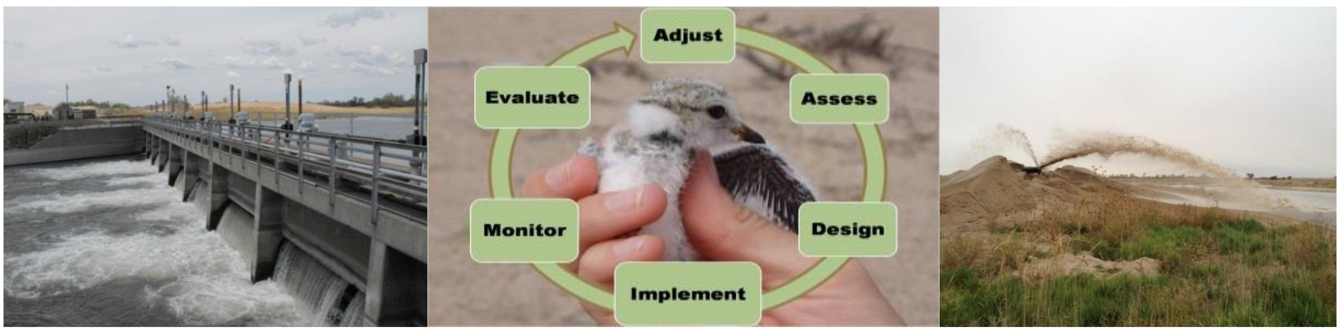
Adaptive Management on the Platte River



05/29/2015

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

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Prepared by the Executive Director's Office of the
Platte River Recovery Implementation Program
4111 4th Avenue, Suite 6
Kearney, NE 68845
www.PlatteRiverProgram.org

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.

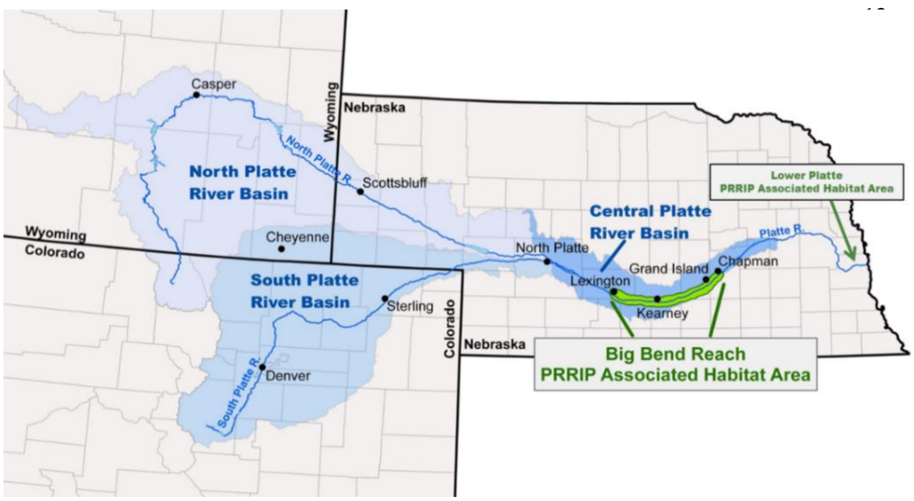

Figure 1. Map depicting Program area, including the Associated Habitat Reaches on the central and lower Platte River.

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.

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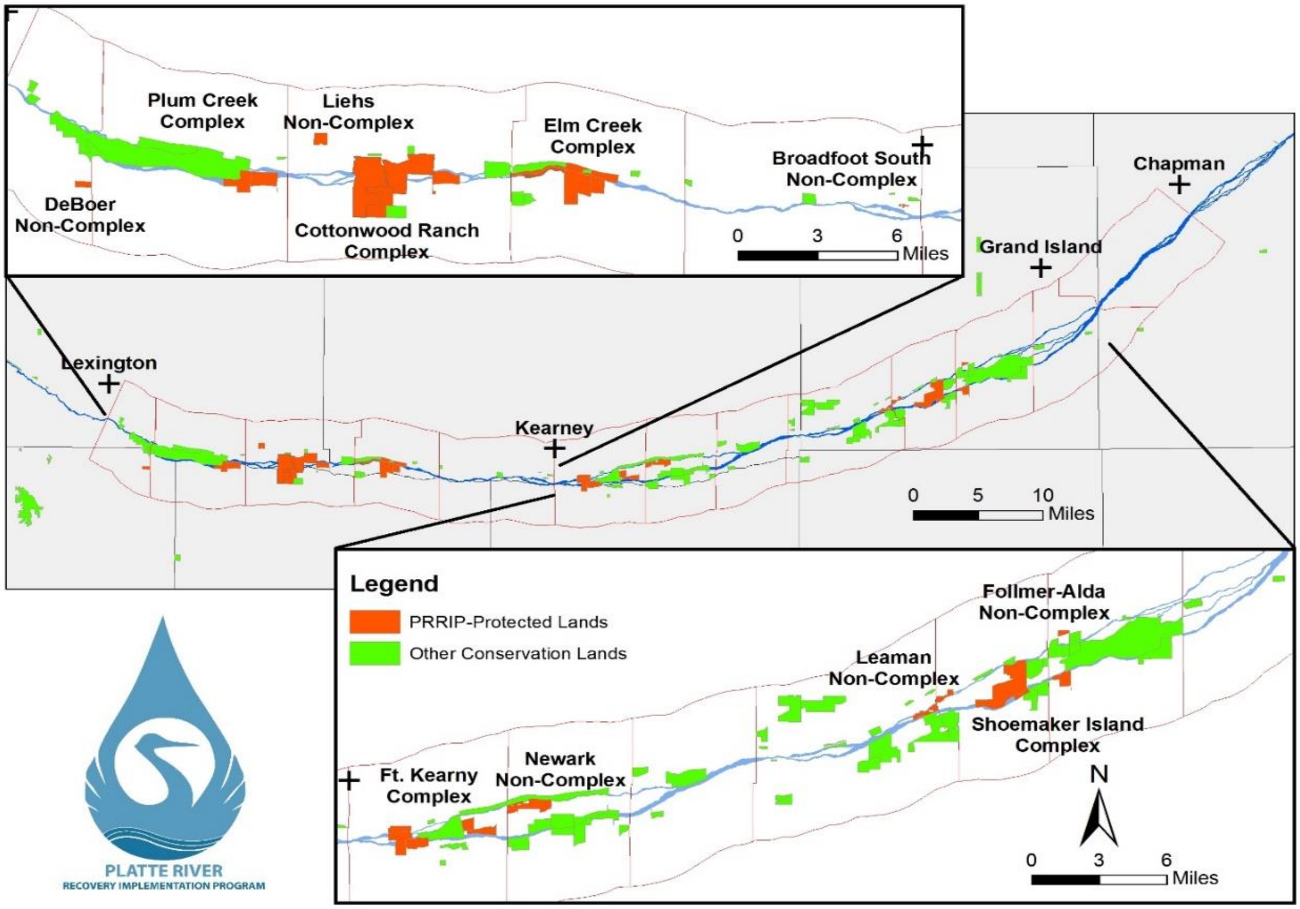

Figure 2. Program habitat complexes in the Associated Habitat Reach.

