Adaptive Management on the Platte River

11/20/2014

Platte River Recovery Implementation Program
Adaptive Management Plan (AMP)
2014 "State of the Platte" Report
(updated primarily with 2013 data)

PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

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PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2014 "State of the Platte"

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 1 below, followed by a new feature in the 2014 report – individual "Report Cards" for each Big Question. The Report Cards are intended to provide the GC with information that highlights scientific learning since 2013, key conclusions, and a forecast of when (or if) the EDO expects each Big Question will be answered during the First Increment. The Report Cards provide the most succinct summary of the status of each Big Question and how Program data is being utilized to evaluate the Big Questions and their underlying priority hypotheses.

The Report Cards are followed by detailed 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. In general, those endnotes include hyperlinks to information available in the Public Library section of the Program's web site.

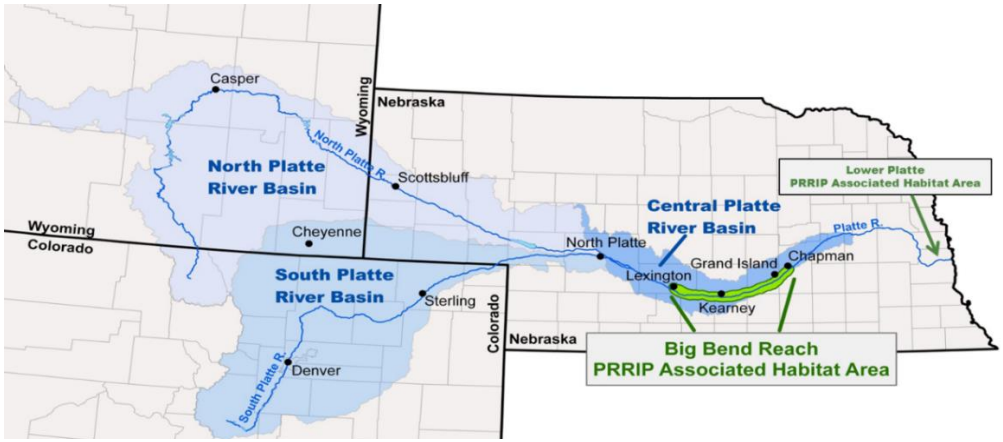

Figure 1. Map depicting Program area, including the Associated Habitat Reaches on the central and lower Platte River.

The 2013 State of the Platte Report included assessments incorporating Program data from years 2007-2012. The 2014 report primarily incorporates an additional year of data from 2014, though where noted some observations and/or data from 2014 were included to provide context or insight.

With the exception of Big Question #6, 2012 data did not lead to changes in the Big Question assessments in 2013. Of the eleven Big Questions, one answer is conclusive (#8), five are trending positive (#3, #4, #6, #9, and #10), one is trending negative (#1), and four remain inconclusive and open to further investigation (#2, #5, #7, and #11). As in 2013, assessment of the Big Questions in 2014 reveals the Program is on track towards meeting the AMP management objectives.

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

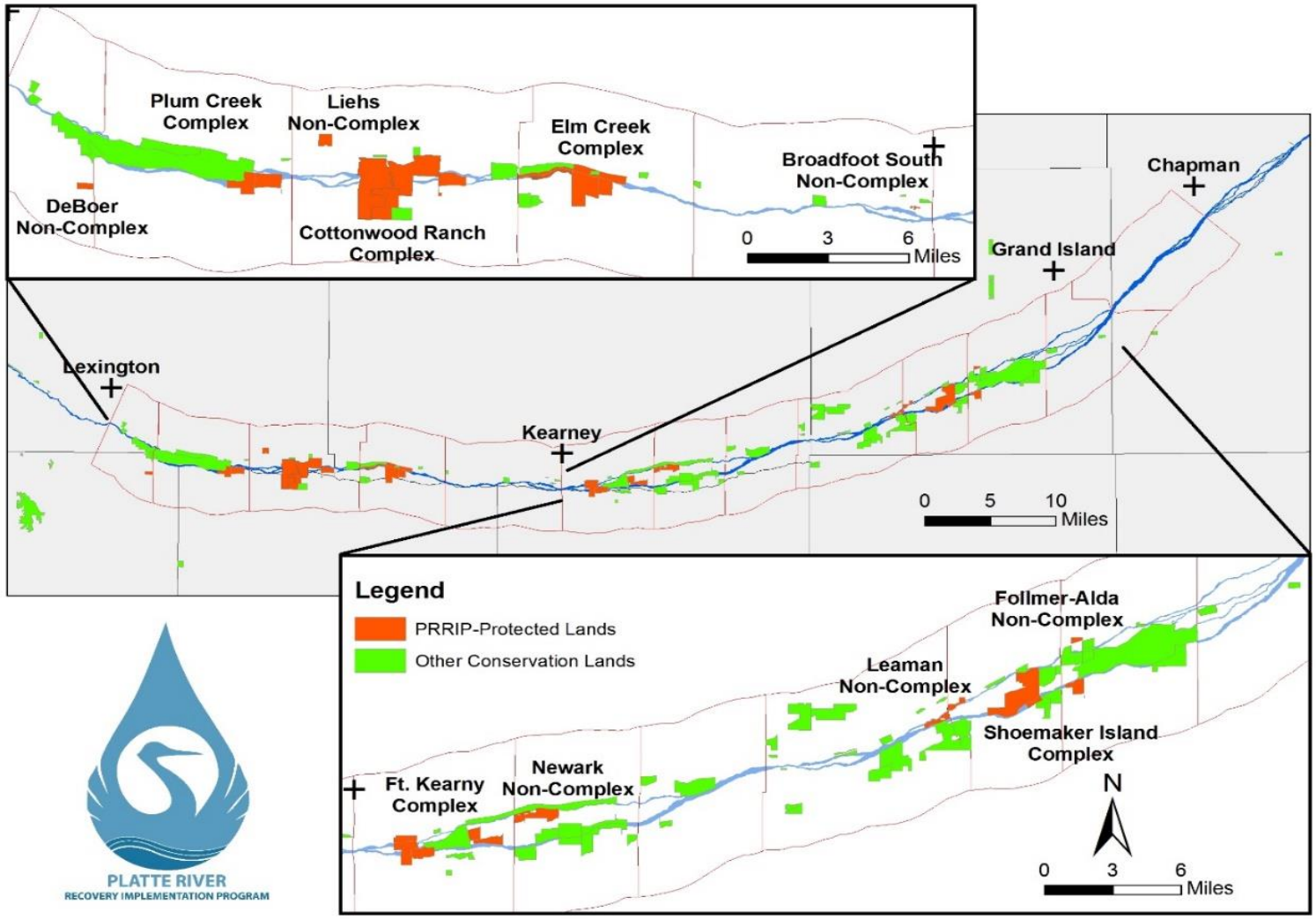

Figure 2. Program habitat complexes in the Associated Habitat Reach.

