and increased numbers of nests… **The Program should acknowledge these alternative explanations in the State of the Platte Report and evaluate them to the greatest degree possible given available data."**

- We understand that Program scientists "are still working through how to acknowledge these alternative explanations" (statement in the document "PRRIP Responses to May 2014 ISAC report"). There isn't much to work through. The State of the Platte report could simply quote or paraphrase text from the October 2013 or May 2014 ISAC reports as alternative explanations of the observed patterns. If alternative explanations are not acknowledged (even if they can't be tested with current data), it will likely be difficult for the published analyses of BQ #6 to pass successfully through a peer review. Peer reviewers need to see that scientists have openly considered all plausible explanations of observed patterns, not only their preferred hypothesis. **The ISAC recommends that the Program implement our previous recommendations from our October 2013 and May 2014 reports, and illustrate alternatives using comprehensive conceptual ecological models for each species, as recommended in the ISAC's 2009 report (pages 7, 15-18).**

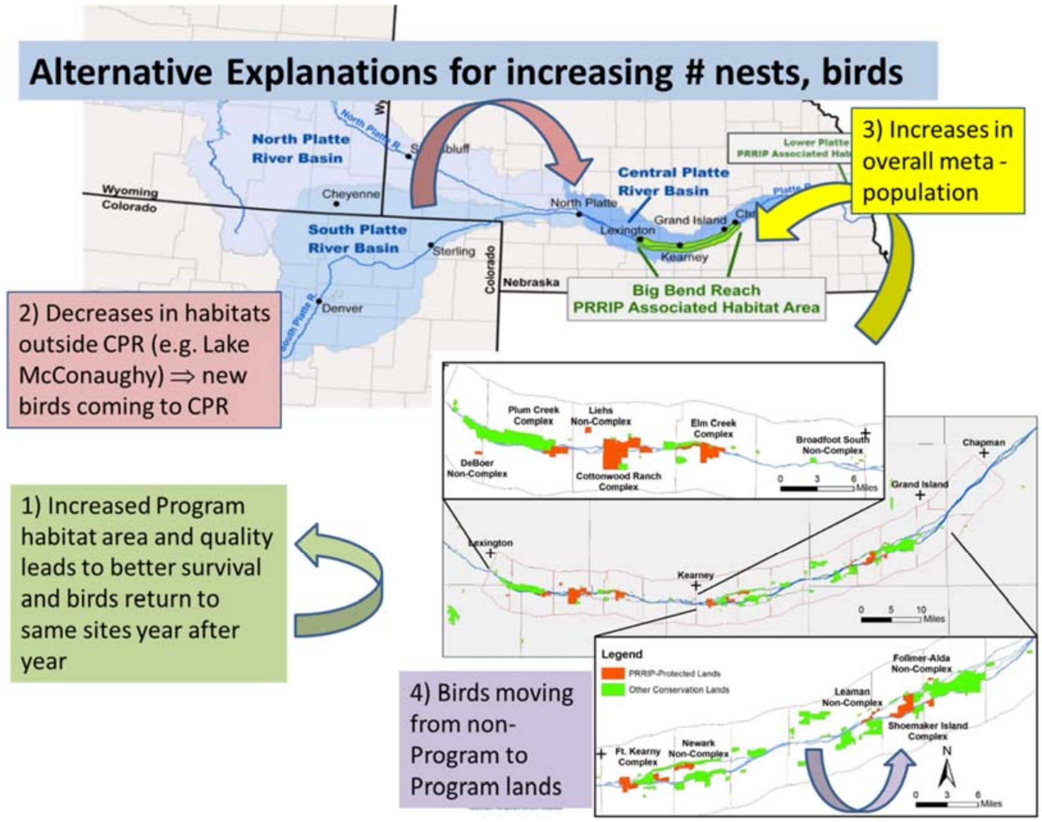


Figure 1: Illustration of alternative hypotheses to explain increasing numbers of nests and birds on Program Lands. (Source: ISAC presentation to Governance Committee on June 10, 2014).

- BQ #7 – Are both suitable in-channel and off-channel nesting habitats required to maintain central Platte River tern and plover populations?
  - *Current rating in 2014 report card:* One thumb down
  - *ISAC comments and recommendations:*
    - We agree with the one thumb down assessment. Furthermore, Jason Farnsworth's very helpful analysis (Table 1) showed that fledging birds on off-channel habitat is more cost-effective than fledging birds on in-channel habitat.
    - Jason's analysis assumed that the fledge ratio of birds nesting on in-river islands was equal to fledge ratios on off-channel habitats. The synthesis papers show that the height of bars and timing of peak flows in the Central Platte unfortunately increase the risk of nest loss, so in-river habitats likely have lower fledging rates and higher costs / fledgling than indicated in Table 1. It would be good for Jason to show a range of costs / fledgling that incorporate a range of reasonable assumptions about fledgling rates.
    - In addition to the metrics in Table 1, it would be helpful to show the cost per fledgling based on the sum of both terns and plovers.

Table 1: Comparison of the costs of creating off-channel and in-channel habitat. (Source: Jason Farnsworth, Land Presentation at 2014 AMP Session)

Mechanical NPV/Benefit

- Tern density: 1 pair per acre
- Plover density: 1 pair per 5 acres
- Tern fledge ratio: 0.7 chicks per nest
- Plover fledge ratio: 1.13 chicks per nest

	Off-Channel	On-Channel
Net Present Value of Costs	$ 1,273,288	$ 2,297,869
Tern Fledglings	2,310	1,101
Cost per Tern Fledgling	$ 551	$ 2,087
Plover Fledglings	746	355
Cost per Plover Fledgling	$ 1,707	$ 6,464

- BQ #8 – Does forage availability limit tern and plover productivity on the central Platte River?
  - *Current rating in 2014 report card:* One thumb down
  - *ISAC comments and recommendations:*
    - ISAC agrees with this conclusion, and has comments on the draft journal article (see more detailed responses below under ISAC question #6).
    - The most important finding is that tern fledging does not decline at low flows
- BQ #9 – Do Program flow management actions in the central Platte River avoid adverse impacts to pallid sturgeon in the lower Platte River?
  - *Current rating in 2014 report card:* One thumb up
  - *ISAC comments and recommendations:*
    - ISAC agrees with this conclusion. No new information was presented to change this assessment.
- BQ #10 – How do Program management actions in the central Platte River cumulatively contribute to least tern, piping plover, and whooping crane recovery?
  - *Current rating in 2014 report card:* One thumb up
  - *ISAC comments and recommendations:*
    - ISAC agrees with this conclusion
    - **The word "How" should be removed from BQ #10, so that the question can be answered either positively or negatively.**

2) Is the PRRIP (stakeholders, EDO, and contractors) implementing Adaptive Management Plan management actions, research and monitoring, and data synthesis in a way that facilitates hypothesis/Big Question testing and evaluation of the FSM management strategy?

- The ISAC believes that the Program is doing adaptive management as intended in the Adaptive Management Plan. In both this and previous reports the ISAC has made various recommendations for improving the design and implementation of actions, as well as monitoring and evaluation methods. The Program has been very responsive to the ISAC's recommendations, and such iterative improvements are a hallmark of rigorous adaptive management.
- Adaptive management involves iterative learning from management actions, research and natural variability. The Program has been intensively involved in such learning, as evident through the annual Adaptive Management Plan reporting sessions, and periodic changes in actions, modelling, monitoring, analyses and conclusions.
- The program is implementing AM as described in the U.S. Department of Interior technical guide to adaptive management (Williams et al. 2009) and is consistent with other earlier guides to adaptive management (Holling et al. 1978, Taylor et al. 1997, Sit and Taylor 1998, BC Ministry of Forests 2000).
- Adaptive management hypotheses can be tested using unexpected natural events as well as deliberately implemented management experiments (Taylor et al. 1999, Melis et al. 2006). For example, as described in the ISAC Oct 2013 report (answers to BQ 1), the Program does not need to have exactly SDHF magnitude and duration of flows to gain knowledge about the efficacy of SDHF for habitat creation and maintenance. Flows in excess of SDHF have occurred opportunistically, and where there is sediment balance these events are reasonable tests of SDHF and provide useful information for BQ 1. Further suggestions on tests of SDHF and geomorphic monitoring are found at the end of this report in part c of section **9) Other ISAC Suggestions**.
- **We recommend that the Program concisely document each of the AM steps that have been completed for each of the Big Questions in each year of the program (conceptually illustrated in Table 2), including documenting the learning that has occurred from both planned and unplanned/natural experiments.** This would be a valuable synthesis for both the Platte Program and other large AM programs. To be valuable for Program learning, this documentation will require a detailed description of exactly how hypotheses were tested, a candid assessment of the challenges encountered, and various iterations to revise previous steps in the AM cycle (i.e., the devils are in the details). To lessen the burden of this task, we suggest that the EDO go through a first pass at a high level in a concise format, and then evaluate the most appropriate form and timing for a more detailed description.
- **We also advise the Program to conduct periodic evaluations of all existing research and monitoring programs to assure they are yielding information capable of discriminating among alternative priority hypotheses that address Big Questions, and revise or eliminate those that do not.**

Table 2. Conceptual illustration of documenting AM steps completed by the Program for each Big Question. The arrows in 2012 and 2013 illustrate hypothetical revisions of hypotheses, experimental designs, monitoring and evaluation.

Big Question	AM Step	2007	2008	2009	2010	2011	2012	2013	2014
1	1-Assess	Step 1.1	Step 1.2				Step 1.3		
	2-Design		Step 2.1	Step 2.2			Step 2.3		
	3-Implement			Step 3.1	Step 3.2				
	4-Monitor			Step 4.1				Step 4.2	
	5-Evaluate			Step 5.1				Step 5.2	
	6-Adjust						Step 6.1		
2									
…									

3) **Given existing channel conditions and multiple outside influences on performance (e.g. extensive vegetation encroachment and associated management), how can the Program best test the hypotheses underlying Big Question #2 and arrive at an answer?**
Reference Document – 2014 State of the Platte Report Cards

- The ISAC's view is that the range of flows and channel width responses experienced over the last several years is sufficient to answer BQ #2 and test hypothesis PP-1b. The ISAC supports the Program's proposal to change the answer to both BQ #2 and hypothesis PP-1b to 1 thumb down.
- Figure 4 in the Big Questions report cards illustrates that SDHF is not sufficient on its own to increase the width of the vegetation-free channel. SDHF could only work in concert with *Phragmites* control (spraying, grazing, drying) and other mechanical actions. **It is worth exploring biological controls on *Phragmites* including cattle, though we recognize the challenges of keeping cattle out of the river. Additional ideas are given here: http://greatlakesphragmites.net/files/JGilbert-Phrag-talk_April-5-2013.pdf**
- The best test of alternative combinations of actions would involve measures of biological effectiveness, cost effectiveness, and persistence over time.