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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.

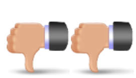
Icon	Trend or Answer Explained by Icon
	• Big Question and underlying hypotheses **answered conclusively** in the **affirmative** • Foundational documents, analysis, and other references on which this assessment is based have undergone peer review through the PRRIP peer review process and/or publication 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
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?		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; two manuscripts now in development will be published and 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; manuscript now in development will be published and will likely support a "two thumbs up" assessment in the 2015 State of the Platte Report.
Effectiveness – 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.
Larger Scale Issues – Application of Learning		
10. How 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 natural sandbar following the 2011 event (2012 nesting season) and two tern nests were initiated on a natural sandbar following the 2013 event (2014 nesting season) on habitat that did not conform to the Program's minimum suitability criteria. The plover nest was successful, due in part, to the lack of any runoff events in 2012. The two tern nests, initiated on sandbars formed by a peak discharge exceeding 9,000 cfs, were inundated during the 2014 late-spring rise at a discharge of approximately 3,000 cfs.

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).

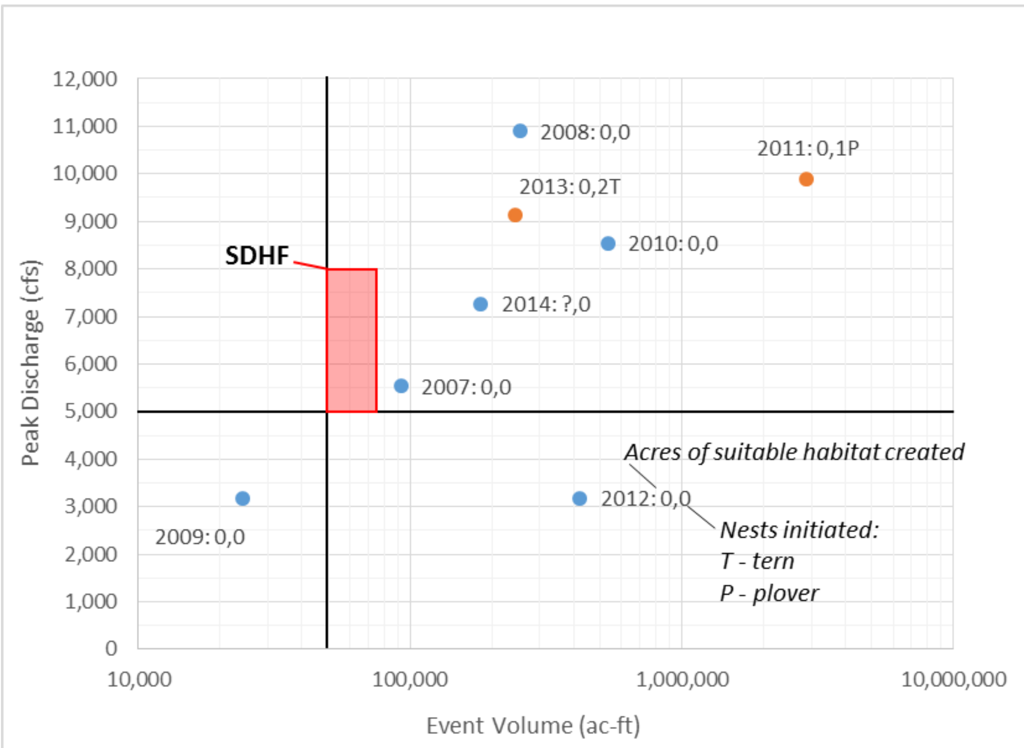


Figure 1. First Increment peak flow event magnitudes and volumes in relation to SDHF. Acres of suitable habitat created and species response (nest incidence) are provided for each event.

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 indicate that the 2013 event, in many areas, 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 including but not limited to:

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.

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:

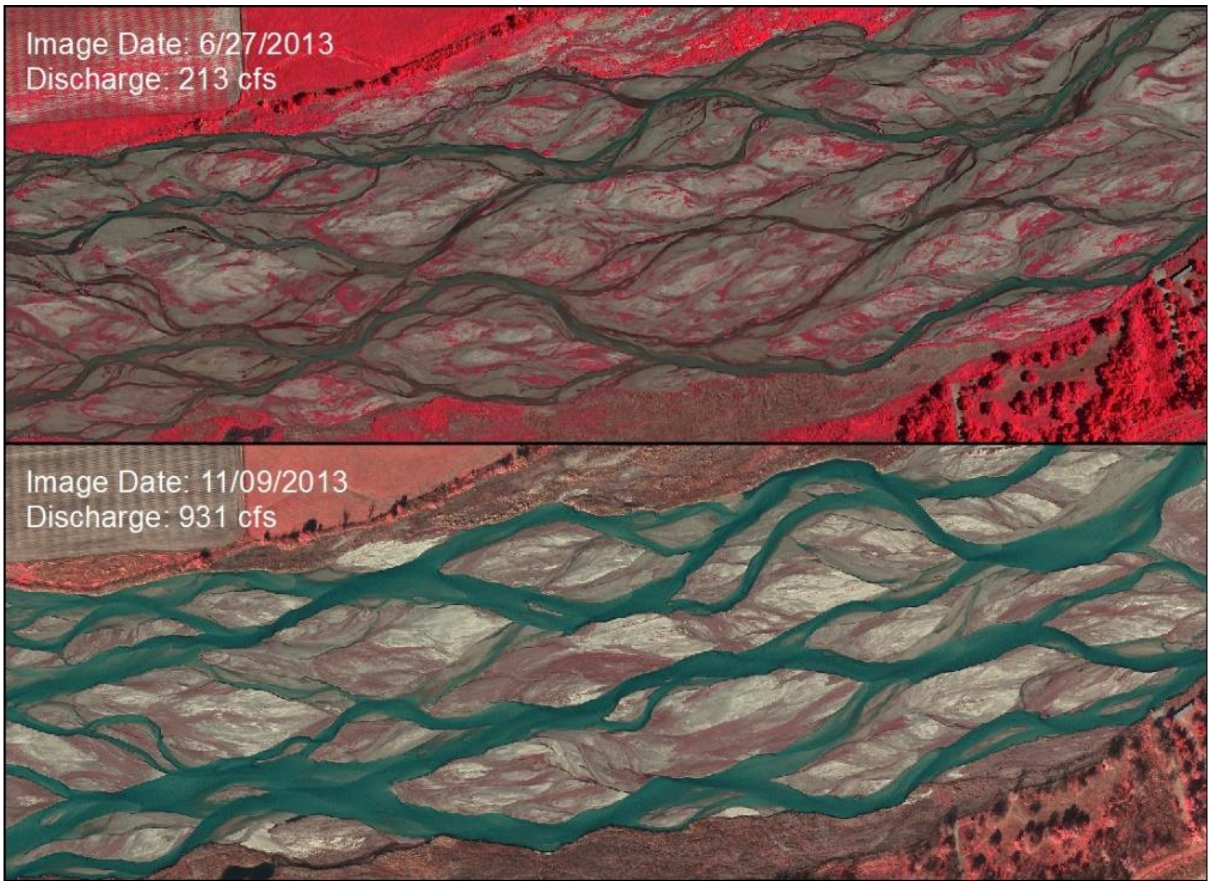
The original analysis of SDHF performance based on the Bureau of Reclamation SedVeg model included four vegetation species: cottonwood, willow, spike rush, and cord grass. In the SedVeg model, all plants below the maximum water surface elevation were removed by a peak flow when mean flow velocity exceeded 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 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. One previous analysis established 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:

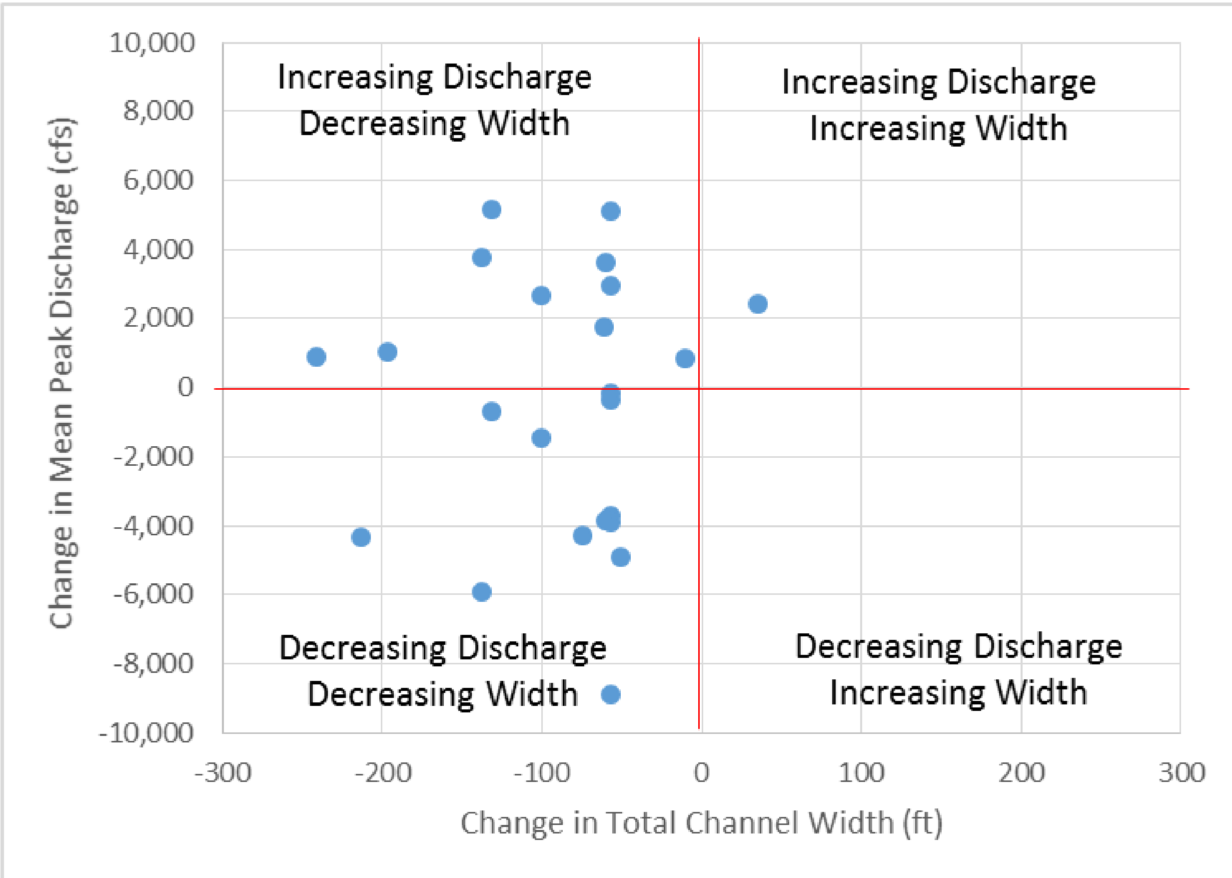
- Peak flows in the AHR are not competent to remove mature woody vegetation or erosion-resistant species like phragmites.
- Mechanical clearing and leveling are necessary to create suitable channel configurations and facilitate channel adjustments to changes in flow and sediment.
- Flow and sediment 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 decreased slightly during the fall migration season.

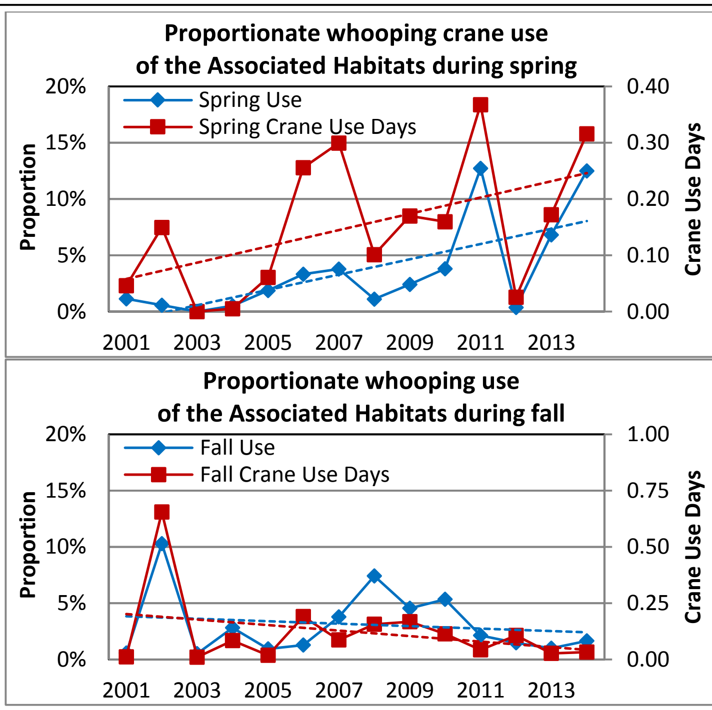


Figure 1. Program whooping crane monitoring data indicate the proportion of the whooping crane population that utilized the Associated Habitats (blue) and crane use days (red) within the Associated Habitats/bird in the population may be increasing during spring (top) and decreasing during fall (bottom), 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:

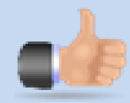
- Addressing remaining uncertainties will change BQ assessment.
- Habitat selection analyses will be complete in 2015-2017 and should provide evidence to change the assessment of this Big Question.
- Peer review or publication of data analyses (monitoring, telemetry, and stopover study data) and habitat 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 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.