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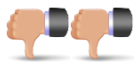
"Quick Reference" Guide

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 and 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

PRRIP Big Questions = What we don't know but want to learn	Broad Hypotheses[1]	Priority Hypotheses[2]	2012 Assessment	2013 Assessment	2014 Assessment
<u>Implementation</u> – Program Management Actions and Habitat					
1. Will implementation of SDHF[3] produce suitable[4] tern and plover riverine nesting habitat on an annual or near-annual basis?	*PP-1a: Flows of 5,000 to 8,000 cfs magnitude in the habitat reach for a duration of three days at Overton on an annual or near-annual basis will build sandbars to an elevation suitable for least tern and piping plover habitat.*	Flow #1			
2. Will implementation of SDHF produce and/or maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis?	*PP-1b: Flows of 5,000 to 8,000 cfs magnitude in the habitat reach for a duration of three days at Overton on an annual or near-annual basis will increase the average width of the vegetation-free channel.*	Flow #3, Flow #5			
3. Is sediment augmentation necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?	*PP-2: Between Lexington and Chapman, eliminating the sediment imbalance of approximately 400,000 tons annually in eroding reaches will reduce net erosion of the river bed, increase the sustainability of a braided river, contribute to channel widening, shift the river over time to a relatively stable condition, and reduce the potential for degradation in the north channel of Jeffrey Island resulting from headcuts.*	Sediment #1			

[1] From the Final Program Document, Adaptive Management Plan (AMP), Broad Hypotheses, Pages 14-17.

[2] From the Final Program Document, Adaptive Management Plan (AMP), Table 2, Pages 70-78. See **Appendix C** for the specific language of each Priority Hypothesis listed as well as the associated X-Y graph.

[3] Short-Duration High Flows (SDHF) = 5,000-8,000 cfs at Overton for 3 days. This is the only flow-related management action specified in the AMP.

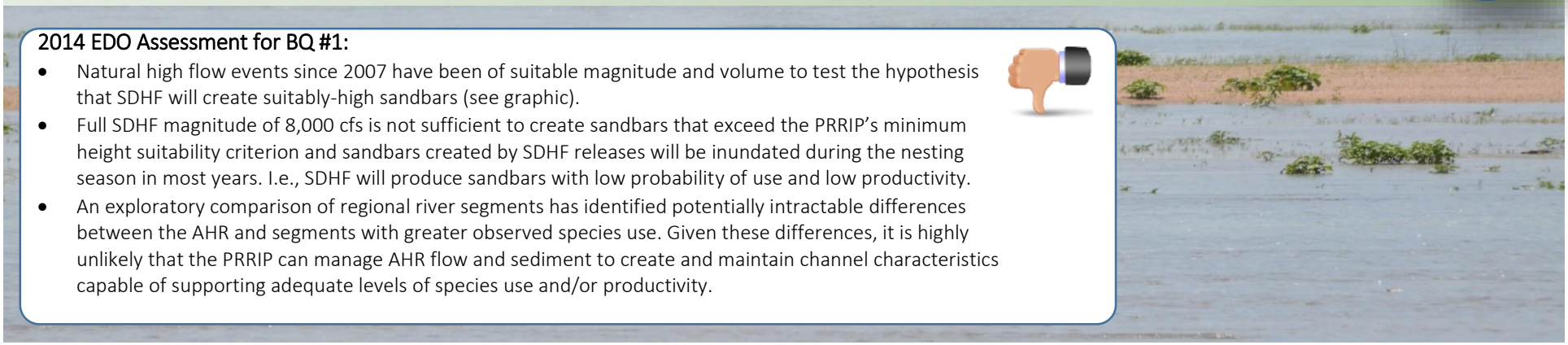
[4] The term "suitable" is defined by the Program either as a function of habitat suitability criteria developed by the Technical Advisory Committee (see **Appendix D**) or Department of Interior (DOI) target habitat criteria in Land Plan Table 1 (see **Appendix E**).

PRRIP Big Questions = What we don't know but want to learn	Broad Hypotheses	Priority Hypotheses	2012 Assessment	2013 Assessment	2014 Assessment
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?	*PP-3: Designed mechanical alterations of the channel at select locations can accelerate changes towards braided channel conditions and desired river habitat.*	Mechanical #2			
<u>Effectiveness</u> – Habitat and Target Species Response					
5. Do whooping cranes select suitable riverine roosting habitat in proportions equal to its availability?	*WC-1: Whooping cranes that use the central Platte River study area during migration seasons prefer habitat complexes (Land Plan Table 1) and use will increase proportionately to an increase in habitat complexes. WC-4: In the central Platte River study area, whooping cranes prefer conditions created by species target flows and annual pulse flows.*	WC1, WC3			
6. Does availability of suitable nesting habitat limit tern and plover use and reproductive success on the central Platte River?	*TP-1: In the CPR study area, terns and plovers prefer/do not prefer riverine habitats as described in Land Plan Table 1 and use will/will not increase proportionately to an increase in habitat complexes.*	T1, P1			
7. Are both suitable in-channel and off-channel nesting habitats required to maintain central Platte River tern and plover populations?	*TP-2: The maintenance of tern & plover populations in the central Platte requires/does not require that sandpits & river continue to function together to provide nesting and foraging habitat. TP-3: Ephemeral river nesting areas are/are not needed for long-term nesting success of tern & plover.*	TP1			

PRRIP Big Questions = What we don't know but want to learn	Broad Hypotheses	Priority Hypotheses	2012 Assessment	2013 Assessment	2014 Assessment
8. Does forage availability limit tern and plover productivity on the central Platte River?	*TP-4: Existing river flows do/do not provide a sufficient forage base throughout the central Platte River study reach for populations of terns and plovers during the nesting season.*	T2, P2		*N/A – question answered in 2012*	
9. Do Program flow management actions in the central Platte River avoid adverse impacts to pallid sturgeon in the lower Platte River?	*PS-2: Water related activities above the Loup River do/do not impact pallid sturgeon habitat.*	PS2			
<u>Larger Scale Issues</u> – Application of Learning					
10. How do Program management actions in the central Platte River contribute to least tern, piping plover, and whooping crane recovery?	*S-3: Program management actions will/will not have a detectable effect on target species use of the associated habitats.*	S1b			
11. What uncertainties exist at the end of the First Increment, and how might the Program address those uncertainties?	N/A	N/A			

The Program's "Big Questions", associated Broad Hypotheses from the AMP, and associated Priority Hypotheses from the AMP.

BQ #1 – Will implementation of Short-Duration High Flow releases produce suitable tern and plover riverine nesting habitat on an annual or near-annual basis?



2014 EDO Assessment for BQ #1:

- Natural high flow events since 2007 have been of suitable magnitude and volume to test the hypothesis that SDHF will create suitably-high sandbars (see graphic).
- Full SDHF magnitude of 8,000 cfs is not sufficient to create sandbars that exceed the PRRIP's minimum height suitability criterion and sandbars created by SDHF releases will be inundated during the nesting season in most years. I.e., SDHF will produce sandbars with low probability of use and low productivity.
- An exploratory comparison of regional river segments has identified potentially intractable differences between the AHR and segments with greater observed species use. Given these differences, it is highly unlikely that the PRRIP can manage AHR flow and sediment to create and maintain channel characteristics capable of supporting adequate levels of species use and/or productivity.