4) **How should the Program evaluate the "cumulative contribution" of management actions to target species recovery and thus develop an assessment for Big Question #10?**
Reference Document – 2014 State of the Platte Report Cards

- As stated above, the Program should remove "How" from start of big question 10 since in its current form the question can't be answered either positively or negatively.
- To answer BQ10, work through cause-effect pathways in conceptual models for each species (i.e., from implementation of actions to habitat change to biological response measures), evaluating the

likelihood of each step being true, and also examining the likelihood of other explanations (e.g., Figure 2, Table 3)

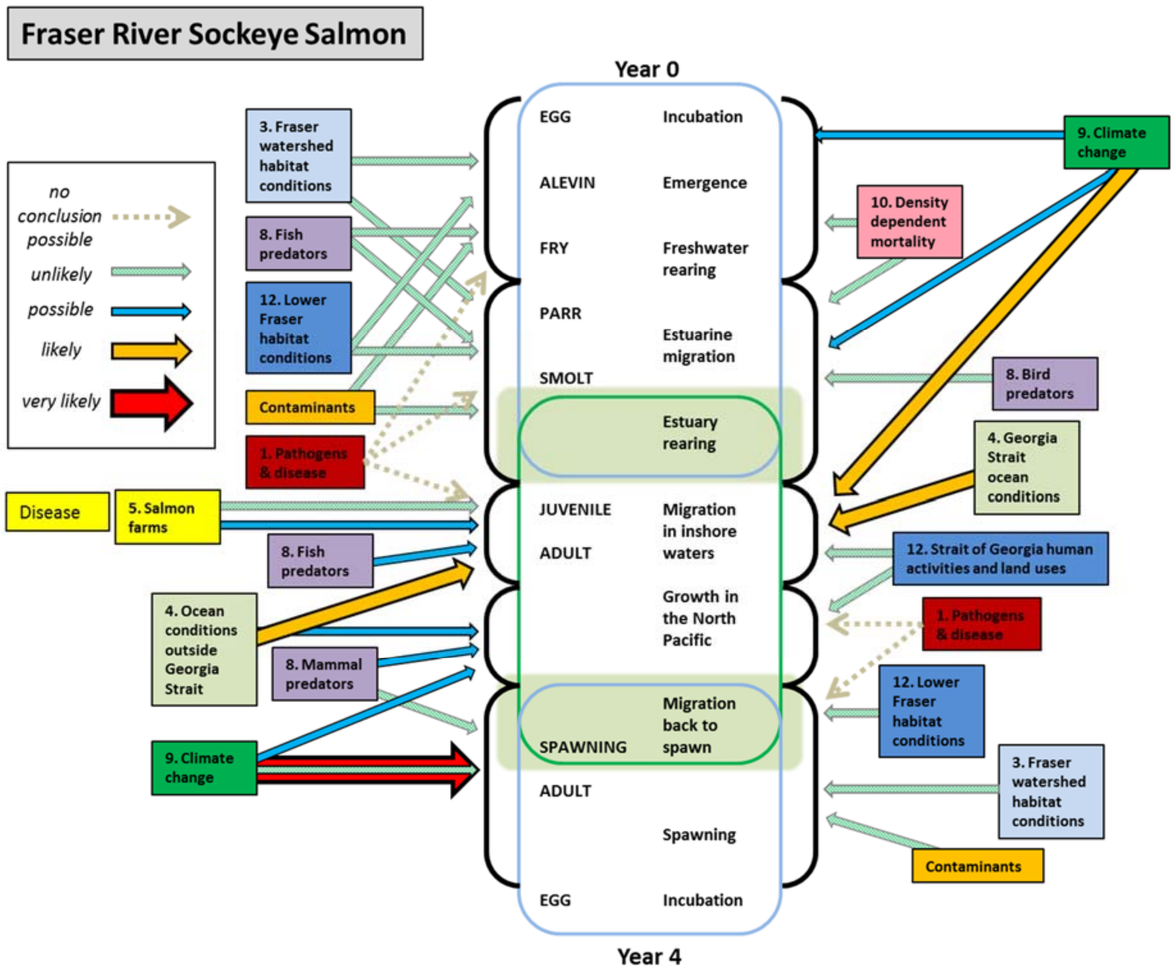


Figure 2. Example of a conceptual model that summarizes the likelihood of different causes for observed changes in a species. The topic illustrated is declines in the productivity of sockeye salmon in the Fraser River, with twelve hypothesized causes that interact cumulatively to affect different life history stages (middle part of diagram). The sockeye conceptual model and possible mechanisms of change are much more complicated than the Platte conceptual models. The width and color of the arrows designates the likelihood of each possible cause (see legend in upper left). Table 3 shows the same analysis in tabular form. Source: summary presentation of Marmorek et al. 2011.

Table 3. Tabular representation of the likelihood of different causes for observed changes in a species (alternative form to summarize the information in Figure 2). Source: Marmorek et al. 2011

Factor	Life History Stage				
	STAGE 1 Incubation, Emergence and Freshwater Rearing	STAGE 2 Smolt Outmigration	STAGE 3 Coastal Migration & Migration to Rearing Areas	STAGE 4 Growth in N. Pacific and Return to Fraser	STAGE 5 Migration back to spawn
Forestry[a]	Unlikely	Unlikely	n.a.	n.a.	Unlikely
Mining	Unlikely	Unlikely	n.a.	n.a.	Unlikely
Large hydro	Unlikely	Unlikely	n.a.	n.a.	Unlikely
Small hydro	Unlikely	Unlikely	n.a.	n.a.	Unlikely
Urbanization above Hope	Unlikely	Unlikely	n.a.	n.a.	Unlikely
Agriculture	Unlikely	Unlikely	n.a.	n.a.	Unlikely
Water Use	Unlikely	Unlikely	n.a.	n.a.	Unlikely
Contaminants	Unlikely	Unlikely	n.a.	n.a.	Unlikely
Density Dependent Mortality	Unlikely	Unlikely	Unlikely[b]	Unlikely[b]	Unlikely[b]
Pathogens	No conclusion possible	No conclusion possible	No conclusion possible	No conclusion possible	No conclusion possible
Predators	Unlikely	Unlikely	Possible	Possible	Unlikely[b]
L. Fraser land uses	Unlikely	Unlikely	n.a.	n.a.	Unlikely
Strait of Georgia human activity & land uses	n.a.	n.a	Unlikely	Unlikely	n.a.
Climate Change	Possible	Possible	Likely	Possible	Definitely[c] Unlikely[d]
Marine Conditions	n.a.	n.a.	Likely	Possible	n.a.
Salmon Farms – Waste	n.a.	n.a.	Unlikely	n.a.	n.a.
Salmon Farms – Escapees	n.a.	n.a.	Unlikely	n.a.	n.a.
Salmon Farms – Sea Lice	n.a.	n.a.	Unlikely	n.a.	n.a.
Salmon Farms – Disease	n.a.	n.a.	Possible Unlikely	n.a.	n.a.
Hatcheries - Disease	n.a.	n.a.	Unlikely	n.a.	n.a.

c: escapement and harvest

d: R/S productivity

5) **Are the assumptions, methods, results, and conclusions in the sixth Tern and Plover Habitat Synthesis chapter reasonable?**
Reference Document – EDO memo on channel width and nest incidence

- Yes. ISAC members have provided the EDO with detailed suggestions on how to improve the presentation of these results.

6) **Are the assumptions, methods, results, and conclusions in the Forage Fish Analysis manuscript reasonable?**
Reference Document – Forage Fish Analysis manuscript

- ISAC has some questions on the draft manuscript's assumptions, but generally agrees with the overall conclusion that forge fish availability does not limit tern fledgling success (productivity). The most convincing evidence in the paper is in Figure 3 (relationship between fledgling success and flow), which does not require using the forage fish data. There are alternative hypotheses that could explain the paper's conclusions that were unable to be tested given the design of the forage fish monitoring program. Detailed comments and suggestions which we think would greatly improve the manuscript have been provided to the EDO.

- **We recommend that once this manuscript is revised to include multiple lines of evidence (USGS Sherfy report data; tern bioenergetics model), that it undergo the Program's internal peer review process as recommended by ISAC guidelines (2013 Report on the Platte River Recovery Implementation Program, pgs. 11-16) prior to submitting for publication.**

- We reiterate previous recommendations over the approach taken to address forage fish availability that are specific to this Big Question, but applicable to Program monitoring in general (ISAC 2009 Report on the Platte River Recovery Implementation Program; e.g. pg. 29: *It is recommended that a forage fish evaluation program be designed to explicitly test PRRIP interior least tern (ILT) foraging priority hypotheses, and be based primarily on the tern's perspective not the fishes*'.). Robust AM requires monitoring programs be designed and implemented to yield results that explicitly assess performance of management actions at achieving Program objectives (see Block et al 2001, Nichols and Williams 2006, Lyons et al 2008 for general guidance on designing monitoring for AM). Legacy monitoring such as the Nebraska Public Power District and Central Nebraska Public Power and Irrigation District's forage fish monitoring protocol were adopted to address Big Question 8, "Does forage availability limit tern and plover productivity on the central Platte River? However, these legacy monitoring programs did not provide information specifically designed to serve Program needs. Preparing this product as a manuscript to illustrate how surveillance monitoring data can be statistically analyzed for an AM/decision analysis case study, perhaps better illustrates the importance of designing targeted effectiveness monitoring capable of discriminating among alternative priority hypotheses at a program's outset.

7) **Are the assumptions, methods, results, and conclusions in the Planform Management manuscript reasonable?** *Reference Document* – Planform Management manuscript

- The ISAC felt that the oral presentation at the AMP Reporting Session was much stronger than draft manuscript.
- **The Planform Management manuscript needs much more work before it is ready to be submitted for peer review or to a journal.** Specifically, the manuscript should:

  - have a clearly stated objective that leads to evidence and a conclusion (the paper at present has a very "meandering" form);
  - use more recent planform literature (many of the references cited in Table 1 are no longer considered valid hypotheses, and are therefore not worthy of evaluation);
  - clarify the purpose of Table 1 with a more informative caption, which clarifies the meaning of the symbols (e.g., increasing the relationship variable is related to an increase (+) or decrease (-) in width, depth, etc.)
  - recognize that a lot of planforms that are called "braiding" may not be whooping crane habitat; and
  - respond to other detailed comments provided to the EDO by the ISAC.
- There is a worthwhile journal article here though it will require a fresh start. The available data sets for the Central Platte are unusually rich, and include records of channel change, planform and dimensions, together with flows, sediment transport, and vegetation. The focus on older references throughout is misguided. There are a number of significant independent variables which need to be

considered, well beyond what even more recent contributions have considered, (e.g., the relative importance of flows during seed germination versus the annual peak). The authors should consider focusing the paper on rejection of oversimplified planform models / discriminators in making decisions in the Platte as even the more mechanistic planform predictors do not capture some of the key processes that affect unvegetated width (the most direct physical metric related to the biological endpoint).

- A recommended path forward would be to have a revised version of the paper put through the Program's internal peer review process and then decide if it's appropriate to be published in a journal.

8) Do you have any recommendations for revisions or updates to the Target Flow Process recommended by the ISAC to the Governance Committee in 2012?
Reference Document – Target Flow Scope of Work

- Adaptive management involves learning. The ISAC has changed its view since 2012 on the best Target Flow Process in response to Program research and monitoring and the improved understanding of the system.
- Our current view is that the best possible use of program resources within the First Increment is to assess what *combinations* of actions (flow, sediment, mechanical) are likely to be most *effective* in achieving Program goals and objectives within currently available amounts of land and water, rather than focusing only on tools for determining target flows.
- This assessment should be accomplished through structured decision analysis, as recommended in comments 10 and 11 from our May 2014 report, including both cost and biological effectiveness of different actions.
- Such a decision analysis would explore a range of alternative combinations of actions, including changing the frequency, magnitude, timing and location of interacting flows, sediment and mechanical actions.
- The models used within the decision analysis could include a variety of tools and approaches which would have been explored under the original target flow process. Additionally, it will require more comprehensive conceptual ecological models (CEMs) built around the life-history of each of the target species that the Program specific CEMs currently in use (See main findings on CEMs from ISAC 2009 pgs. 7, 15-18).
- While it will be essential to externally review a completed decision analysis, the ISAC believes that this structured decision making process could be accomplished by the EDO working with the TAC and ISAC and using advice from an outside decision analysis expert as needed, rather than bringing in many outside experts through a workshop process as suggested in the 2012 target flow process.