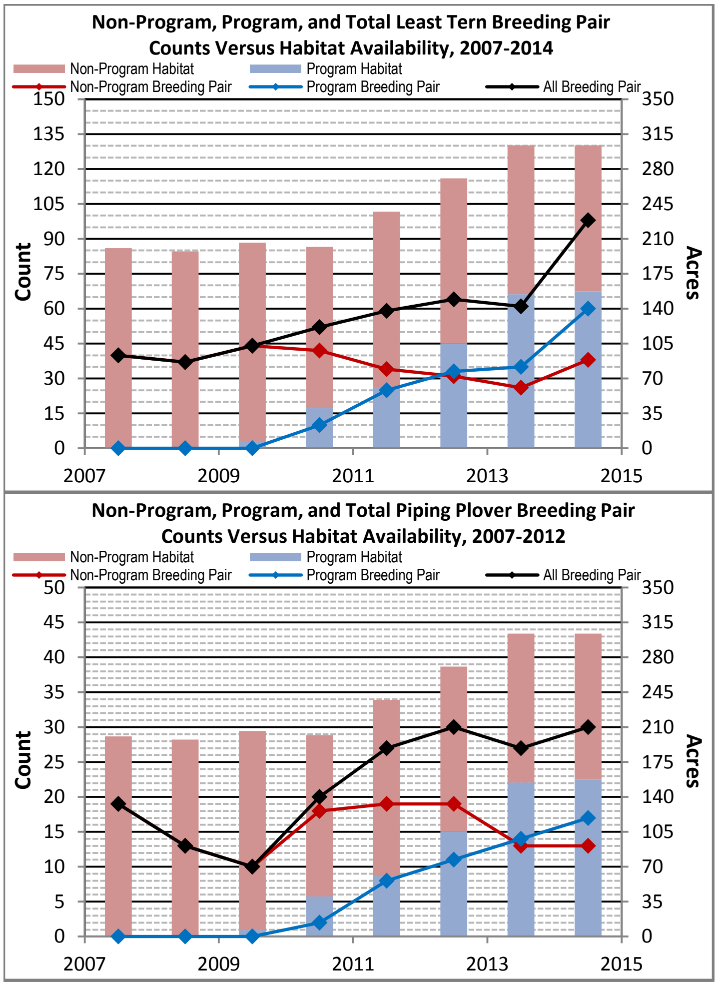


Figure 1. Relationships between availability of Program-defined suitable nesting habitat owned by the Program (blue bars) and non-Program entities (red bars) and tern (top plot) and plover (bottom plot) Program (blue line), non-Program (red line) and combined (black line) breeding pair counts, 2007–2014.

What do we still need to know?

- If current levels of off-channel nesting habitat limits 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 limits 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 has 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 has 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.

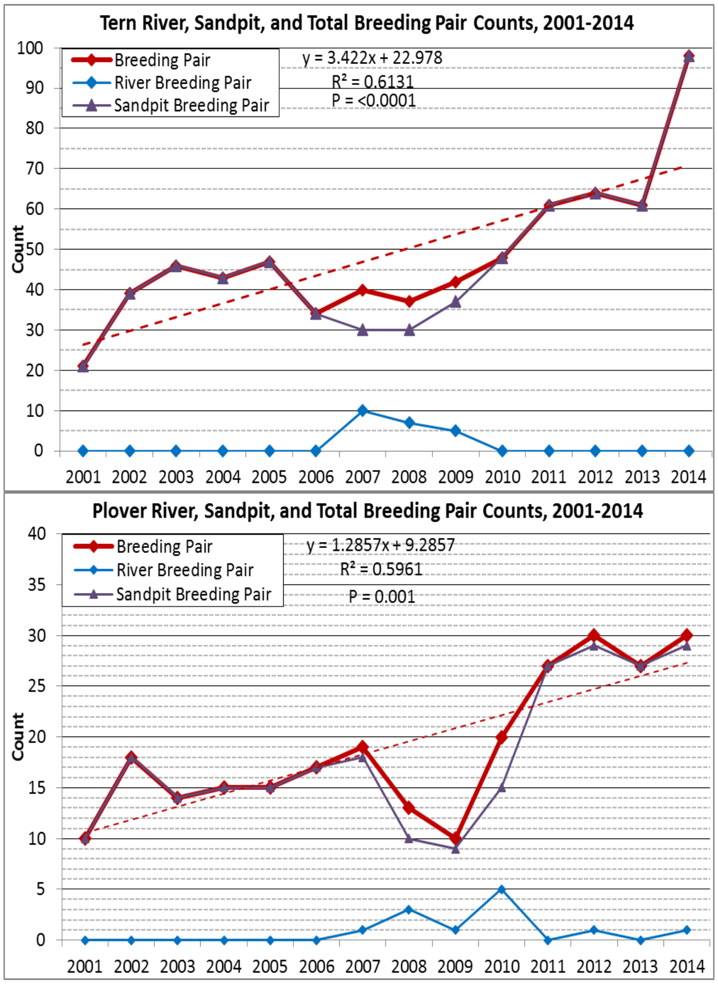


Figure 1. Annual tern (left plot) and plover (right plot) total, riverine, and sandpit breeding pair counts, 2001-2014. Trend lines (dashed lines) represent significant increases in tern and plover breeding pair counts during 2001-2014 with the most substantial increases occurring since inception of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

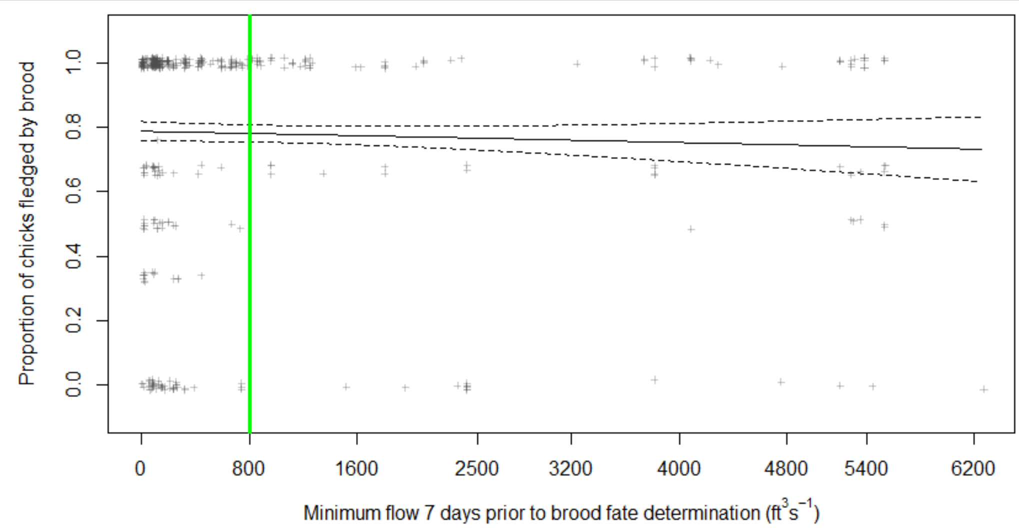


Figure 1. Results from data analysis showing the relationship between flow and tern productivity. Note the grey "+" signs shows the proportion of chicks that fledged for each brood (i.e., number of fledglings/number of eggs that hatched). Note the green line shows that most broods experienced flows less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

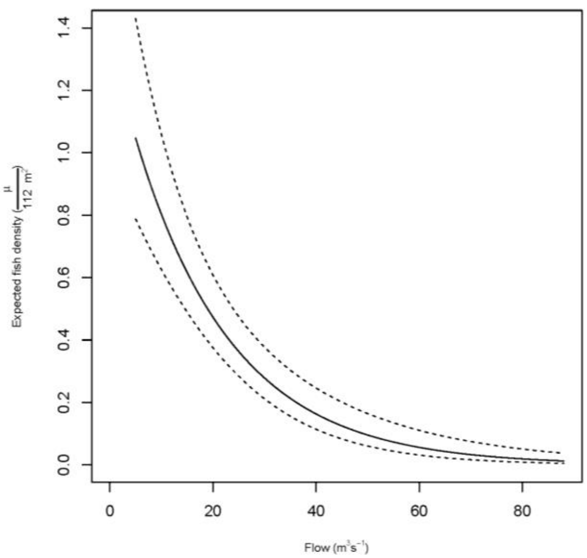


Figure 2. Regression model (Eq. 3.1–3.2) showing the relationship between expected forage fish density $(\mu/112.5\ m^2)$ and average daily flow the day seining occurred (posterior median = solid black line; 95% CIs = dashed black lines).