How does this Big Question relate to Program priority hypotheses?

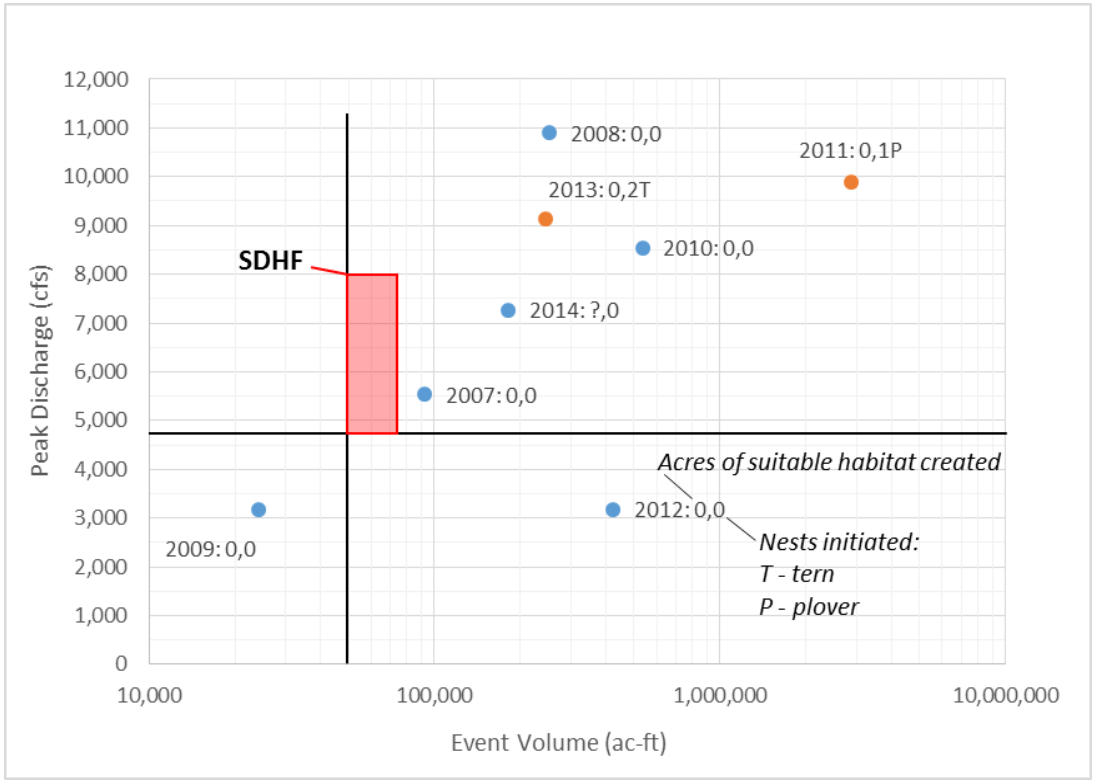
Based upon the SedVeg model and associated assumptions in the FSM management strategy, it is hypothesized that under a balanced sediment budget, flows of 5,000 to 8,000 cfs magnitude for three days (SDHF) will build sandbars to an elevation that is suitable for tern and plover nesting. The Program's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

What the science says in 2014:

- Observed sandbar heights in the AHR are somewhat lower than was assumed in the original analysis of SDHF performance.
- Three peak flow events (2010, 2011 & 2013) that exceeded SDHF magnitude and duration did not produce sandbar habitat exceeding the minimum height criterion.
- Two out of the total of three nests initiated on natural riverine sandbars formed by these peak flow events were inundated during the late spring rise, which often occurs during the nesting season.
- The Niobrara is the only regional river that supports species densities that approximate proposed AHR recovery objectives.
- The wide channels and large sandbars (~30 ac) used by these species on the Niobrara River are absent from the AHR.

We estimate with confidence that:

- Sandbars created by a full SDHF magnitude of 8,000 cfs would be 0.5 – 1.0 ft lower than the minimum height criterion and would be inundated at flows experienced in the AHR during most nesting seasons.
- Flow magnitudes of 11,000 - 15,000 cfs would be necessary to produce sandbars exceeding the minimum height criterion.
- Even at these discharge magnitudes, suitably-high sandbars would be small in size and total suitable sandbar area would be well below the AMP objective of 10 acres per river mile.
- The lack of large sandbars in the AHR is likely related to bed material grain size and the mode of sediment transport. Sufficiently fine sediment is not available to shift the AHR into the range observed in the Niobrara



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.

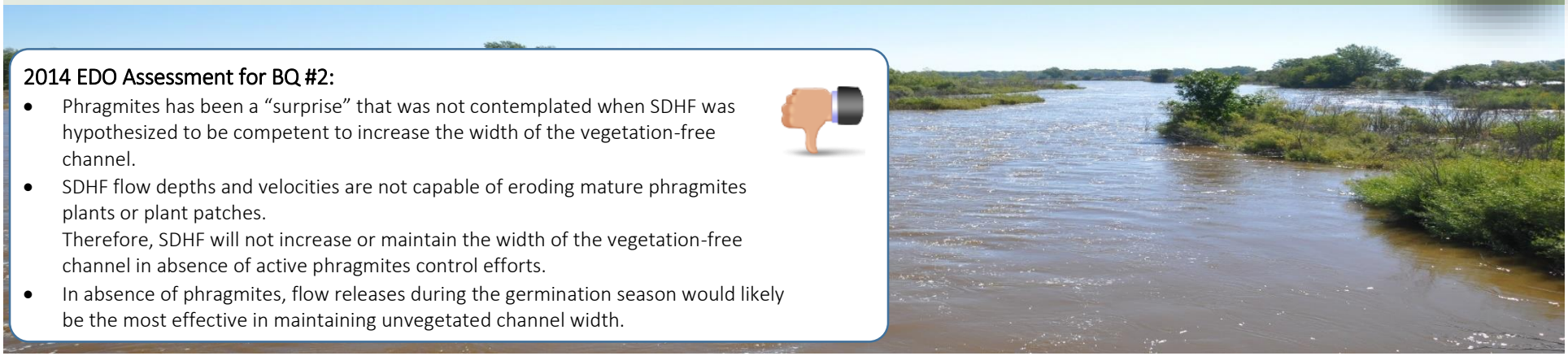
Remaining uncertainties include:

- Given variability in channel geometry and discharge, it is difficult to accurately identify the portion of the AHR that is in sediment balance on an annual basis.
- The duration/volume of natural high flow events have greatly exceeded SDHF. Accordingly, it is not known if SDHF duration is sufficient to mobilize existing bedforms and produce new sandbars.
- On-channel species productivity in other regional river segments is not well documented.