9) Other ISAC suggestions

- The ISAC has the following additional suggestions to improve the Program:
  - **a. Format of AMP reporting sessions:**
    - **i. have presentations link back to big questions and hypotheses, either via the EDO or directly**
    - **ii. have documents and 3-page executive summaries intended for review distributed at least <u>10 days prior</u> to ISAC meetings, so that ISAC members have time to review them,**

   iii. **distribute all PowerPoint files 24-hours prior to presentations; and**
   iv. **use hyperlinks in documents.**

b. The cost analysis provided by Jason Farnsworth (Table 1) was very helpful. It may be worth putting this material into a separate document, or under BQ 10. See ISAC comments 10 and 11 from our May 2014 report.

c. ISAC thoughts and recommendations on geomorphic sampling:
   i. The Tetra Tech geomorphic assessment delivered orally on October 14th indicated that given what has been learned to date, the current monitoring regime will not deliver enough observations within an acceptable time frame (both sediment transport and cross-sections). It's likely not feasible to assess year to year changes in sediment storage and transport. The monitoring of both cross-sections and sediment transport could be improved by more intensive, site-specific sampling on a rotating annual schedule (e.g., once every 5 years), rather than making a couple of observations each year at every site. Sediment transport sampling needs to span a wide range of discharges, including high flows. Intensive sampling will still encounter high variance, but will be able to develop more reliable estimates of any changes over time in mean sediment transport.
   ii. Similar slope, discharge and grain size means that there isn't much difference in cross sections within a reach, and also little change from year to year. Variability within a year is however a concern.
   iii. **The ISAC recommends more intensive sampling within a year at fewer places (e.g. 20-30 samples over 1 year across a wide range of discharges including high flows), with a 5-year sampling frequency to see if the sediment-discharge relationship has changed.** The sampling frequency may need to be adapted to flow conditions (i.e., sampling in years with a wide range of flows will be much more informative than sampling during a very low flow year), though we recognize that it isn't possible to accurately predict water year conditions in advance.
   iv. **Shoemaker Island is an example of a high priority reach which could be a focus for more intensive sampling**
   v. **Continue LIDAR (ideally green LIDAR) and aerial photography every year to get system wide estimates of changes in topography**
   vi. **It would be worth exploring the ability to create contrasts in FSM (i.e., some F&M, some FSM), and to further clarify the purpose of FSM (i.e., to build bars, to prevent channel degradation, to remove vegetation, or all of these).** First, if there is a decision to tinker with the low flow regime to suppress vegetation encroachment through inundation (during germination) and/or drying, then those flows will be expressed differently (e.g. depth, duration, hydroperiod, soil moisture) in varying cross-section / floodplain geometries across program lands. These sites may have diverse assemblages of plant species with different tolerances that occupy elevational gradients that vary in frequencies and durations of inundation / drying across sites. Flows that drown one species may help another by increasing soil moisture later on. Second, mechanical approaches may include spraying, grazing, and heavy equipment. This would seem to lend itself to some systematic testing of different combinations of these F&M treatments, and sediment augmentation might also contribute to setting up some contrasts. The right set of contrasts depends on the objectives, which could be either: 1) taking another shot at getting the river to build

higher bars with finer sand (challenges with stage-discharge and flow timing relative to nesting notwithstanding); or 2) simply offset a probable trend of reach wide degradation. Mechanical approaches are clearly necessary –we don't need to look at treatments without mechanical as non-Program channels will shrink over time. The river is evolving to "pearls on a string" (the wide places where mechanical interventions have widened the channel). Contrasts could include different combinations of mechanical treatments (with and without sediment augmentation in areas of likely channel degradation).

vii. **the Program should explore the feasibility of acquiring finer sand (but not too fine), to build higher bars** (building on the physical comparison synthesis paper), though the stage-discharge relationship may still preclude the creation of sufficient bars in the Central Platte reach

d. ISAC thoughts and recommendations on vegetation sampling:

i. The vegetation sampling seems disconnected from program goals and big questions. Identifying all of the different vegetation species on thousands of quadrats seems very labor intensive, and these data are not being used to test any specific Program hypotheses or big questions.

ii. The key performance measure of interest is unvegetated width, which does not require enumerating other species. The Program is interested in understanding what happens to distribution and abundance of undesirable species (e.g., *Phragmites*, 7 others), but enumerating all other species is not required.

iii. The sampling frequency (annual) is insufficient to detect the causes of vegetation change (e.g., ice, flows, herbicide, mechanical).

iv. It is worth rationalizing the vegetation sampling to focus on the species which the Program hopes to remove with flows and other actions, with less detailed observations at each quadrat for the system scale monitoring. Monitoring should focus on testing the effectiveness of specific actions (e.g., dry flows, inundation) for killing particular species of undesired vegetation.

v. Get a system wide picture of *Phragmites* and other plants, and get a detailed picture of mechanisms of vegetation scour etc. at a smaller intensively monitored site such as Shoemaker Island.

vi. Flying LIDAR and hyper spectral imagery to assess vegetation, and then ground truthing with vegetation sampling of key undesirable species might save lots of money.

e. Monitoring of whooping crane habitat selection for BQ #5:

i. It is worth finishing local analyses that are in progress by WEST, and to clearly understand the uncertainty in conclusions given the small sample sizes

ii. USGS analyses of GPS data for whooping cranes were very worthwhile in informing Program habitat criteria and should be given a high weight in future Program decisions on habitat suitability criteria for whooping cranes (see detailed comments on BQ #5 under ISAC question 1)

iii. **once local and GPS analyses are completed, then it's worth assessing what is the most cost effective investment (i.e., more money into GPS work vs local work in the CPR)**

References

BC Ministry of Forests 2000. An Introductory Guide to Adaptive Management for Project Leaders and Participants. http://www.for.gov.bc.ca/hfp/amhome/Training/am-intro-guide.htm

Block, W. M., A. B. Franklin, J. J.P. Ward, J. L. Ganey, and G. C. White. 2001. Design and implementation of monitoring studies to evaluate the success of ecological restoration on wildlife. Restoration Ecology 9:293-303.

ISAC (Independent Science Advisory Committee). 2009. 2009 Report on the Platte River Recovery Implementation Program. Prepared for the PRRIP Governance Committee. 38 pp.

ISAC (Independent Science Advisory Committee). 2013. 2013 Report on the Platte River Recovery Implementation Program. Prepared for the PRRIP Governance Committee. 17 pp.

ISAC (Independent Science Advisory Committee). 2014. Responses to Questions Posed by the Platte River Recovery Implementation Program (PRRIP) in April 2014. 10 pp.

Lyons, J. E., M. C. Runge, H. P. Laskowski, and W. L. Kendall. 2008. Monitoring in the context of structured decision-making and adaptive management. Journal of Wildlife Management 72:1683-1692.

Marmorek, D., D. Pickard, A. Hall, K. Bryan, L. Martell, C. Alexander, K. Wieckowski, L. Greig and C. Schwarz. 2011. Fraser River sockeye salmon: data synthesis and cumulative impacts. ESSA Technologies Ltd. Cohen Commission. Tech. Rep. 6. 273p. Vancouver, B.C. www.cohencommission.ca

Melis, T.S., S.J.D. Martell, L.G. Coggins, W.E. Pine III and M.E. Andersen. 2006. Adaptive management of the Colorado River ecosystem below Glen Canyon Dam, Arizona: using science and modeling to resolve uncertainty in river management. Adaptive Management of Water Resources. AWRA Summer Specialty Conference, Missoula, Montana. June 26-28, 2006. http://www.gcmrc.gov/library/reports/Synthesis/Melis2006.pdf

Nichols, J. D., and B. K. Williams. 2006. Monitoring for conservation. Trends in Ecology and Evolution 21:668-673.

Sit, V. and B. Taylor (editors). 1998. Statistical Methods for Adaptive Management Studies. Res. Br., B.C. Min. For., Res. Br., Victoria, BC, Land Manage. Handb. No. 42.

Taylor, B., L. Kremsater, and R. Ellis. 1997. Adaptive management of forests in British Columbia. B.C. Min. For., For. Practices Br., Victoria, B.C.

Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

Reponses of Platte River Recovery Implementation Program (PRRIP or Program) to November 2014 Independent Scientific Advisory Committee (ISAC) Recommendations

What is this document?

This document provides official responses from the Program to ISAC recommendations from November 2014. The ISAC recommendations are contained in the November 16, 2014 ISAC report to the Governance Committee (GC). That report contains written responses from the ISAC to the GC regarding a set of eight questions posed to the ISAC that served as the focus of discussions during the October 14-16, 2014 ISAC meeting in Omaha, NE. Responses were drafted by the Executive Director's Office (EDO) and will be reviewed with the Technical Advisory Committee (TAC).

Format for responses:

ISAC recommendations are reported below in the same blue text and numerical order as contained in the November 16, 2014 ISAC report. Some ISAC responses to the Program questions in that report did not contain recommendations, thus the inconsistent numbering seen below. Each recommendation is listed under the Program question to which it pertains. An official Program response follows each comment.

ISAC Question #1 – Are the 2014 Big Question assessments logical based on your understanding of Program data and consistent with what you have learned during your involvement with the Program?

1. **General recommendations:**
   - **The graphic is very important and will be main piece read by the Governance Committee, so making this graphic scientifically correct and easily understood is essential**
   - **Slider bars should have the key metrics related to each big question (e.g., habitat for BQ 1, not # nests on third bar)**
   - **Include more explanation in assessment caption for slider bars (e.g., relationship to objectives; showing Short-Duration High Flows (SDHF) on bars, meaning of red and green)**
   - **You may not need green on some bars, just red (more not always better)**
   - **Include report cards at the front of State of the Platte Report so that previous lines of evidence are not lost, with updates to the State of the Platte report included in the main report**

Program response:

These recommendations generally refer to the new Report Cards drafted by the EDO and discussed with the ISAC and TAC at the October 2014 AMP Reporting Session. Since that meeting, the EDO decided to incorporate other changes in the 2014 State of the Platte Report and the Report Cards are not being used at this time.

2. **General recommendation:**
   - **We recommend that the Program use phrases which distinguish among different levels of evidence, such as:**
     - We're certain of the following…
     - We estimate with confidence that…
     - Current models predict…
     - Remaining uncertainties include…

	o Our judgment is that… o Our predictive ability would be enhanced if…
	Program response: The EDO generally adopted this phrasing in the Big Question assessments contained in the 2014 State of the Platte Reports.
3.	**For Big Question #1:** • **Figure 1 should list the amount of suitable in-river habitat created next to each point, not the number of nests.** • **Including cost on Figure 1 (top x axis) is misleading, since many of the high flow events were natural, and such high volumes would not have been purchased; the cost of water can and should be discussed in the text.**
	Program response: This figure has been updated accordingly in the 2014 State of the Platte Report.
4.	**In 2015, the Program should consider revising BQ #2 to BQ #2a: "If applied after herbicide and mechanical actions to remove vegetation, will SDHF during the vegetation germination season be able to maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis?**
	Program response: This will be a discussion topic for the Program in 2015 after completion of the 2014 State of the Platte Report.
5.	**The Program should describe a process and timeline for revising habitat suitability criteria for whooping cranes.**
	Program response: This will be a discussion topic for the Program in 2015 after completion of the 2014 State of the Platte Report.
6.	**We recommend addressing sediment augmentation on a small scale rather than on a 90-mile scale (e.g., in 5 miles below J2 reservoir, using finer sediment grain size; or at Shoemaker Island). This will be a much more tractable adaptive management experiment, with stronger spatial and temporal contrasts, that can be intensively monitored to accurately determine changes in sediment transport and storage as well as bar formation.**
	Program response: This will be a primary topic of discussion during the July 2015 joint ISAC/TAC meeting.
7.	**The answer to BQ #4 will need to elaborate on the frequency of mechanical channel alterations required to create and maintain in-river piping plover and least tern habitat on a sustainable basis in these reaches.**
	Program response: This will be a discussion topic for the Program in 2015 after completion of the 2014 State of the Platte Report.
8.	**The Program should clarify which question they really want to answer – WC-1 or BQ #5 (or both).**
	Program response: This will be a discussion topic for the Program in 2015 after completion of the 2014 State of the Platte Report.
9.	**The Program should acknowledge these alternative explanations in the State of the Platte Report and evaluate them to the greatest degree possible given available data.** **The ISAC recommends that the Program implement our previous recommendations from our October 2013 and May 2014 reports, and illustrate alternatives using comprehensive**

conceptual ecological models for each species, as recommended in the ISAC's 2009 report (pages 7, 15-18).

Program response:
These comment refers to alternative explanations for the early conclusion that habitat seems to be limiting for terns and plovers. The Program committed to the development of life-history based CEMs for the target species and then using linkages to those CEMs to help illustrate alternative mechanisms. That process has not yet started.

10. The word "How" should be removed from BQ #10, so that the question can be answered either positively or negatively.

Program response:
That change has been made in the 2014 State of the Platte Report.

ISAC Question #2 – Is the PRRIP (stakeholders, EDO, and contractors) implementing Adaptive Management Plan management actions, research and monitoring, and data synthesis in a way that facilitates hypothesis/Big Question testing and evaluation of the FSM management strategy?

11. We recommend that the Program concisely document each of the AM steps that have been completed for each of the Big Questions in each year of the program (conceptually illustrated in Table 2), including documenting the learning that has occurred from both planned and unplanned/natural experiments.

Program response:
Under consideration. Initial discussion of how best to implement this recommendation may be conducted as a part of evaluating the full adaptive management cycle as it pertains to Big Question #1.

12. We also advise the Program to conduct periodic evaluations of all existing research and monitoring programs to assure they are yielding information capable of discriminating among alternative priority hypotheses that address Big Questions, and revise or eliminate those that do not.

Program response:
This is a general course of practice within the Program. For example, the GC approved a revised whooping crane monitoring protocol in June 2015 and the status of the geomorphology/in-channel vegetation monitoring protocol will be discussed during the July 2015 joint ISAC/TAC meeting.

ISAC Question #3 – Given existing channel conditions and multiple outside influences on performance (e.g. extensive vegetation encroachment and associated management), how can the Program best test the hypotheses underlying Big Question #2 and arrive at an answer?