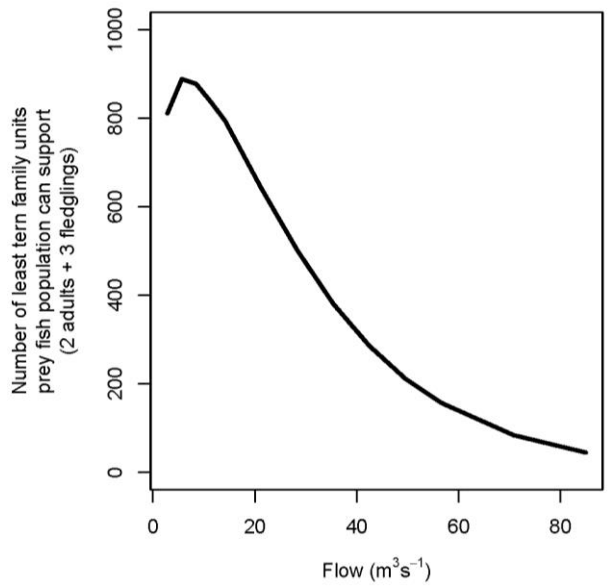


Figure 3. Numbers of least tern family units (defined as 2 adults + 3 chicks) the prey fish population in the Program Associated Habitat Area could potentially support.

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.

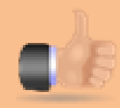
2) Further Program actions for the pallid sturgeon (for example, pallid sturgeon habitat use/selection research[19]) are a policy decision that is the sole discretion of the Governance Committee. The U.S. Fish and Wildlife Service maintains the GC needs to address, at the policy level, perceived disagreement 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. How 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

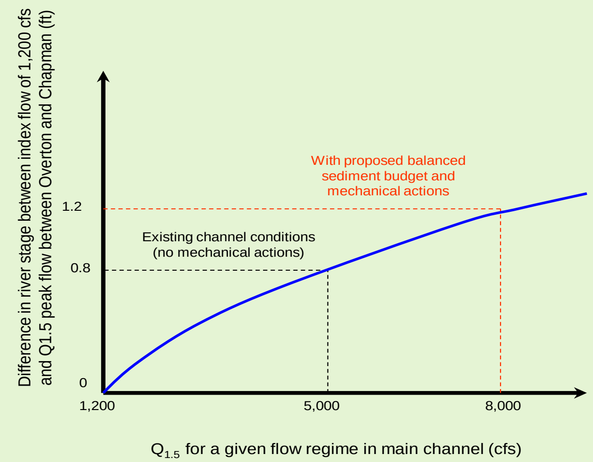
Independent Scientific Advisory Committee (ISAC) Comments and Executive Director's Office (EDO) Responses