Answering BQ #1 during the First Increment

- Remaining uncertainties are not critical in answering BQ #1.
- Six tern/plover habitat synthesis chapters, now in peer review, will serve as the best source for synthesized reference data for this question.
- Once peer review is complete, Program staff expect Big Question #1 to be answered with a definitive “two thumbs down” in 2015.
- The Governance Committee will be presented information suggesting that decision-making should move into the final “Adapt” stage of adaptive management.

BQ #2 – Will implementation of Short-Duration High Flow releases produce and/or maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis?



2014 EDO 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.

How does this Big Question relate to Program priority hypotheses?

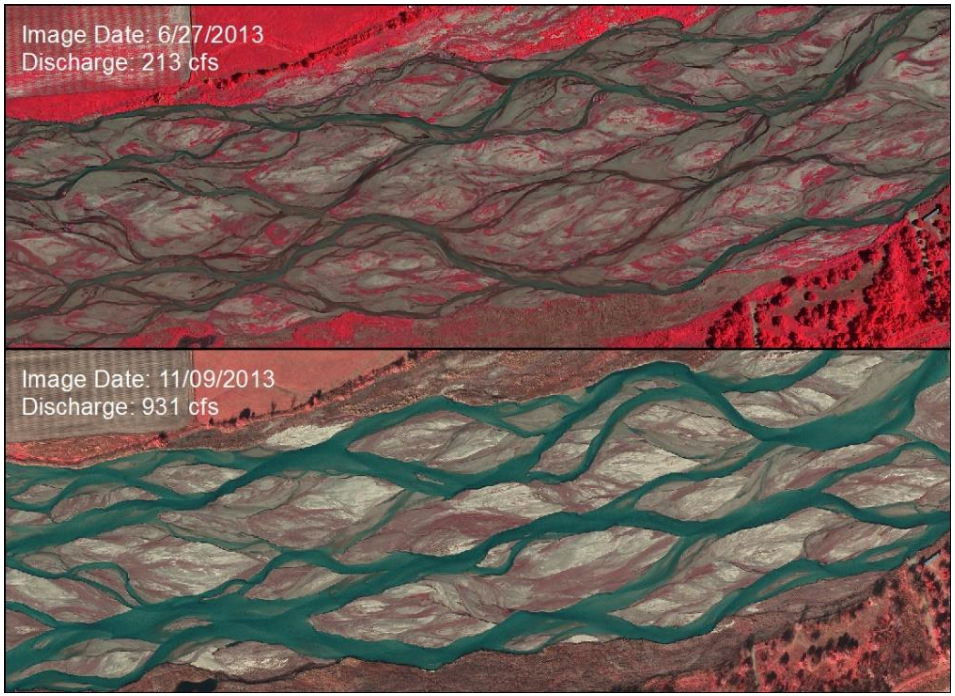
Based upon the SedVeg model and associated assumptions in the FSM management strategy, it is hypothesized that under a balanced sediment budget flows of 5,000 to 8,000 cfs magnitude for three days on an annual or near annual basis (SDHF) will increase the average width of the vegetation-free channel 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.

What the science says in 2014:

- The original analysis of SDHF performance did not include the exotic strain of phragmites that was primarily responsible for channel narrowing during the drought of 2001 – 2007.
- Directed research indicates that phragmites is extremely erosion-resistant and SDHF flow depths and velocities are only sufficient to scour the very weakest individual plants.
- Phragmites occurrence and percent cover declined during the period of 2009-2012 and were stable in 2013. The reduction is positively correlated with herbicide application and not correlated with peak flow magnitude or inundation duration.
- Mean total channel width did not change during the period of 2009-2013. Mean unvegetated channel width increased in 2010-2011 and decreased in 2012-2013.
- Change in unvegetated channel width was most highly correlated with mean discharge during the seed germination season.
- The fall 2013 natural high flow event, which exceeded SDHF in magnitude and duration, did not effectively scour vegetation and mobilize bedforms in much of the AHR (see graphic).

We estimate with confidence that:

- Implementation of SDHF and sediment augmentation in absence of active phragmites control efforts will not maintain unvegetated channel width and may exacerbate channel incision and vertical accretion of vegetated bar forms.
- *If* phragmites is actively controlled, flow releases during the germination season would likely be the most effective in maintaining unvegetated channel width.



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

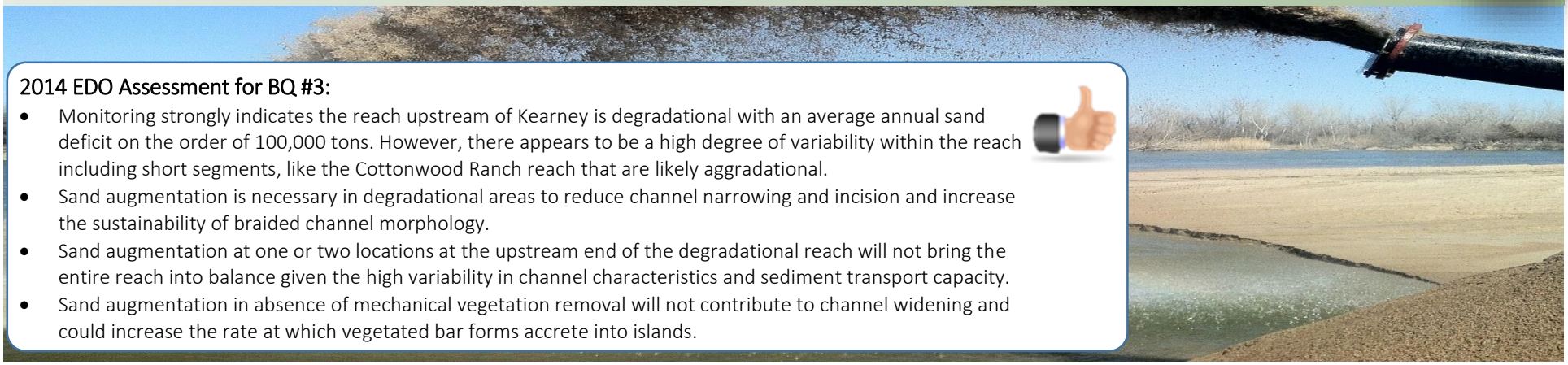
Remaining uncertainties include:

- The use of flow to prevent plant establishment during the germination season and/or cause inundation mortality has not been well explored to date.
- The duration/volume of natural high flow events have greatly exceeded SDHF. Accordingly, it is not known if SDHF duration is sufficient to mobilize existing bedforms even if they are lightly vegetated.
- Baseline assumptions about the frequency and efficacy of future phragmites control efforts are currently lacking.

Answering BQ #1 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 the studies are published, Program staff expect Big Question #2 to be answered with a definitive "two thumbs down" in 2015.
- The Governance Committee will be presented information suggesting that this Big Question be revised to reflect the ongoing necessity of some level of mechanical/herbicide control of phragmites.