13. It is worth exploring biological controls on Phragmites including cattle, though we recognize the challenges of keeping cattle out of the river. Additional ideas are given here: http://greatlakesphragmites.net/files/JGilbert-Phrag-talk_April-5-2013.pdf

Program response:
This has been explored as a part of the ongoing effort to manage Phragmites within the channel.

ISAC Question #6 – Are the assumptions, methods, results, and conclusions in the Forage Fish Analysis manuscript reasonable?

14. **We recommend that once this manuscript is revised to include multiple lines of evidence (USGS Sherfy report data; tern bioenergetics model), that it undergo the Program's internal peer review process as recommended by ISAC guidelines (2013 Report on the Platte River Recovery Implementation Program, pgs. 11-16) prior to submitting for publication.**

Program response:
This document has been revised accordingly and will be peer reviewed through the Program's internal peer review process in September 2015.

ISAC Question #7 – Are the assumptions, methods, results, and conclusions in the Planform Management manuscript reasonable?

15. **The Planform Management manuscript needs much more work before it is ready to be submitted for peer review or to a journal.**

Program response:
The manuscript is being revised accordingly.

General ISAC Recommendations

16. **Format of AMP reporting sessions:**
    a. **have presentations link back to big questions and hypotheses, either via the EDO or directly**
    b. **have documents and 3-page executive summaries intended for review distributed at least <u>10 days prior</u> to ISAC meetings, so that ISAC members have time to review them,**
    c. **distribute all PowerPoint files 24-hours prior to presentations; and**
    d. **use hyperlinks in documents.**

Program response:
These formatting recommendations are under consideration for the October 2015 AMP Reporting Session in Denver.

17. **Geomorphic sampling:**
    - **The ISAC recommends more intensive sampling within a year at fewer places (e.g. 20-30 samples over 1 year across a wide range of discharges including high flows), with a 5-year sampling frequency to see if the sediment-discharge relationship has changed.**
    - **Shoemaker Island is an example of a high priority reach which could be a focus for more intensive sampling.**
    - **Continue LIDAR (ideally green LIDAR) and aerial photography every year to get system wide estimates of changes in topography.**
    - **It would be worth exploring the ability to create contrasts in FSM (i.e., some F&M, some FSM), and to further clarify the purpose of FSM (i.e., to build bars, to prevent channel degradation, to remove vegetation, or all of these).**
    - **The Program should explore the feasibility of acquiring finer sand (but not too fine), to build higher bars**

Program response:
All topics of discussion during the July 2015 joint ISAC/TAC meeting in Kearney.

18. **Vegetation sampling:**
    - **It is worth rationalizing the vegetation sampling to focus on the species which the Program hopes to remove with flows and other actions, with less detailed observations at each quadrat for the system scale monitoring. Monitoring should focus on testing the**

effectiveness of specific actions (e.g., dry flows, inundation) for killing particular species of undesired vegetation. • **Get a system wide picture of Phragmites and other plants, and get a detailed picture of mechanisms of vegetation scour etc. at a smaller intensively monitored site such as Shoemaker Island.** • **Flying LIDAR and hyper spectral imagery to assess vegetation, and then ground truthing with vegetation sampling of key undesirable species might save lots of money.**
Program response: All topics of discussion during the July 2015 joint ISAC/TAC meeting in Kearney.
19. Whooping crane habitat selection: • **Once local and GPS analyses are completed, then it's worth assessing what is the most cost effective investment (i.e., more money into GPS work vs local work in the CPR).**
Program response: This will be discussed once analyses are completed.

APPENDIX B

Technical Advisory Committee (TAC) Comments and Executive Director's Office (EDO) Responses

Comments by the Downstream Water User Technical Advisory Committee members on the 2014 State of the Platte Report

(These comments were developed using a previous draft version of the State of the Platte Report with different line numbers. All responses from the EDO are directed at the State of the Platte Report text in the original line numbers as identified below).

Line 119 and 120 – the term "natural" is somewhat misleading, both areas of river where the islands formed have seen extensive mechanical vegetation control for decades prior to the creation of the PRRIP and some since that time.

***EDO response** – Statement now reads: "A total of one plover nest was initiated on a ~~natural~~ sandbar that was disked during fall of 2010 and was overtopped by ~~following~~ the 2011 high-flow event (2012 nesting season). ~~and~~ Similarly, two tern nests were initiated on a ~~natural~~ sandbar that was disked during the fall of 2013 and was subsequently overtopped by ~~following~~ the 2013 high-flow event (2014 nesting season). None of these nests were on habitat that ~~did not~~ conformed to the Program's minimum suitability criteria.*

Line 126 – Suggest inserting U.S. Fish and Wildlife in front of proposed. In the Cooperative Agreement era it was agreed those objectives would not be used. However, with increased knowledge of how the river creates habitat it might be time to address what role the central Platte should play in species recovery as noted at line 630.

***EDO response** – Reference added at the end of this assessment to indicate species recovery objectives were proposed by the U.S. Fish and Wildlife Service but not agreed to by the Program.*

Line 184 thru 205 - Identify these are PRRIP staff ideas and have not been vetted through the stakeholder adaptive management process.

***EDO response** – Language added to address this comment.*

Line 215 – Phragmites was not a surprise and was discussed at length, there just was not data to indicate how it reacted to scour as opposed to other species. Now there is.

***EDO response** – The EDO continues to consider the presence of phragmites as a "surprise" in the context of adaptive management and resilience. No mention is made of phragmites in the Program document, no priority hypotheses in the AMP address phragmites and its impacts on channel morphology, and there is no record in Cooperative Agreement or EIS documents of planning or budget allocation to address the impacts of phragmites.*

Line 277 - may wish to indicate this is consistent with what Johnson 1994 found.

***EDO response** – Statement now reads: "We are currently unable to assess the potential effectiveness of annual flow releases during the germination season although, similar to findings of Johnson (1994), system-scale monitoring results suggest that channel inundation that prevents new vegetation from colonizing the channel is the key factor in maintaining unvegetated channel width.*

Line 293 - may wish to reference Johnson 1994.

***EDO response** – Statement now reads: Johnson (1994) recommended a discharge target of 2,600 293 – 3,000 cfs during the month of June to prevent seedling germination.*

Line 313 – Agree there is a sediment deficit, agree there may be need to be address that sediment deficit to maintain channel width and braiding. Do not follow how that equates to suitable habitat for the target species. Need some kind of connection of how braided river is habitat.

EDO response – *Comment noted. Channel width is an important habitat metric for all three target bird species. Anastomosed, wandering, and meandering channel planforms are all narrower than a braided planform. Additional work can be undertaken to develop numerical comparisons if the TAC/GC so desire.*

Line 415 – The PRRIP needs to lead or partner with other interested parties to control phragmites.

EDO response – *In general, the EDO concurs phragmites will need to be controlled through mechanical (spraying and biomass removal) and/or other means in the long term and long-term management will require logistical and financial partnerships.*

Line 6?? – Do we have data that is collected at the same intensity as the PRRIP data from all other areas to know similar increases have not been seen?

EDO response – *Statement now reads: Similar increases have not been observed ~~within~~ throughout the species range.*

Line 698 – Do not understand. If productivity is number of young produced over time, we know it does not or at least has not. In addition to the PRRIP somebody has been studying islands natural and constructed for over 30 years and the answer has always been the same. Few birds in certain years but no sustained use.

EDO response – *Providing what the Program has defined as 'Suitable In-channel Nesting Habitat' on an annual basis has been the issue to date. Until we have multiple years where Program-defined suitable in-channel nesting habitat is available, there is no way to know if in-channel habitat could support similar levels of productivity.*

Line 700 – Do not understand. We were under the impression from the foraging study that terns foraged almost exclusively in the river and plovers stay on pits.

EDO response – *The study did show terns foraged primarily on the river and plovers on pits, however, productivity in areas without flowing water does not seem to plummet when the river goes dry. That leads us to question if a flowing river truly is required for successful reproduction.*

Line 702 – There exists published information that pits will be suitable habitat for about 5 years.

EDO response – *It appears even small, relatively low areas that have never been managed can provide suitable nesting habitat for more than 5 years as the non-access islands at Broadfoot South have now had nesting for 6 consecutive years. That leads us to believe larger, higher nesting areas that have had vegetation management for multiple years may provide suitable nesting habitat for 10+ years.*

U.S. Fish and Wildlife Service Comments on the 2014 State of the Platte Report

BQ#1- The Service will work with the TAC to develop recommendations for the Governance Committee regarding tern and plover nesting. The Service supports continuing in-channel mechanical nesting island construction and maintenance and we recognize the importance of off-channel nesting habitat in the central Platte River as well.

EDO response – *The EDO will continue to work with the TAC to develop recommendations for "adjusting" in regard to Big Question #1.*

BQ#2- This big question addresses whether SDHF will produce and/or maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis. The Service does not agree with one thumb down and we do not support moving this to two thumbs down. We believe "inconclusive" is still appropriate at this time.

The Adaptive Management Plan includes hypotheses related to the ability of SDHF to improve green line elevation and unvegetated channel width. These metrics are thought to be important in "producing and maintaining suitable whooping crane habitat." BQ#2 does not clearly define what metrics pertaining to suitable habitat for whooping cranes have been met or are not being met. It would be helpful to define "suitable whooping crane habitat" as well as "produce and/or maintain" to help guide whether the question has been answered.

The final paragraph of BQ#2 states "The Program's directed scour research, now in manuscript development, will serve as the best source for synthesized reference data for this question." Given that this research was largely a modeling exercise, the Service believes using system-scale vegetation monitoring that measures the effect of high flow events on green line elevation and unvegetated channel width should be the primary mechanism for answering this question. System level aerial imagery may be another useful tool. While models can be helpful tools, the Service considers actual scientific monitoring data (e.g. PRRIP vegetation monitoring) to carry the most weight.

We do not disagree that phragmites is unlikely to be eliminated or entirely controlled by a SDHF, however, it remains to be determined whether SDHF can be used to effectively manage vegetation and maintain suitable habitat at an acceptable level within the associated habitat reach. System-scale Program vegetation monitoring has demonstrated that high flow events of 8,000 cfs and 10,000 cfs in 2010 and 2011, respectively, (post 2013 high flow vegetation monitoring has not been conducted yet), were effective in raising the green line elevation and increasing the unvegetated channel width. It also indicates that these metrics were negatively affected by low flows during the growing season of 2012 and 2013. There was no SDHF in either 2012 or 2013 (through the period of vegetation monitoring and growing season).

The assessment for BQ#2 uses images from one location (near Rowe Sanctuary) during one flow event to demonstrate that an SDHF is not effective in mobilizing the river bed. Given the high degree of variability within the central Platte River (channel widths ranging from a couple hundred feet to over one thousand feet), it would be useful to investigate aerial imagery from multiple years at multiple locations containing a variety of channel widths.

While SDHF may not be the only management tool needed to create or maintain suitable whooping crane habitat, we believe it can be useful (specifically during multi-year periods where natural high flows do not occur) in maintaining or further preventing channel narrowing, vegetation encroachment, and habitat degradation that ultimately reduces habitat conditions for whooping cranes. High flow events occurring since Program implementation indicate they improve habitat conditions over those that would exist in absence of SDHF or similar magnitude flows. Habitat conditions prior to Program implementation contained multiple years without flows exceeding or approaching SDHF magnitude. From 2000 through 2006, the highest recorded flow at the USGS stream gage at Kearney was 4,100 cfs. During that seven-year period, four (4) years contained years without any flows above 2,000 cfs. Conditions during this period provide a useful reference for conditions in absence of SDHF or similar magnitude flows. During PRRIP implementation, SDHF magnitude or greater flows have occurred in six of the nine years (2007, 2008, 2010, 2011, 2013, 2015), which is equivalent to the frequency recommended within the FSM strategy. It would be useful to complete an assessment comparing key geomorphic and vegetation characteristics between 2007 and 2015 reach wide on the central Platte River.