APPENDIX B

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

APPENDIX C

Tier 1 Priority Hypotheses & Associated X-Y Graphs

<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>1. Will implementation of SDHF produce suitable tern and plover riverine nesting habitat on an annual or near-annual basis?</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
</tr>
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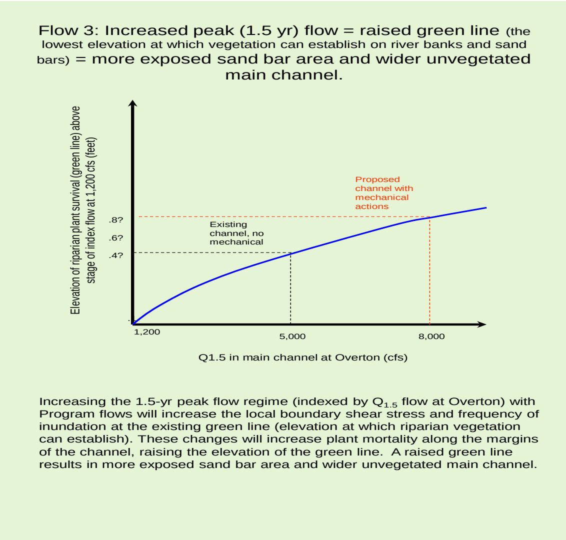
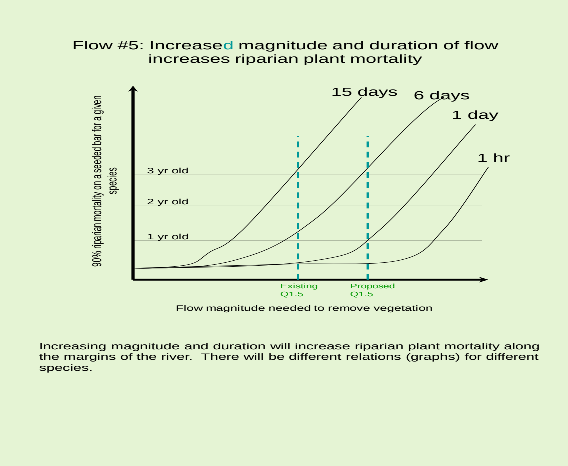
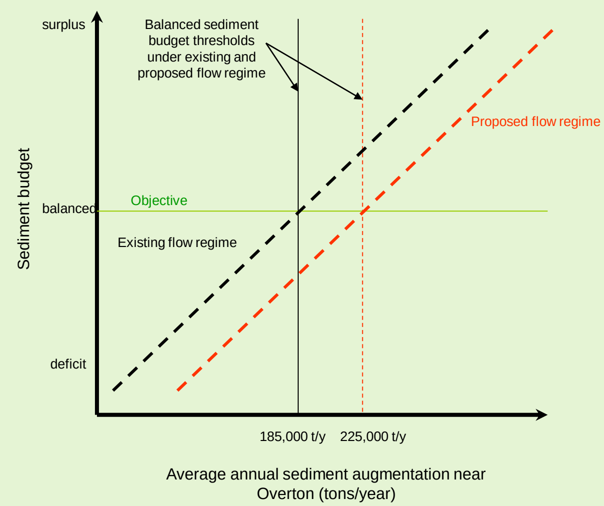
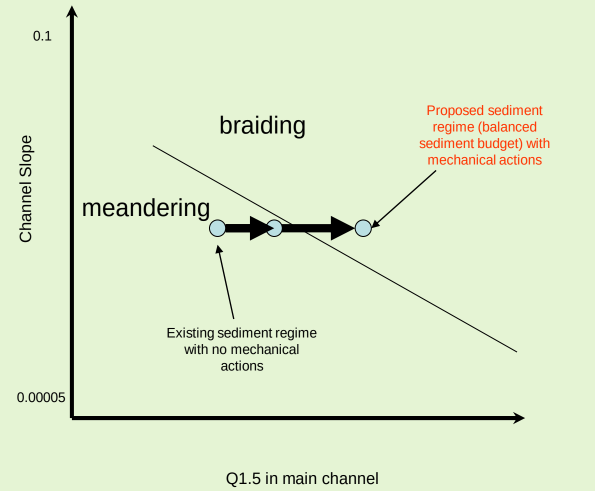
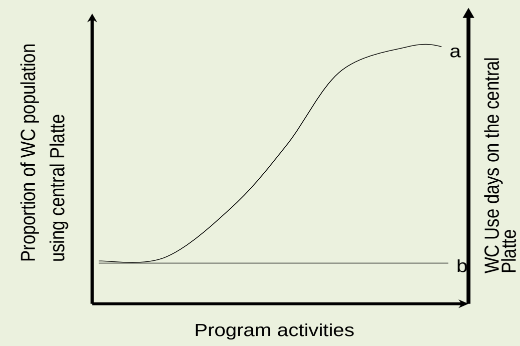
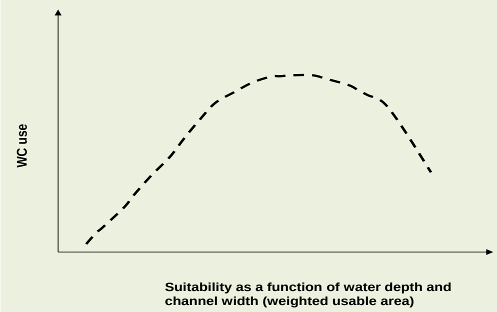
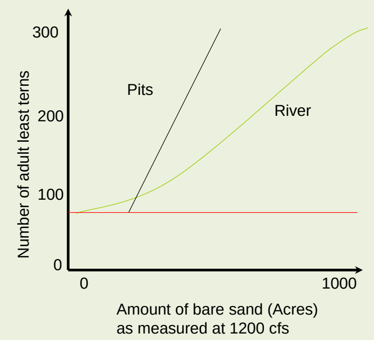
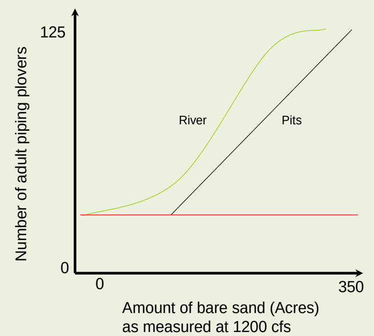
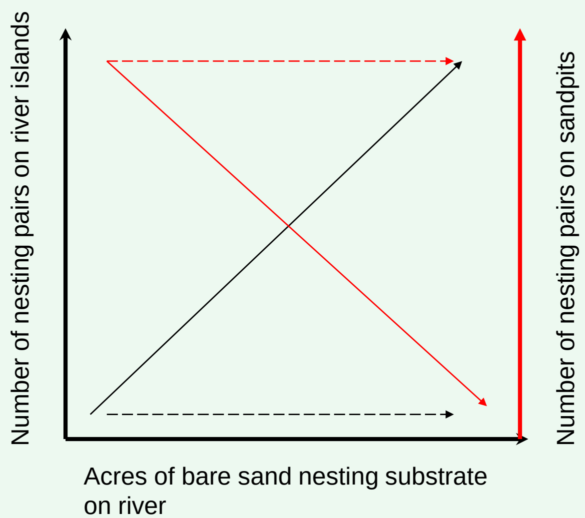
<table>
<tr><th>PRRIP “Big Questions”</th><th>Priority Hypotheses</th><th>Alternative Hypotheses</th><th>X-Y Graphs</th></tr>
<tr><td colspan="4"><u>Implementation</u> – Program Management Actions and Habitat</td></tr>
<tr><td rowspan="2">2. Will implementation of SDHF produce and/or maintain suitable 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>
</td></tr>
</table>

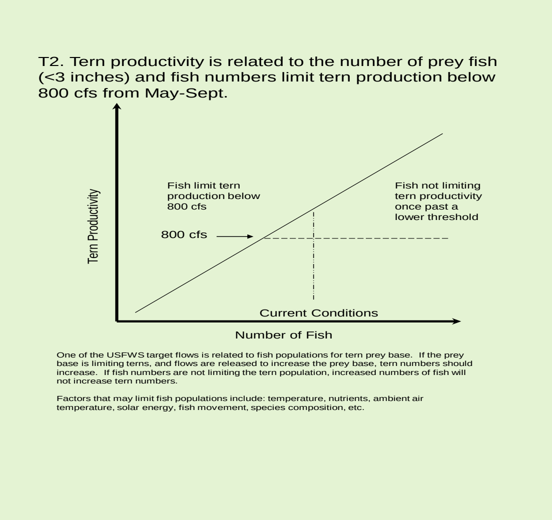
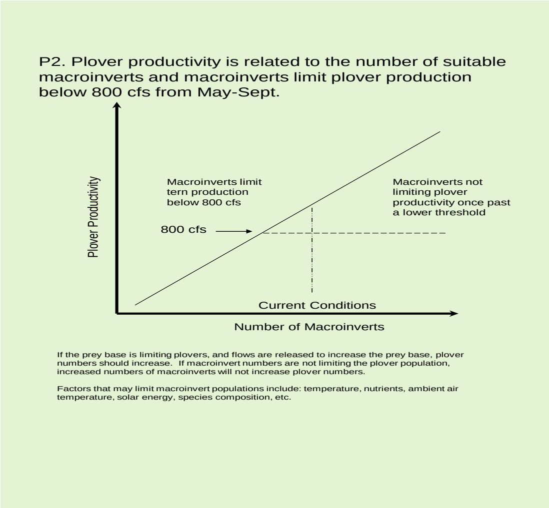
PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
Implementation – Program Management Actions and Habitat			
3. Is sediment augmentation necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?	**Sediment #1**: Average sediment 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.

PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
Implementation – Program Management Actions and Habitat			
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?	**Mechanical #2**: Increasing the Q1.5 in the main channel by consolidating 85% of the flow, and aided by Program flow and a sediment balance, flows will exceed stream power thresholds that will convert main channel from meander morphology in anastomosed reaches, to braided morphology with an average braiding index > 3.	Higher stream power (higher 1.5 yr. Q and/or more consolidation of side channels) needed to convert channel to braided morphology. Lower stream power will convert channel to braided morphology.	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.

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.

PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
Effectiveness – Habitat and Target Species Response			
6. Does availability of suitable nesting habitat limit tern and plover use and reproductive success on the central Platte River?	**T1**: Additional bare sand habitat will ↑ number of adult least terns. **P1**: Additional bare sand habitat will ↑ number of adult piping plovers.	Bare sand is not currently limiting number of adults.	T1: Additional bare sand habitat will increase the number of adult least terns.  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.  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

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>
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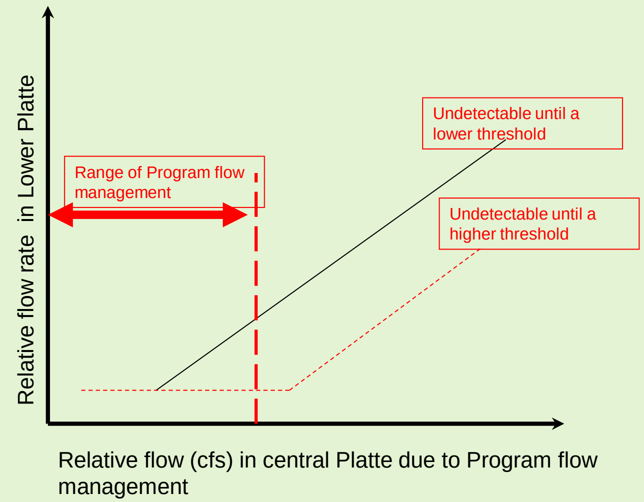
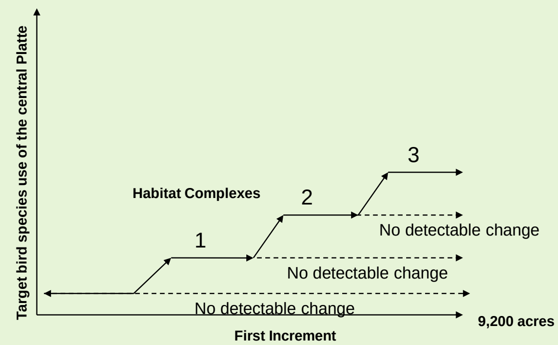
</table>

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.

<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>Larger Scale Issues</u> – Application of Learning</td></tr>
<tr><td>10. Do Program management actions in the central Platte River contribute to least tern, piping plover, and whooping crane recovery?</td><td><u>S1b</u>: Program land management actions (i.e. restoration into habitat complexes) will have a detectable effect on target bird species' use of the associated habitats.</td><td>Cannot detect a significant effect on indicators.</td><td>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
<u>Distribution</u> – 3 complexes distributed throughout study reach
<u>Location</u> – 6,400 ac above Minden; 2,800 ac below Minden
<u>Channel</u> – 2 miles long; 1,150 ft channels (overall 30% increase in channels >750 ft); maintained by clear/level/pulse approach
<u>Wet Meadows</u> – 640 ac per complex (10% increase in central Platte region)
<u>Buffers</u> – Up to 0.5 miles wide but may be variable
<u>Restoration</u> – At least 50% of land would undergo restoration</td></tr>
<tr><td>11. What uncertainties exist at the end of the Second Increment, and how might the Program address those uncertainties?</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

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

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

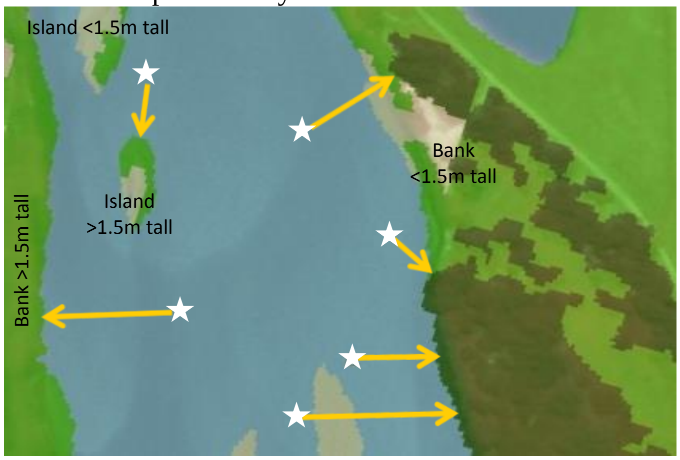


Figure 1. Distance to Obstruction

- *<u>Criterion</u>* – 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

- *<u>Definition</u>* – 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.

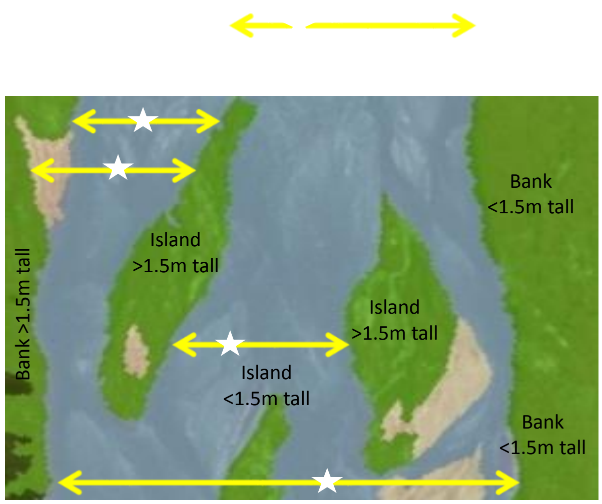


Figure 2. Unobstructed Channel Width

- *<u>Criterion</u>* – 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.

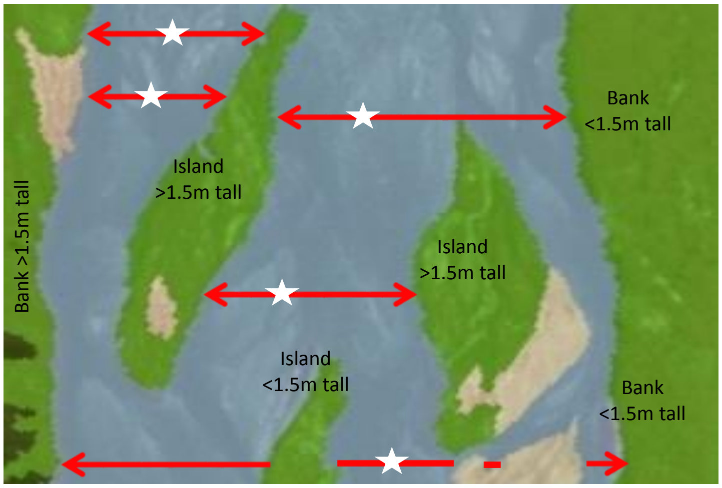


Figure 3. Wetted Channel Width

- *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.

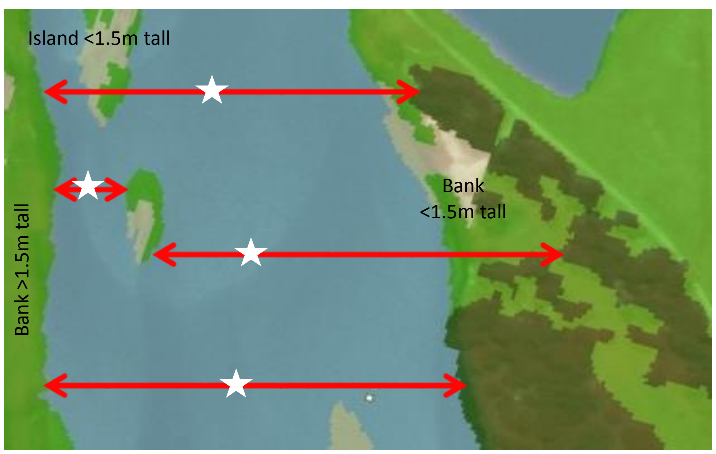


Figure 4. Unobstructed View Width

- *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).