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



2014 EDO 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 likely 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 will not contribute to channel widening and could increase the rate at which vegetated bar forms accrete into islands.

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.

What the science says in 2014:

- Monitoring strongly indicates portions of the AHR upstream of Kearney are degradational with an average annual sand deficit on the order of 100,000 tons.
- The annual sand deficit is highly variable with the majority of the degradation occurring during high discharge years.
- Approximately 180,000 tons of sediment was augmented in 2012-2013 to test augmentation means and methods. Mechanical augmentation through island leveling and channel widening is a more cost-efficient and flexible method than sand pumping.
- Mechanically widened and managed reaches like the Cottonwood Ranch habitat complex function as sediment traps that accumulate augmented sand.

We estimate with confidence that:

- Observed narrowing and incision in degradational reaches is a strong indicator that it will be difficult to sustain a wide, braided channel morphology in those reaches without augmentation.
- The presence of scour-resistant vegetation severely limits the potential for the channel to widen in response to sediment augmentation and could exacerbate the rate at which vegetated bar forms accrete into islands.
- Sand augmentation 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 variability in channel characteristics and sediment transport capacity.

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.

Remaining uncertainties include:

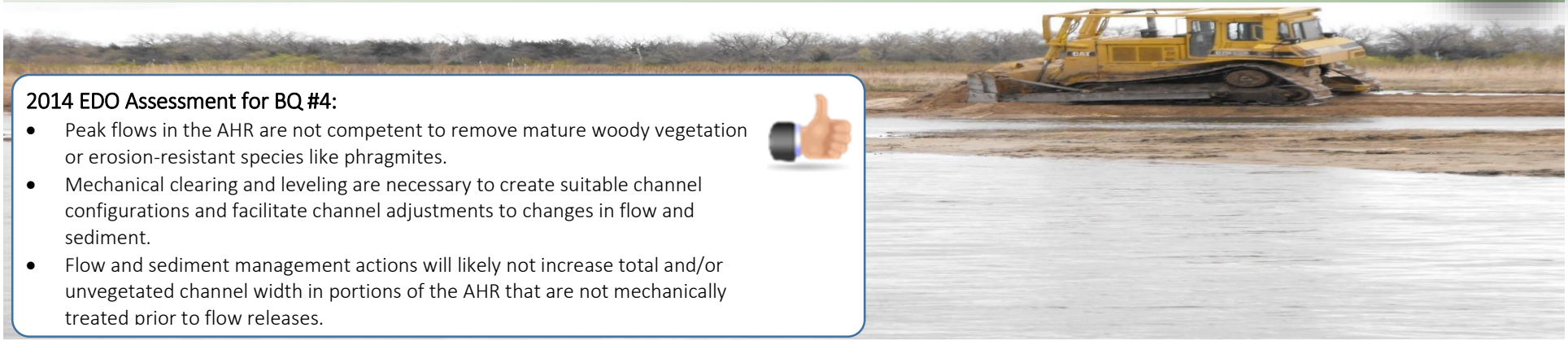
- Annual deficits may range from almost 0 tons in drought years to 400,000 tons in high-discharge years. It is not known if the entire deficit can be offset during high-discharge years.
- It is not known how the variability in channel characteristics and sediment transport capacity will affect the number and location of sediment augmentation sites.
- The speed and magnitude of channel response to augmentation is still unknown. Minor changes in channel geometry were observed during the pilot project but long-term augmentation will be necessary to better evaluate response.

Answering BQ #1 during the First Increment

- The Program is currently preparing to develop a full scale sediment augmentation design and obtain the necessary permits and authorizations.
- Full scale operations and response monitoring will likely begin in 2015.

Implementation – Program Management Actions and Habitat

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



2014 EDO 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.

How does this Big Question relate to Program priority hypotheses?

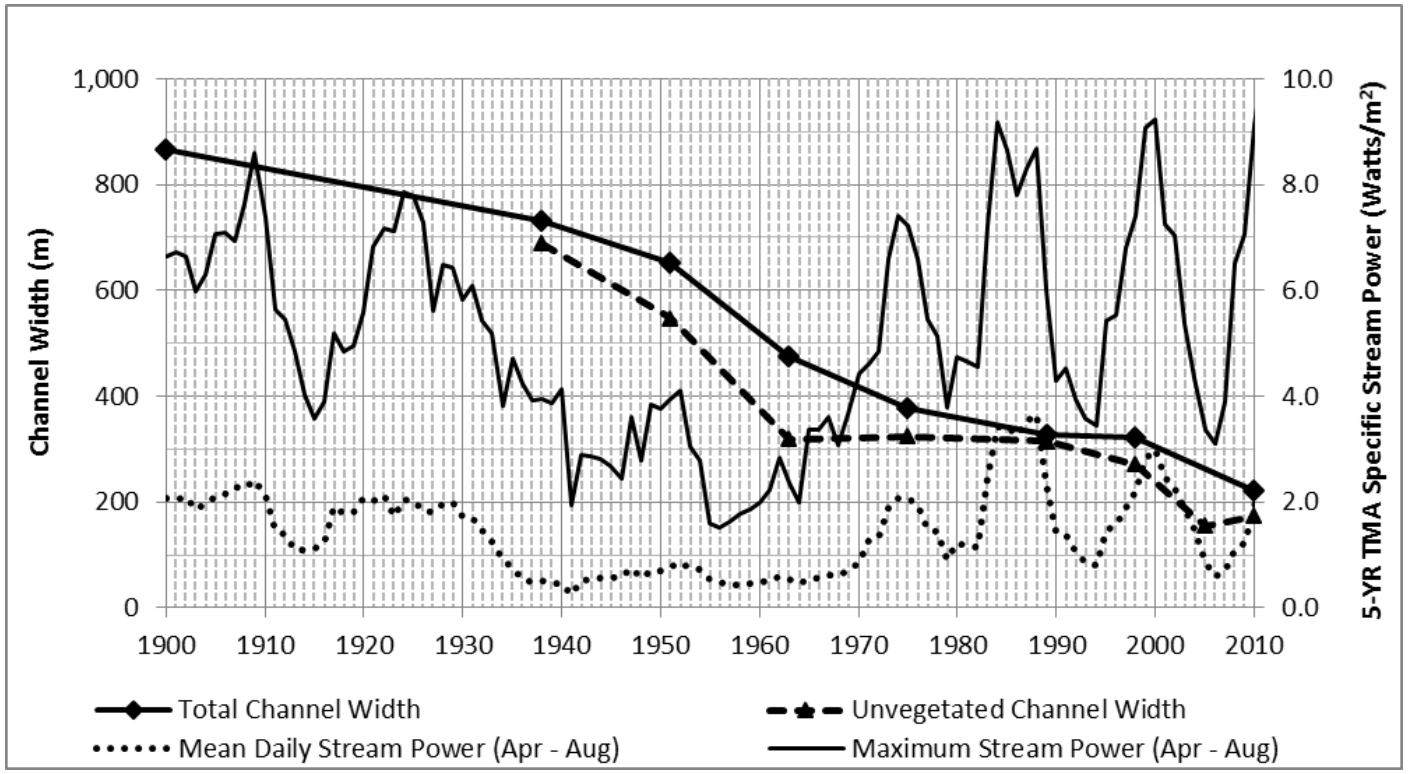
Based on the SedVeg model and associated assumptions in the FSM management strategy, it is hypothesized that designed mechanical channel alterations like mechanical clearing and leveling of islands, channel widening, vegetation clearing from banks are needed to accelerate the creation of, and/or to maintain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