The Service estimates with confidence that:

1) The PRRIP has not released a flow in the magnitude approximating an SDHF and is still not capable of releasing a flow of the magnitude of an SDHF. Many complex relationships have yet to be investigated regarding SDHF's ability to improve/maintain habitat conditions for whooping cranes.
2) Natural high flows approximating or exceeding SDHF magnitude (2010 and 2011) actively removed a majority of vegetation species within the active channel. This raised the green line and increased the unvegetated channel width. We recognize much of the phragmites removed was chemically treated, which aids in the ability of flow to remove them. However, in absence of high flow events experienced within the first increment, much of the phragmites biomass would have persisted in the river, reducing bed and bar mobility. These areas would recolonize with vegetation.
3) Flows releases in the magnitude of SDHF during appropriate times (multi-year periods without bank full flows) improve habitat conditions for whooping cranes throughout the entire associated habitat reach above that which would be seen in absence of a SDHF magnitude flow events. It remains to be seen if the amount of improvement is sufficient.
4) Mechanical maintenance in not feasible throughout the entire river and will not benefit the entire associated habitat reach.

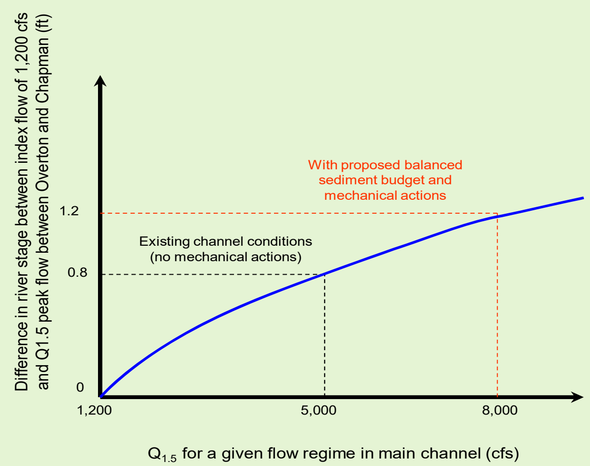
The Service recognizes there may be other beneficial flow releases (e.g. supplemental June base flows during seedling germination) that could reduce or prevent in-channel vegetation and maintain habitat conditions for whooping cranes. In absence of the ability to actually implement an SDHF during appropriate times, we support exploring and testing alternative flow releases that may maintain or improve whooping crane habitat suitability. Once it is possible to release a SDHF, investigations into its effectiveness could resume. Ultimately, the Service supports using adaptive management to find the most effective flow releases for reducing or preventing in-channel vegetation encroachment and maintaining or improving whooping crane habitat; we recognize that alternative flow releases (or some combination of them with or without SDHF) may be as effective as an SDHF at maintaining sufficiently wide, vegetation free roosting habitat for whooping cranes throughout the central Platte River. While mechanical treatment can be a useful tool when combined with flow management, we do not support alternatives that only implement mechanical treatment to improve or maintain whooping crane habitat conditions as this is not capable of sustaining the entire central Platte River ecosystem, which is important migratory habitat for whooping cranes and a variety of other migratory water birds.

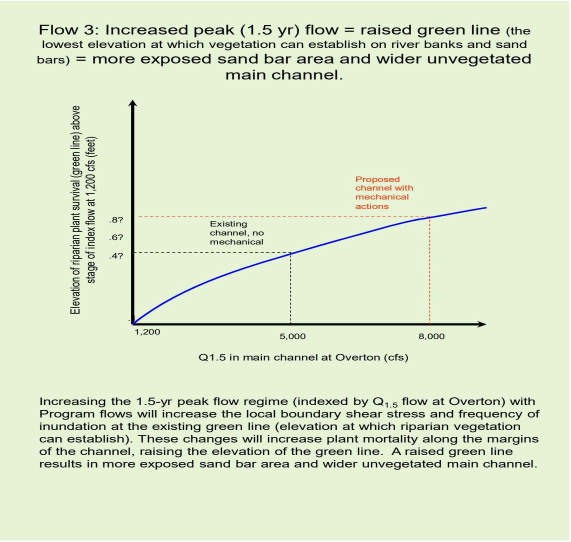
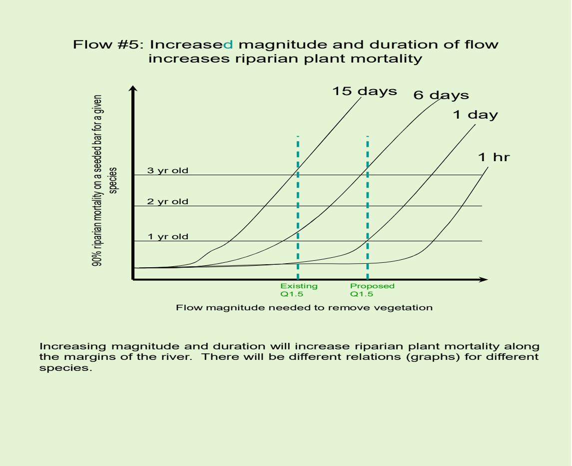
EDO response *– The EDO believes that the whooping crane habitat synthesis chapters, now in development, will address many of the issues raised in these comments.*

Big Question #9- The Service will address comments related to this big question at the September 2015 Governance Committee meeting. We have no further comment at this time.

APPENDIX C

Tier 1 Priority Hypotheses & Associated X-Y Graphs

PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
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?	**Flow #1:** ↑ the variation between river stage at peak (indexed by Q1.5 flow @ Overton) and average flows (1,200 cfs index flow), by ↑ the stage of the peak (1.5-yr) flow through Program flows, will ↑ the height of sandbars 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 ILT and PP. Bars may become quickly vegetated, making them poor habitat for target species. Bars can be created or maintained by mechanical or other means.	Flow 1: Increasing river stage variation will increase sand bar height  Increasing the variation between river stage at peak flow (indexed by $Q_{1.5}$ 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, assuming balanced sediment budget.

<table>
<tr><th>PRRIP “Big Questions”</th><th>Priority Hypotheses</th><th>Alternative Hypotheses</th><th>X-Y Graphs</th></tr>
<tr><td colspan="4"><u>Implementation</u> – Program Management Actions and Habitat</td></tr>
<tr><td rowspan="2">2. Will implementation of SDHF produce and/or maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis?</td><td><u>Flow #3</u>: ↑ 1.5-yr Q with Program flows will ↑ local boundary shear stress and frequency of inundation @ existing green line (elevation at which riparian vegetation can establish). These changes will ↑ riparian plan mortality along margins of channel, raising elevation of green line. Raised green line = more exposed sandbar area and wider unvegetated main channel.</td><td>Insufficient Program flows to adequately increase shear stress on banks. Plant mortality can be achieved by other means.</td><td>
</td></tr>
<tr><td><u>Flow #5:</u> ↑ magnitude and duration of a 1.5-yr flow will ↑ riparian plan mortality along the margins of the river. There will be different relations (graphs) for different species.</td><td>Insufficient Program flows to adequately increase shear stress on banks. Plant mortality can be achieved by other means.</td><td>
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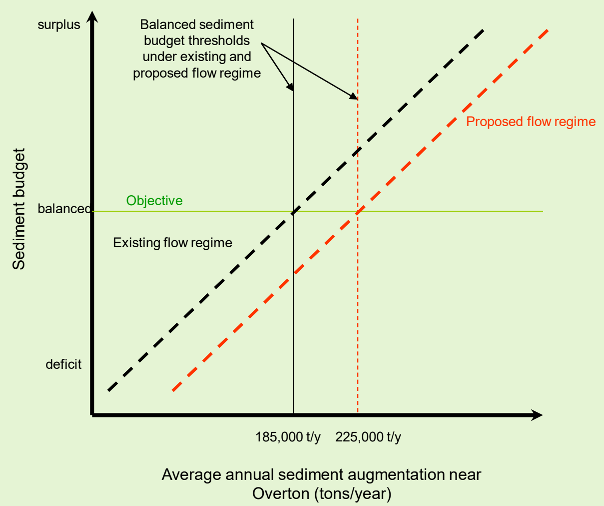
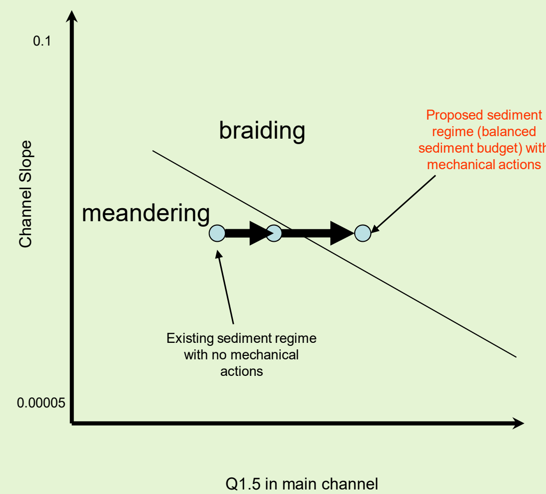
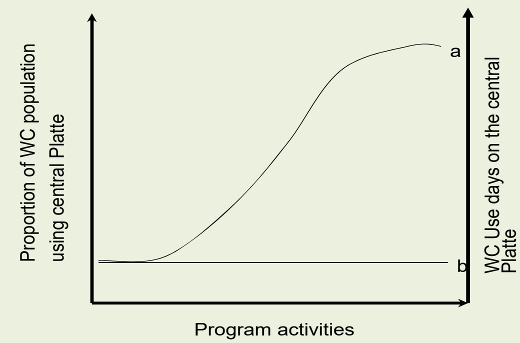
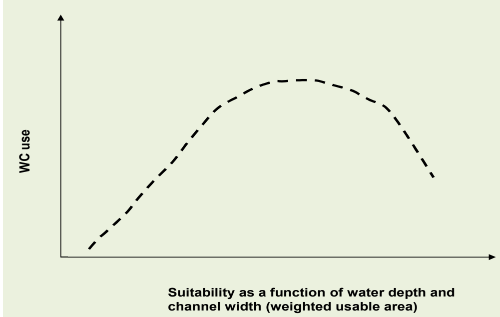
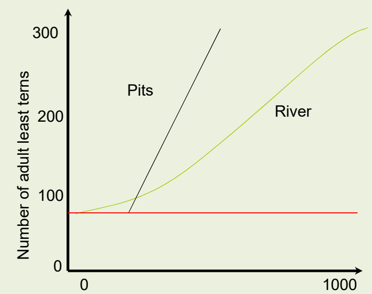
PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
Implementation – Program Management Actions and Habitat			
3. Is sediment augmentation necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?	**Sediment #1**: Average sediment augmentation near Overton of 185,000 tons/yr. under existing flow regime and 225,000 tons/yr. under GC 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.	Sediment 1: Sediment augmentation balances the sediment budget.  Sediment augmentation near Overton to 185,000 tons/yr under existing flow regime and 225,000 tons/year under the Governance Committee proposed flow regime achieves a sediment balance to Kearney.

<table>
<tr><th>PRRIP “Big Questions”</th><th>Priority Hypotheses</th><th>Alternative Hypotheses</th><th>X-Y Graphs</th></tr>
<tr><td colspan="4"><u>Implementation</u> – Program Management Actions and Habitat</td></tr>
<tr>
<td>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?</td>
<td><u>Mechanical #2</u>: 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.</td>
<td>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.</td>
<td>Mechanical (channel manipulation) 2: Stream power determines braided channel morphology (this focuses on channel consolidation rather than increased releases)


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 the main channel from a meander morphology in anastomosed reaches to a braided morphology with an average braiding index greater than 3.</td>
</tr>
</table>

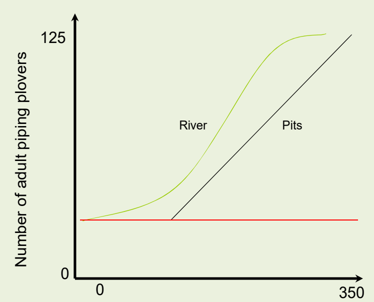
PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
Effectiveness – Habitat and Target Species Response			
5. Do whooping cranes select suitable riverine roosting habitat in proportions equal to its availability?	**WC1**: Whooping crane use will increase as function of Program land and water management activities.	Whooping crane use will not increase as function of Program land and water management activities.	WC 1. Whooping Crane use will increase as function of Program land and management activities.  a. The amount of whooping crane use days will increase as Program activities increase. b. Whooping crane use days will not increase with Program activities. Analysis and consideration will be needed to investigate Program activities and non Program activities (e.g., Trust land management). Analysis could also be done on a bridge segment basis as well as a system basis.
	WC3: 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?).	Whooping crane use is not related to habitat suitability. The prediction of habitat suitability for whooping crane in-channel habitat is not a function of water depth (preferred depth?) and channel width (define as wetted width, open width, other?).	WC 3. Whooping crane use is related to habitat suitability  The prediction of habitat suitability for whooping crane in channel habitat as a function of water depth and unobstructed channel width. FWS Instream flow recommendation for fall and spring whooping crane migration season is 2,400 cfs. Farmer et al. estimates that peak suitability is achieved at 1700 cfs.