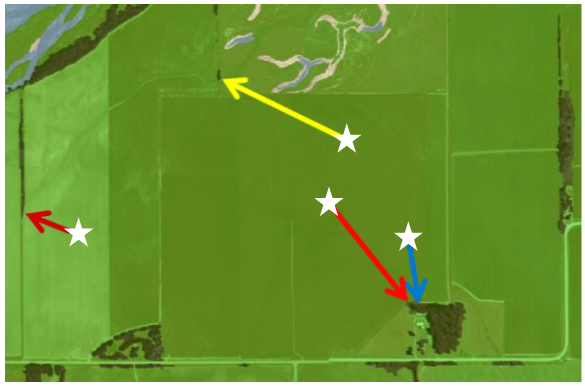


Figure 5. Distance to Obstruction

- *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.

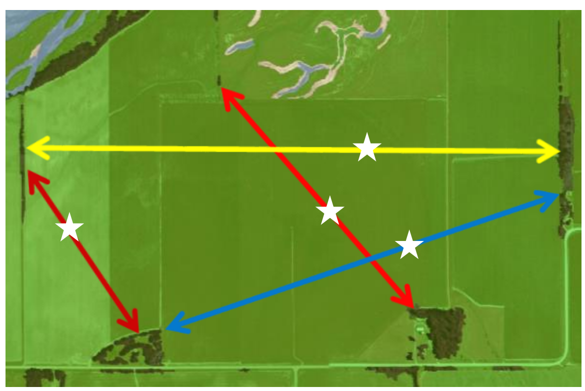


Figure 6. Unobstructed View Width

- *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
Whooping crane habitat requirements	Size – 640 contiguous acres or more when possible Unobstructed view area – As far as possible (330 feet = minimum habitat criteria) Low vegetative structure area – As much as possible Water area – As much as possible while maintaining wet meadow flora and fauna	During land review process then evaluate annually

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.

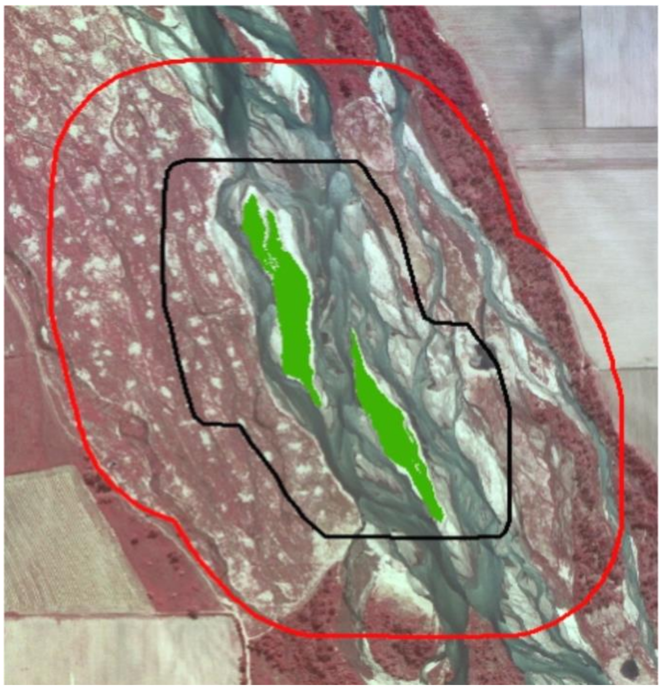


Figure 1. Suitable nesting area (green) with ≥1.5 acres of exposed bare sand within a ¼ mile stretch of channel.

- *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.

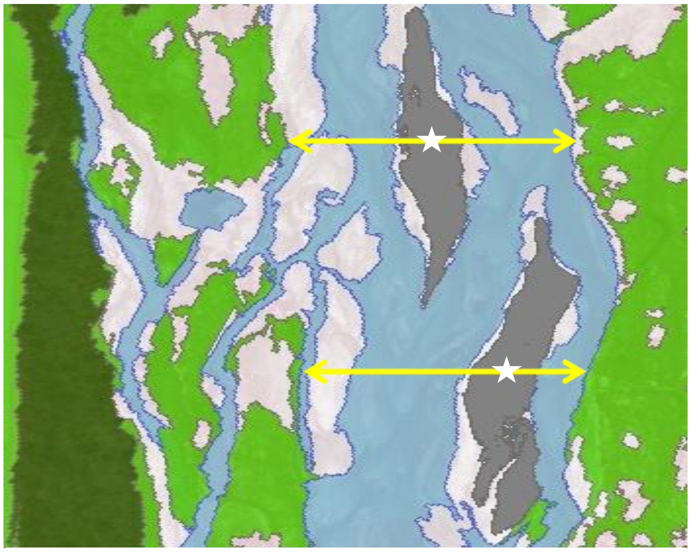


Figure 2. Channel width measured perpendicular to flow from the center of potentially suitable nesting areas.

- *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).

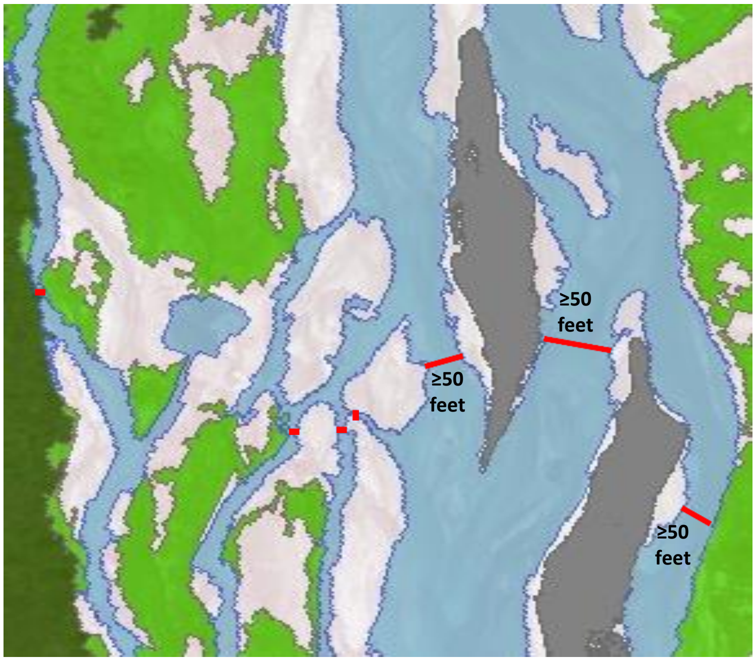


Figure 4. Channel width measured as the shortest distances across water from the edge of potentially suitable nesting areas to the bank lines on each side.

- *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.

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.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2014 State of the Platte Report
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.
[14] 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.
[15] 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.