What the science says in 2014:

- The original analysis of FSM performance assumed that the geometry of the AHR would freely adjust to changes in flow and sediment and mechanical alterations would accelerate that process.
- The AHR 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.
- Phragmites is extremely erosion-resistant and SDHF flow depths and velocities are only sufficient to scour the very weakest individual plants. Ability to scour woody vegetation decreases dramatically in the year following seed germination.
- Mechanically-managed reaches of the AHR are significantly wider than unmanaged reaches whether or not flow is consolidated.

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.



Relationship between stream power and channel width in the Shelton to Wood River bridge segment 1900-2010. Increases in peak and mean daily stream power during wet cycles in the 1980s and 1990s did not result in channel widening. This is an example of the vegetation "ratchet" effect.

Remaining uncertainties include:

- Baseline assumptions about the frequency and efficacy of future phragmites control efforts are currently lacking.
- 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.

Answering BQ #1 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.
- One this manuscript is peer reviewed, Program staff expect Big Question #4 to be answered with a definitive "two thumbs up" in 2015.

Effectiveness – Habitat and Target Species Response

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

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 increased during spring migration season and remained steady during the fall.

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).

What Does the Science Say in 2014?

- 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.[5]
- Though variable, the proportion of the whooping crane population documented within the AHR during the spring migration increased significantly over the past 14 years.
- Fall use of the Platte River remained fairly constant over the past 13 years.[6]

We can say with confidence

- Program habitat management efforts have been implemented to increase whooping cranes use of the Program Associated Habitat Area and include tree removal, bank line and channel disking and widening, flow releases, sediment augmentation and wet meadow creation and maintenance.
- Whooping crane use (proportion of the population and crane use days) of the Platte River during spring has increased significantly since 2001.

[5] PRRIP Spring 2014 Whooping Crane Monitoring Report.

[6] PRRIP Fall 2013 Whooping Crane Monitoring Report.

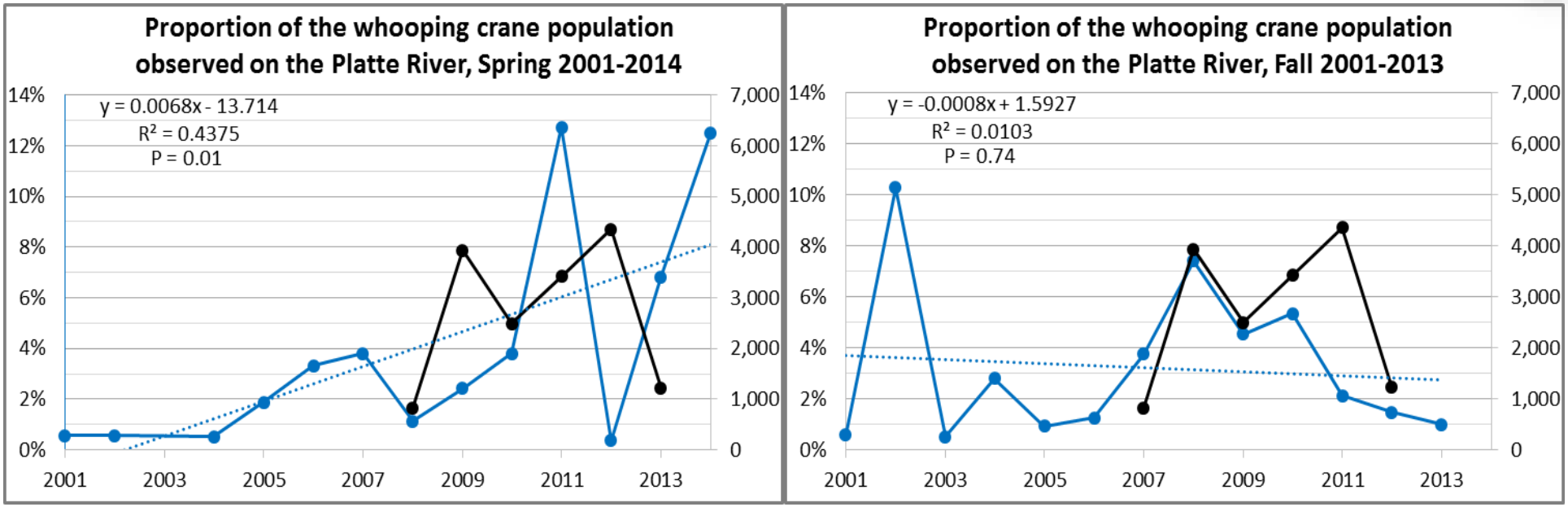


Figure 6. Trends (dashed lines) in the proportion (blue line) of the whooping crane population observed on the Platte River during spring (left) and fall (right) migration, 2001-2014. Radio-marked whooping cranes not detected are not included. Black lines represent Program-defined suitable in-channel habitat acres 2008-2013 (spring) or 2007-2012 (fall).

Remaining uncertainties include:

- If current levels of roosting and foraging habitat limit whooping crane use of the Associated Habitat Reach.
- 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.

Answering BQ #5 during the First Increment

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

Effectiveness – Habitat and Target Species Response

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

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 during the First Increment occurred on off-channel sandpits making for a thin comparison with on-channel island nesting.

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).

What Does the Science Say in 2014?

- Off-channel nesting habitat availability has increased.
- Tern and plover breeding pair counts increase at a similar rate as habitat availability does.
- 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.

We can say with confidence:

- There is a strong, positive correlation between tern and plover breeding pair counts and habitat availability.
- Increases in off-channel habitat has resulted in an increase in breeding pairs within the Associated Habitat Reach.[7]
- 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.

[7] See PRRIP 2012-2013 Tern and Plover Monitoring Report; also relies on provisional 2014 monitoring data.