<table>
<tr><th>PRRIP “Big Questions”</th><th>Priority Hypotheses</th><th>Alternative Hypotheses</th><th>X-Y Graphs</th></tr>
<tr><td colspan="4"><u>Effectiveness</u> – Habitat and Target Species Response</td></tr>
<tr>
<td>6. Does availability of suitable nesting habitat limit tern and plover use and reproductive success on the central Platte River?</td>
<td><u>T1</u>: Additional bare sand habitat will ↑ number of adult least terns.

<u>P1</u>: Additional bare sand habitat will ↑ number of adult piping plovers.</td>
<td>Bare sand is not currently limiting number of adults.</td>
<td>T1: Additional bare sand habitat will increase the number of adult least terns.


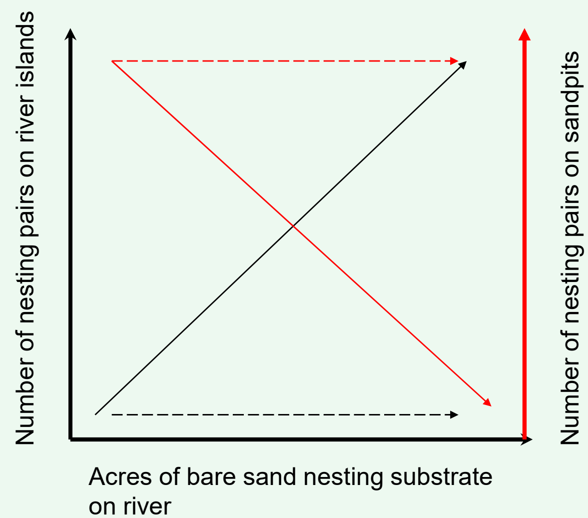
Amount of bare sand (Acres)
as measured at 1200 cfs

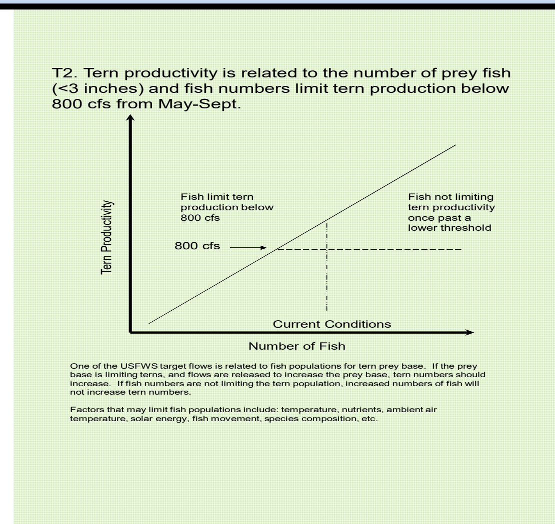
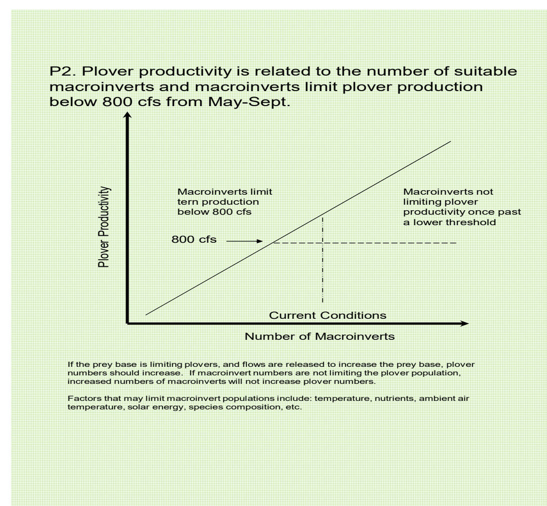
Green line is island densities from central Platte constructed islands using only years when birds were present on islands densities would be approximately half this if we use all years islands were present.
Black line using estimated acres and 96 bird average on 81 acres of sandpits last 4 years
Red line is bare sand not currently limiting so additional acres has no effect.

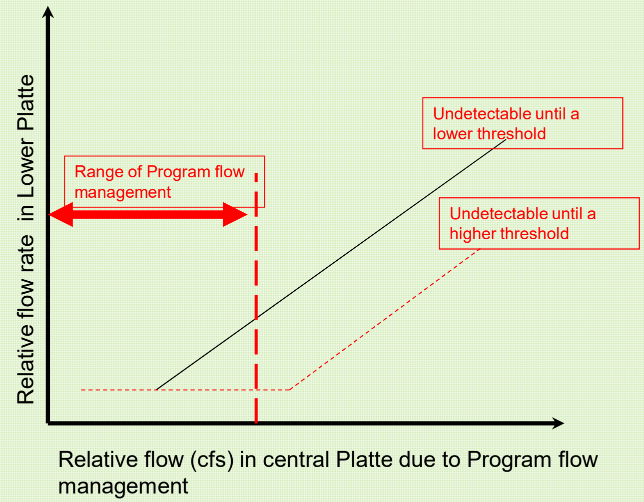
P1. Additional bare sand habitat will increase the number of adult piping plover.


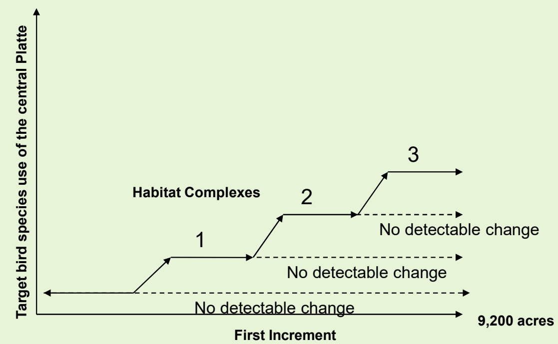
Amount of bare sand (Acres)
as measured at 1200 cfs

Green line is island densities from central Platte constructed islands using only years when birds were present on islands densities are approximately half this is we use all years islands were present.
Black line using estimated acres and 30 bird average on 81 acres sandpits last 4 years
Red line bare sand not limiting so additional acres no effect</td>
</tr>
</table>

PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
Effectiveness – Habitat and Target Species Response			
7. Are both suitable in-channel and off-channel nesting habitats required to maintain central Platte River tern and plover populations?	**TP1**: Interaction of river and sandpit habitat.	ILT and PP show no preference for the river over sandpits.	TP 1. There is an Interaction of river and sandpit habitat.  As river habitat increases, additional birds will 1) move into the region, and birds will continue to use the sandpits at current number or 2) move from sandpits to the river. The relationship between use and location (river, sandpit) may indicate a relative preference for nesting location.

<table>
<tr><th>PRRIP "Big Questions"</th><th>Priority Hypotheses</th><th>Alternative Hypotheses</th><th>X-Y Graphs</th></tr>
<tr><td colspan="4"><u>Effectiveness</u> – Habitat and Target Species Response</td></tr>
<tr><td rowspan="2">8. Does forage availability limit tern and plover productivity on the central Platte River?</td><td><u>T2</u>: Tern productivity is related to the number of prey fish (<3 inches) and fish numbers limit tern production below 800 cfs from May-Sept.</td><td>Prey fish do not limit tern production at 799 cfs or tern production is limited by summer flows of < 50 cfs.</td><td>
</td></tr>
<tr><td><u>P2</u>: Plover productivity is related to the number of suitable macroinverts and macroinverts limit plover production below 800 cfs from May-Sept.</td><td>Macroinverts do not limit plover production at 799 cfs or plover production is limited by summer flows of < 50 cfs.</td><td>
</td></tr>
</table>

PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
Effectiveness – Habitat and Target Species Response			
9. Do Program flow management actions in the central Platte River avoid adverse impacts to pallid sturgeon in the lower Platte River?	**PS2**: 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.	PS 2: Program water management will result in measurable changes on flow in the lower Platte River.  Program flow management results in measurable change in the lower Platte flows. The probability of detecting flow changes in the lower Platte as a result of Program water management activities (e.g., new depletions plans, summer flow augmentation) is improbable. Program pulse flow management will have the greatest chance of resulting in measurable changes in the lower Platte.

PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
Larger Scale Issues – Application of Learning			
10. Do Program management actions in the central Platte River contribute to least tern, piping plover, and whooping crane recovery?	**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.	S1b Program land management actions (i.e., restoration into habitat complexes) will have a detectable effect on target birds species use of the associated habitats  Achieving habitat features on Program lands with characteristic approximating the guidelines in Table of the Land Plan (Habitat Complexes) and the Mgt. Joint Study will be an efficient and biologically effective long-term land conservation and management strategy on the Platte River for the target bird species. Overall habitat complex approach Distribution – 3 complexes distributed throughout study reach Location – 6,400 ac above Minden; 2,800 ac below Minden Channel – 2 miles long; 1,150 ft channels (overall 30% increase in channels >750 ft); maintained by clear/level/pulse approach Wet Meadows – 640 ac per complex (10% increase in central Platte region) Buffers – Up to 0.5 miles wide but may be variable Restoration – At least 50% of land would undergo restoration
11. What uncertainties exist at the end of the Second Increment, and how might the Program address those uncertainties?	N/A	N/A	N/A

1

APPENDIX D

PRRIP Habitat Suitability Criteria

Whooping Cranes & Interior Least Terns/Piping Plovers

DISCLAIMER: Preliminary Habitat Suitability Criteria were based on an evaluation of Cooperative Agreement and Program whooping crane data collected between 2001 and spring 2011 and generally were set to incorporate 90% of whooping crane observations. These criteria are subject to revision based on Program evaluation of future monitoring and research data.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
Whooping Crane Habitat Suitability Criteria Descriptions

Terminology for Quantifying Whooping Crane Habitat Availability

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

Whooping Crane In-channel Minimum Habitat Suitability Criteria (Appendix 1)

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

Channel Depth

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

Suitable Channel Area

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

Distance to Disturbance

- *Definition* – Distance from a point in any direction to the nearest disturbance feature.

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

Distance to Obstruction

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

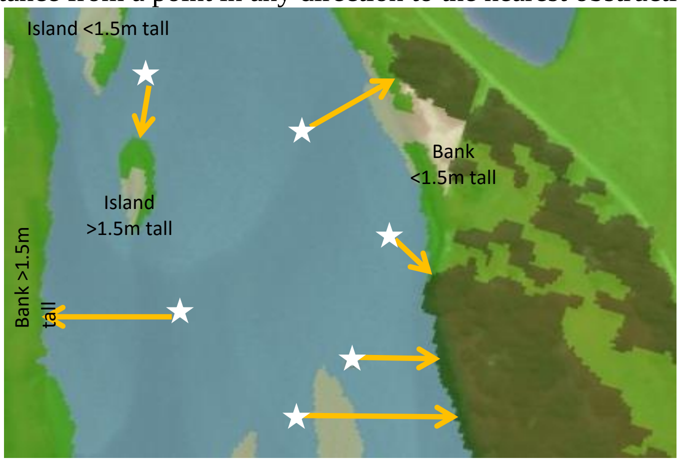


Figure 1. Distance to Obstruction

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

Unobstructed Channel Width

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

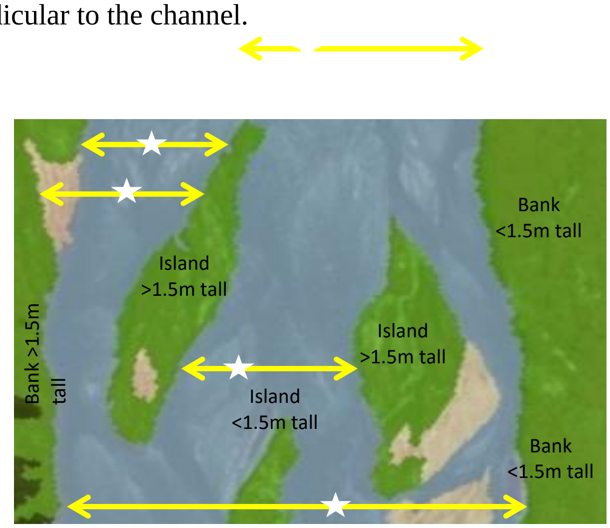


Figure 2. Unobstructed Channel Width

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

Wetted Channel Width

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

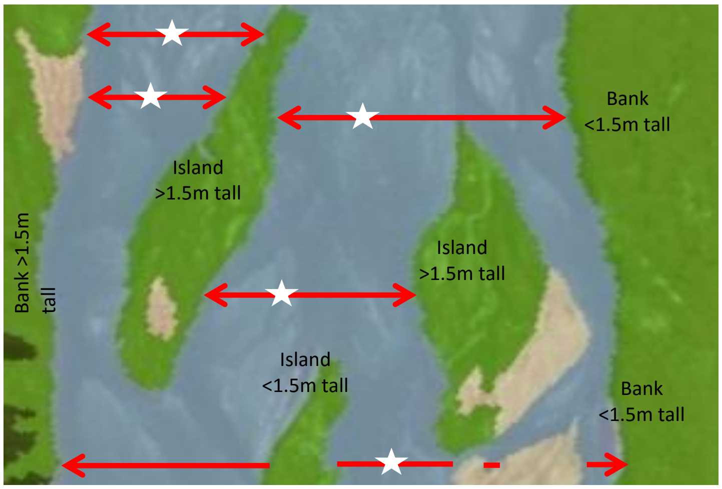


Figure 3. Wetted Channel Width

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

Unobstructed View Width

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

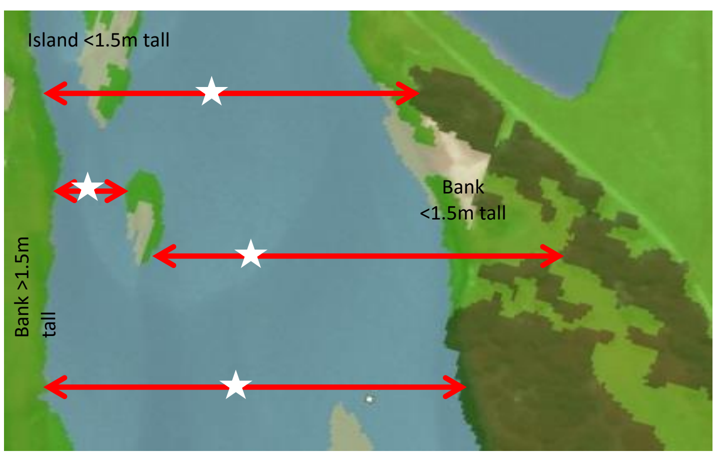


Figure 4. Unobstructed View Width

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

Whooping Crane Off-channel Minimum Habitat Suitability Criteria (Appendix 2)

1. **Area** **≤3.5 miles of main channel or ≤2 miles of side channel**
2. **Landcover Type and Structure**
   - **i. Corn, soybean, alfalfa, wheat, grassland, wet meadow, and palustrine wetland**
     1. Suitable grassland acres determined by visiting a sample of sites
     2. Suitable cropland acres determined by reports of percent of crop fields harvested prior to the migration season
   - **ii. Wet Meadow Criteria**
     1. Wet Meadow Working Group (WMWG) identified potential wet meadow areas
     2. Habitat availability assessment contractor classify all grassland types as grassland
        - i. Identified grasslands that conform to the Program's Wet Meadow Habitat Guidelines (Appendix 3) and meet all Program WC Minimum Habitat Criteria will be classified as whooping crane wet meadow habitat by the habitat availability assessment contractor; however, the WMWG will make the final determination of whooping crane wet meadow areas on a site-by-site basis.
   - **iii. Palustrine Wetland Criteria (Roost Habitat)**
     1. ≥5 acres of water area ≤18 inches deep
     2. ≥25% of the water area ≤12 inches deep
     3. at least 1 water area that is 500 feet × 500 feet
3. **Distance to Obstruction** **≥75 feet**
4. **Unobstructed View Width** **≥330 feet**
5. **Distance to Disturbance Feature** **≥285 feet**

Area

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

Landcover Type and Structure

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

- *Palustrine Wetland* – ≥5 acres of water area ≤18 inches deep with ≥25% of the water area ≤12 inches deep and at least 1 water area that is 500 feet × 500 feet.

Distance to Obstruction

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

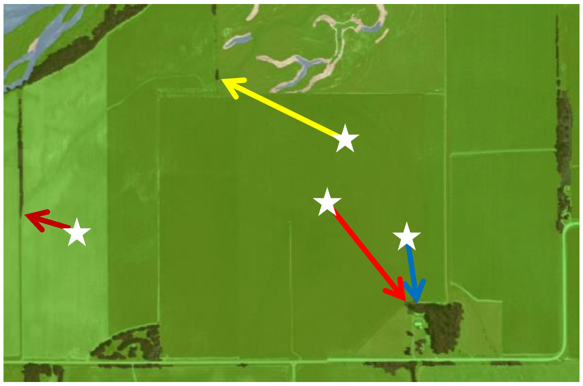


Figure 5. Distance to Obstruction

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

Unobstructed View Width

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

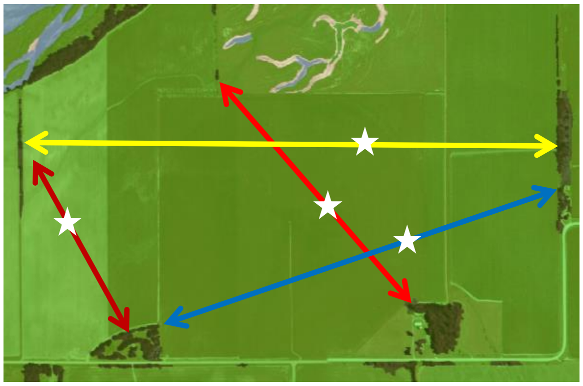


Figure 6. Unobstructed View Width

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

Distance to Disturbance Feature

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

Figure 7. Distance to Disturbance Feature

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

Appendix 1. Percentiles for in-channel habitat metrics collected at whooping crane roost locations on the central Platte River, 2001 – Spring 2011.

Metric	5%		10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Channel Depth (in)	0.5		1.1	1.7	2.2	3.3	3.9	4.3	4.7	5.2	6.1	6.9	6.9	7.1	7.8	8.6	10.1	10.6	12.1	17.0	21.3
Suitable Channel Area	19%		38%	45%	50%	54%	59%	64%	67%	68%	73%	79%	81%	86%	90%	94%	96%	97%	99%	100%	100%
Distance to Obstruction (ft)	46		72	98	118	135	135	138	161	190	197	233	249	292	302	328	394	479	584	630	787
Unobstructed Channel Width (ft)	212		281	350	390	440	467	521	550	591	620	632	683	714	751	751	813	846	891	950	1207
Wetted Channel Width (ft)	208		256	290	328	341	370	402	417	473	493	516	553	571	614	646	652	689	781	868	1310
Unobstructed View Width (ft)	253		331	381	472	530	622	666	722	750	766	810	840	878	920	1031	1092	1175	1175	1237	1537
Flow (cfs)	94		154	175	220	256	342	427	487	582	698	830	965	1074	1161	1183	1480	1720	2568	3670	4240
Sandbar Roost Height (in)	0.1		0.1	0.2	0.3	0.4	0.6	0.8	0.8	1.0	1.0	2.0	2.1	2.4	3.4	3.6	4.2	5.2	6.8	8.2	10.2
Average Distance to Obstruction (ft)	173		215	258	272	290	300	335	376	433	448	490	497	530	554	621	650	791	809	1166	1351
Channel Openness (acres)	3		4	5	7	8	10	13	14	16	17	20	22	27	31	35	37	47	58	126	241
Transect Channel Depth (in)	4.3		4.5	5.1	5.7	5.7	6.0	6.6	7.0	7.4	8.2	8.4	8.7	9.6	10.1	10.6	11.5	12.6	14.8	17.2	25.5

Appendix 2. Percentiles for off-channel habitat metrics collected at whooping crane use locations along the central Platte River, 2001 – spring 2011.

Metric	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Distance to Obstruction (ft)	33	49	82	164	164	197	210	246	322	328	328	328	361	492	656	820	984	1312	1640	4921
Distance to Disturbance (ft)	105	164	328	328	361	492	656	820	935	984	984	1312	1312	1640	1640	2297	2625	2625	3937	5905
Habitat Type	Channel		Sandbar		Corn		Soybean		Alfalfa		Wheat		Grassland		Wet Meadow			Palustrine Wetland		

Appendix 3. Initial guidelines for classifying Program Wet Meadow Habitat (Revised by the WMWG 2-15-12)

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

DISCLAIMER: These are draft habitat suitability criteria and are subject to revision based on Program evaluation of monitoring and research data.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
Tern and Plover Habitat Suitability Criteria Descriptions

Terminology for Quantifying Tern and Plover Habitat Availability

- Bare Sand – River island or sandpit site with <20% vegetative cover. Bare sand areas can be composed of dry sand or gravel substrate and nest furniture may be present.
- Predator Perch – Tree, power line, power pole, etc. ≥10 feet tall that could be used by an avian predator to view the potential nesting area.

Tern and Plover In-channel Minimum Habitat Suitability Criteria

8. **Suitable Nesting Area – ≥1/4-acre sandbar ≥18 inches above river stage @ 1,200cfs.**
9. **Channel width – ≥400 feet**
10. **Water Barrier – ≥50 feet**
11. **Distance to Predator Perch – ≥200 feet**

Suitable Nesting Area

- *Definition* – ≥0.25-contiguous acres of bare sand 18 inches above river stage @ 1,200cfs with ≥1.5 acres of exposed bare sand within a ¼-mile reach of channel.

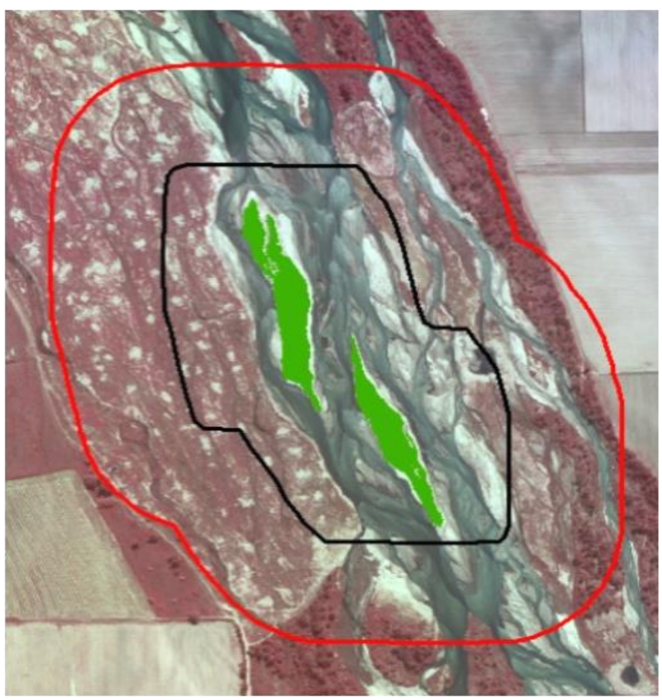


Figure 1. Suitable nesting area (green) with ≥1.5 acres of exposed bare sand within a ¼ mile stretch of channel.

- *Criterion* – all sandbar areas ≥1/4-acre in size and ≥18 inches above river stage @ 1,200cfs are suitable nesting habitat if there is ≥1.5 acres of exposed bare sand within a ¼-mile reach of channel and the areas meet all additional in-channel minimum habitat criteria.

Channel Width

- *Definition* – Along a line perpendicular to the channel extending through the center of a potential nesting island, channel width is the entire open-channel area, including sand, which lies between the vegetation lines of the island or bank on each side of the sandbar.

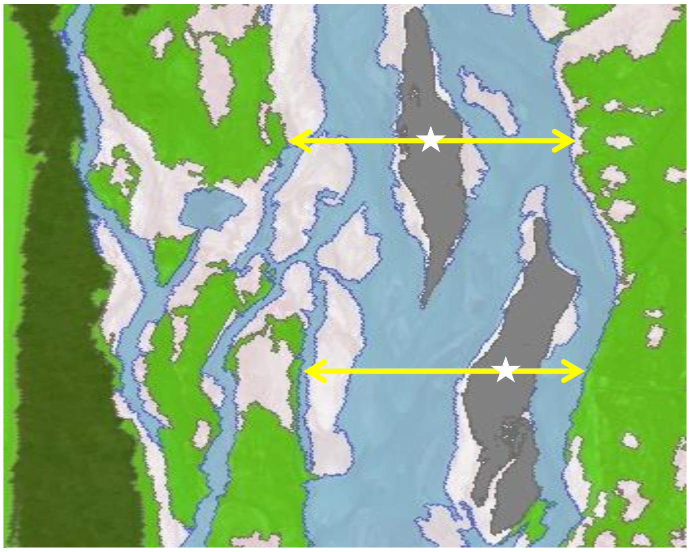


Figure 2. Channel width measured perpendicular to flow from the center of potentially suitable nesting areas.