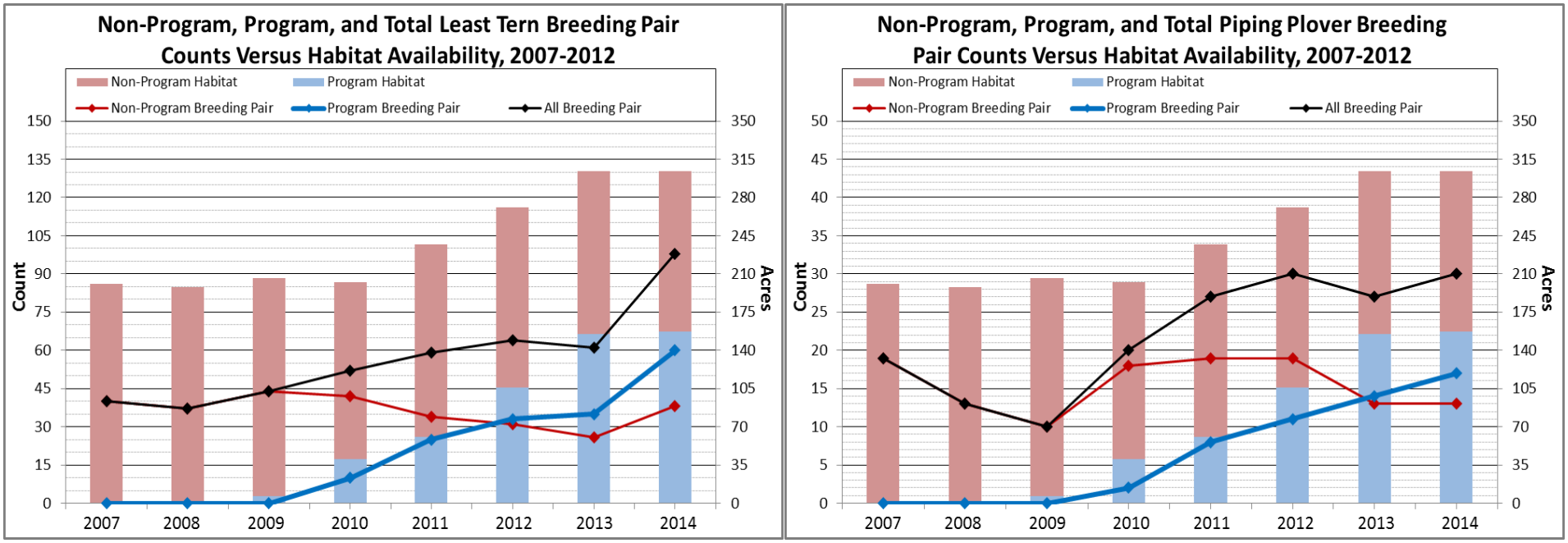


Figure 1. Tern (left plot) and plover (right plot) Program, non-Program, and total breeding pair counts (solid lines) and Program and non-Program habitat availability, 2007-2014.

Remaining uncertainties include:

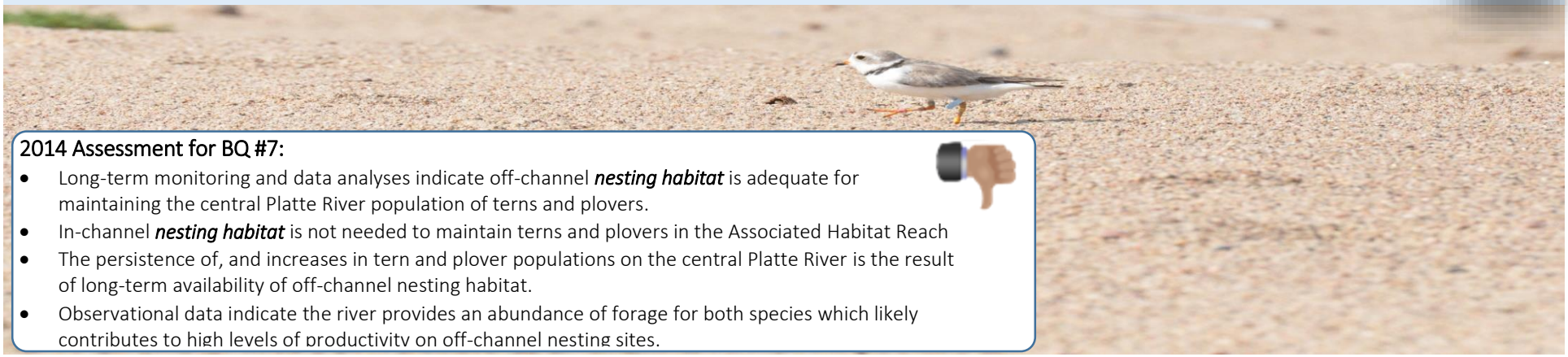
- If current levels of off-channel nesting habitat limits further growth and expansion of the plover population within the Associated Habitat Reach.
- How many tern breeding pair current levels of off-channel nesting habitat can support.
- If in-channel nesting habitat can support similar breeding pair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

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 answering this Big Question.
- Once peer review is complete, Program staff expect Big Question #6 will be answered with a definitive “2-thumbs up” in 2015.
- The Governance Committee will be presented information suggesting decision-making should progress to the final “Adapt” stage of the adaptive management cycle.

Effectiveness – Habitat and Target Species Response

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



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 provides an abundance of forage for both species which likely contributes to high levels of productivity on off-channel nesting sites.

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.

What Does the Science Say in 2014?

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

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.

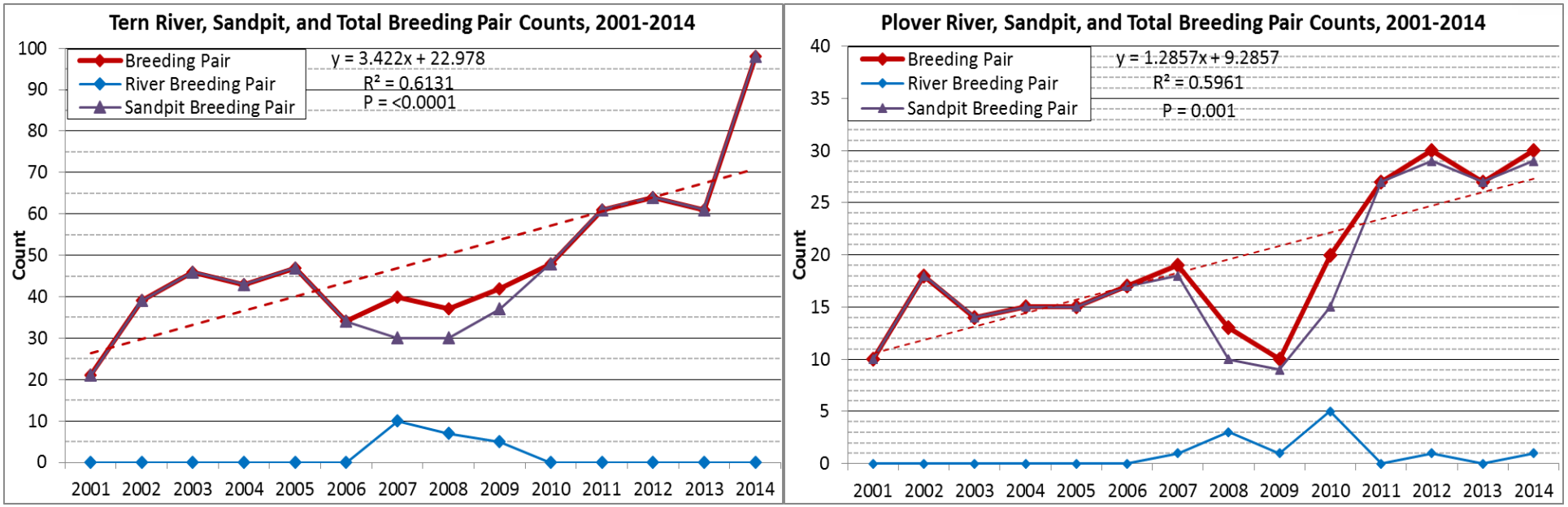


Figure 1. Annual tern (left plot) and plover (right plot) total, riverine, and sandpit breeding pair counts, 2001-2014. Trend lines (dashed lines) represent significant increases in tern and plover breeding pair counts during 2001-2014 with the most substantial increases occurring since inception of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