- *Criterion* – Sandbar areas in channels ≥400 feet wide at 1,200cfs and observed flows are suitable nesting habitat if the areas meet all additional in-channel minimum habitat criteria. Bare-sand areas within channels <400 feet wide contribute to the 1.5 acres of bare sand within a ¼-mile reach of river, but are not suitable nesting habitat.

Distance to Predator Perch

- *Definition* – Distance from the edge of potentially suitable nesting habitat in any direction to the nearest potential predator perch.

Figure 3. 200-foot buffer around predator perches (red area).

Criterion – Sandbar areas ≥200 feet from a predator perch are suitable nesting habitat if the areas meet all additional in-channel minimum habitat criteria. Bare-sand areas <200 feet from a predator perch contribute to the 1.5 acres of bare sand within a ¼-mile reach of river, but are not suitable nesting habitat.

Water Barrier

- *Definition* – Width of individual threads of channel, measured perpendicular to flow, that lie between the bank and potential nesting habitat (Figure 4).

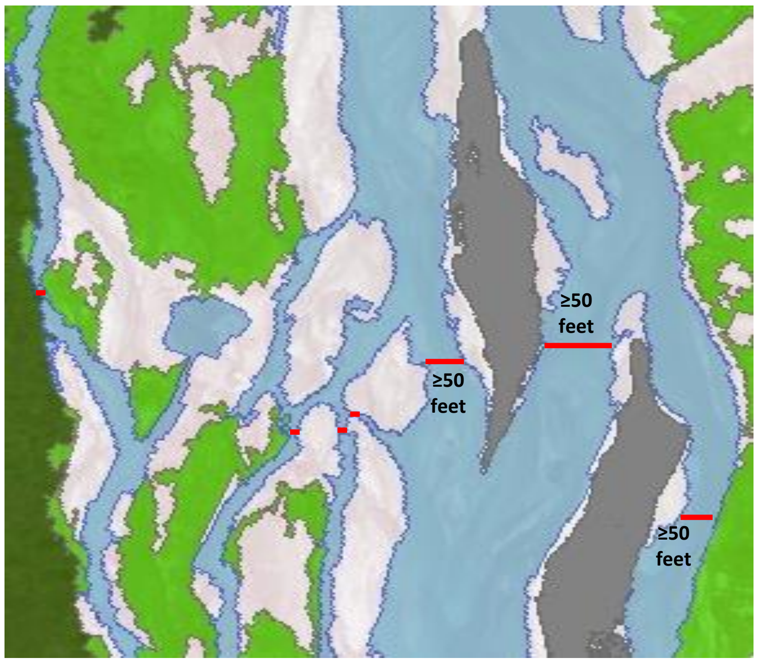


Figure 4. Channel width measured as the shortest distances across water from the edge of potentially suitable nesting areas to the bank lines on each side.

- *Criterion* – Sandbar areas with a ≥50-foot contiguous water barrier between each shoreline and edge of bare sand are suitable nesting habitat if the areas meet all additional in-channel minimum habitat criteria. Bare-sand areas with a water barrier <50 feet contribute to the 1.5 acres of bare sand within a ¼-mile reach of river, but are not suitable nesting habitat.

Tern and Plover Off-channel Minimum Habitat Suitability Criteria

3. **Area – ≤3.5 miles of main channel or ≤2 miles of side channel**
4. **Minimum Habitat Size – ≥1.5 acres of suitable nesting habitat per site; contributing habitat must be ≥0.25 acres in size.**
5. **Distance to Predator Perch – ≥200 feet**
6. **Off-channel sites delineated annually; must contain sand with adjacent water areas**
7. **Suitable Nesting Area – Delineated by monitoring crew annually**

Area

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

Minimum Habitat Size

- *Definition* – Total of ≥1.5 acres of conforming habitat per site
- *Criterion* – ≥¼-acre patches of dry bare sand and/or gravel are suitable nesting habitat if there is ≥1.5 acres of suitable nesting habitat total within a site and the areas meet all additional off-channel minimum habitat criteria.

Distance to Predator Perch

- *Definition* – Distance from potentially suitable nesting habitat in any direction to the nearest potential predator perch.
- *Criterion* – Bare-sand areas ≥200 feet from a predator perch are suitable nesting habitat if the areas meet all additional off-channel minimum habitat criteria.

Water-Sand Criteria

- *Definition* – Off-channel sites will be delineated on an annual basis.
- *Criterion* – Sites with sand and adjacent water areas are suitable nesting habitat if the site meets all additional off-channel minimum habitat criteria.

Suitable Nesting Area

- *Definition* – Delineation of areas within each site that, according to the monitoring crew, are suitable habitat for nesting.
- *Criterion* – Monitoring personnel will hand delineate suitable nesting areas within sites that are monitored to exclude sand and gravel piles and active mining areas that are not conducive to tern and plover nesting. The habitat availability assessment contractor will identify suitable habitat through application of the various filters, document spatial extent and availability of habitat identified via image interpretation, and apply the hand-delineated polygon layer as a final filter to remove unsuitable nesting areas within each site.

APPENDIX E

Department of Interior Target Habitat Criteria

Land Plan Table 1

Table 1. Target Habitat Complex Guidelines[8]

1. Riverine Habitat	**Characteristics**
Location	Between Lexington and Chapman, NE
Channel area	Approximately 2 miles long, 1,150 feet wide and includes both sides of the river. "Channel area" represents the portion of the river that conducts flow and is bounded either by stable banks or permanent islands that obstruct view. At low flows, the channel area includes interconnected small channels and exposed sand or gravel bars and non-permanent islands.
Water depth	A range of depths with approximately 40 percent of the channel area less than 0.7-foot deep during whooping crane migration periods.
Wetted width	90 - 100 percent of channel area inundated during migration periods.
Water velocity	Velocity is variable with depth. During whooping crane migration and least tern and piping plover nesting seasons, velocity should be less than 4 mph in shallow areas.
Sandbars and Channel Morphology	Non-permanent sandbars and low, non-permanent islands throughout the channel area, high enough to provide dry sand during the tern/plover nesting season and free of vegetation that inhibits nesting or creates visual obstructions to whooping cranes. Diverse channel morphology providing a variety of submerged sand bars and other macrohabitats, including backwater areas and side channels inundated by discharge.
Proximity to wet meadow forage habitat	Within 2 miles, but contiguous is preferred.
Distance from disturbance	For whooping cranes: In general, not less than 0.5-mile distant or appropriately screened from potential disturbances. Potential disturbances may include roads, railroads, occupied dwellings, bridges or other activities that would disturb whooping cranes from using a site. For least tern/piping plover: Potential disturbances should be evaluated case-by-case. In general, not less than 0.25 mile distant, or appropriately protected from human disturbances.
Unobstructed View	Good visibility upstream, downstream, and across the channel.
Flight Hazards	Overhead lines should be avoided, if possible. Overhead lines within 0.5 mile of complex boundaries should be evaluated during the screening process to determine whether marking would be appropriate.
Security	Sufficient control to avoid human disturbance to target species.

[8]The Parties have agreed to use these habitat complex characteristics as an initial acquisition, restoration and maintenance target. The states and July 1997 Cooperative Agreement Land Committee continue to disagree that these characteristics represent the "best" habitat or necessary habitat for the target species, or that the Program will be able to sustain the characteristics solely with flow management. The states and July 1997 Cooperative Agreement Land Advisory Committee believe that an approach based on acquiring and developing habitat with a range of characteristics is justified.

1

2. Wet Meadow Habitat	Characteristics
Location	Within 2 miles of the above-described channel area.
Size	Approximately 640 contiguous acres or more.
Distance from Disturbance	In general, not less than 0.5-mile distant or appropriately screened from potential disturbance. Potential disturbances may include roads, railroads, occupied dwellings, bridges or other activities that would disturb target species from using a site.
Vegetation Composition	Native prairie grasses and herbaceous vegetation, lacking or mostly lacking sizable trees and shrubs, occurring in a mosaic of wetland (hydrophytic) and upland (non-hydrophytic) plants.
Hydrology	Swales subirrigated by ground water seasonally near the soil surface and by precipitation and surface water, with the root zone of the soil continuously saturated for at least 5 - 12.5% of the growing season. Except immediately following precipitation events, higher areas may remain dry throughout the year.
Topography and Soils	The topography is generally level or low undulating surface, dissected by swales and depressions. Mosaic of wetland soils with low salinity in swales and non-wetland soils occurring in uplands.
Food Sources	Capable of supporting aquatic, semi-aquatic, and terrestrial fauna and flora characteristic of wet meadows; especially aquatic invertebrates, beetles, insect larvae, and amphibians.
3. Buffer	**Characteristics**
	That portion of a complex used to isolate channel areas and wet meadows from potential disturbances. In general, it is up to 0.5 miles wide, but is variable depending on topography, screening, and other factors. Buffer areas may include an extended wet meadow or channel area, upland grassland, pasture, hay land, cropland, palustrine wetland, woodland, managed sandpits, or a combination of these and other compatible land features.

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Endnotes

[1] This is a restatement of the first bullet under broad hypothesis PP-1. See p. 16 of the Adaptive Management Plan.
[2] This is a re-statement of Priority Hypotheses WC1 and WC3 in the Adaptive Management Plan. In general, these hypotheses suggest that whooping cranes will select habitat similar to Land Plan Table 1 characteristics (see **Appendix C**) and/or habitat created by Program management actions.
[3] This is a restatement of Priority Hypotheses T1 and P1 in the Adaptive Management Plan which suggest that more "bare sand" (i.e. habitat) will result in greater tern and plover use and higher reproductive success.
[4] This is a re-statement of Priority Hypotheses TP1 in the Adaptive Management Plan. This hypothesis is one of the more complex hypotheses in the AMP and may require refinement during the First Increment.
[5] See endnote 46.
[6] See endnote 46.
[7] This is a re-statement of Priority Hypotheses T2 and P2 in the Adaptive Management Plan, which suggest that at low flows a lack of forage fish and invertebrates limit tern and plover productivity on the central Platte.
[8] See the PRRIP 2015 Forage Fish Analysis Report.
[9] See the final USGS report Foraging Ecology of Least Terns and Piping Plovers Nesting on Central Platte River Sandpits and Sandbars.
[10] See the final USGS report Foraging Ecology of Least Terns and Piping Plovers Nesting on Central Platte River Sandpits and Sandbars.
[11] See Final 2014 PRRIP Interior Least Tern & Piping Plover Monitoring Report.
[12] See Final 2014 PRRIP Interior Least Tern & Piping Plover Monitoring Report.
[13] This is a re-statement of Priority Hypothesis PS2 in the Adaptive Management Plan, which suggests that Program water management actions in the central Platte River will result in measurable changes in lower Platte River flow.
[15] Table 10, Page 21 of the Final Stage Change Study presents a description of the six habitat classifications used to evaluate the potential impacts of Program management actions in the central Platte on flow in the lower Platte.
[14] The Dry Conditions Analysis was presented in the Final Stage Change Study as Appendix G, "Alternative Analysis of Program Activities" (see Page 167 of the PDF version of Final Stage Change Study).
[16] Table 2, Appendix G (Page 170 of PDF version of Final Stage Change Study).
[17] See "Interpretation and Analysis" section of the Final Stage Change Study, Page 22.
[18] The "Alternative Analysis of Program Activities" evaluated a hydrologic scenario against all six habitat classifications (i.e. longitudinal habitat in the channel and lateral habitat connections between the channel and floodplain) during both the spring (spawning period) and the fall (overwintering and upcoming spawning movements).
[19] Pallid sturgeon item V.K.3.2, Integrated Monitoring and Research Plan (IMRP), Adaptive Management Plan (Page 45).
[20] See Page 1 of the Adaptive Management Plan for the three overall management objectives of the Program, and Page 3 of the Final Program Document for the Program's three sub-goals that comprise the Program's long-term goal to improve and maintain the associated habitats.
[21] This is a re-statement of Priority Hypothesis S1b in the Adaptive Management Plan. In the context of this Big Question, this hypothesis will be used to evaluate tern, plover, and whooping crane use of Program habitat complexes (or habitat identified as "suitable" by the Program) during the course of the First Increment and evaluate that use in terms of its contribution to the broader health of the overall populations of all three target bird species.
[22] See Page 1 of the Final Program Document, Program Purposes.