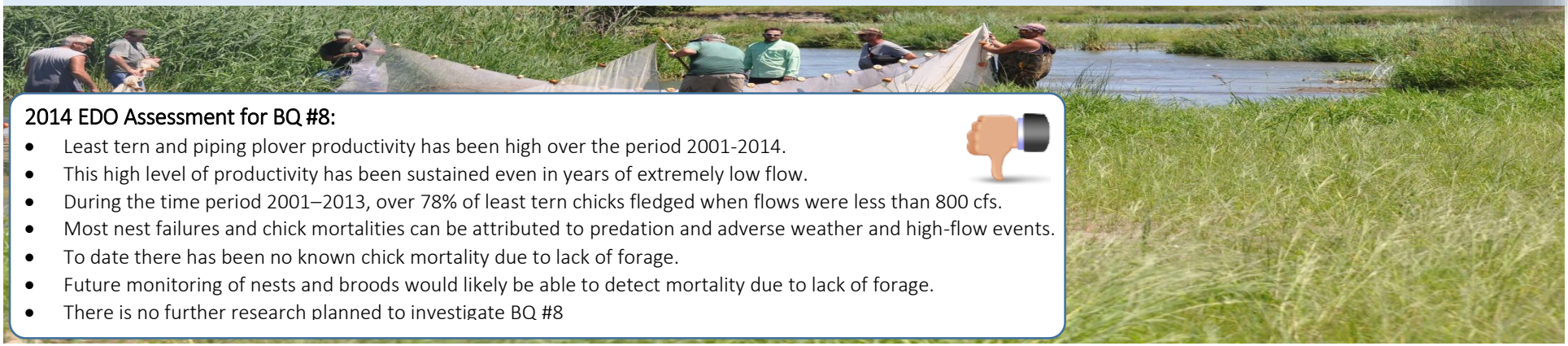
Remaining uncertainties include:

- Whether or not in-channel nesting habitat could result in similar levels of 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 and productivity manuscript 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 2015.
- The Governance Committee will be presented information suggesting decision-making should progress to the final "Adapt" stage of the adaptive management cycle.

BQ #8 – Does forage availability limit tern and plover productivity on the central Platte River?



2014 EDO 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 less than 800 cfs.
- Most nest failures and chick mortalities can be attributed to predation and adverse weather and high-flow events.
- To date there has been no known chick mortality due to lack of forage.
- Future monitoring of nests and broods would likely be able to detect mortality due to lack of forage.
- There is no further research planned to investigate BQ #8

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.

What the science says in 2014:

- If forage availability limits productivity, we 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 the 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 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.

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 for populations of least terns and piping plovers, intensive nest and brood monitoring that is currently planned during the first increment should detect increased rates for mortality which would initiate revisiting BQ #8.

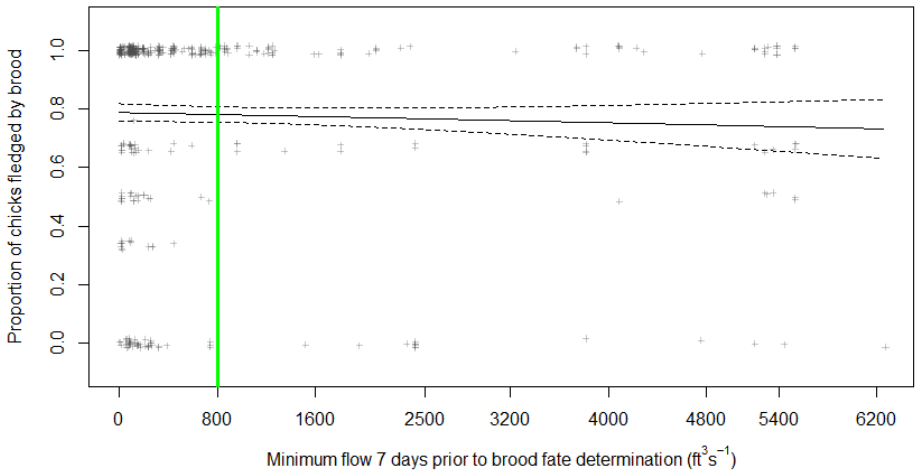


Figure 1. Results from data analysis showing the relationship between flow and tern productivity. Not the grey "+" signs shows the proportion of chicks that fledged for each brood (i.e., number of fledglings/number of eggs that hatched). Note the green line shows that most broods experienced flows less than 800 cfs in the 7 days before they fledged or failed.

Remaining uncertainties include:

- Determining population levels of least tern and piping plovers the forage base can support in the AHR. This would involve answering the question: At what population size would terns and plovers be limited by forage availability?
- Fates of broods that failed with unknown causes, such as the 34 least tern broods, that failed over the period 2001–2013.

Answering BQ #8 during the First Increment

- Remaining uncertainties are not likely to change BQ #8 assessment.
- A report or manuscript will be prepared examining the productivity of least terns and piping plovers within the AHR.
- Once peer review is complete, Program staff expect Big Question #8 to be answered with a definitive "two thumbs down" in 2015.
- The Governance Committee will be presented information suggesting decision-making should move into the final "Adapt" stage of adaptive management.

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

APPENDIX A

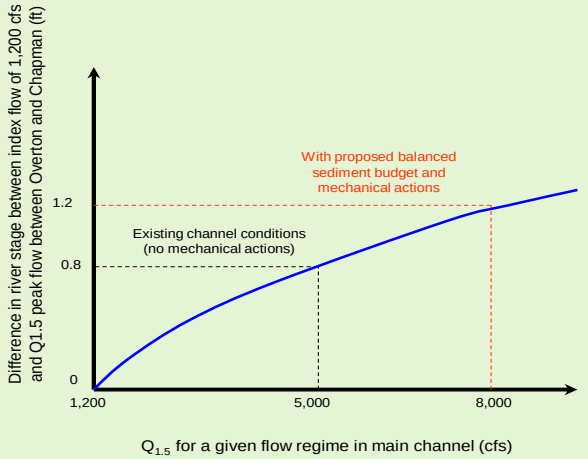
ISAC COMMENTARY ON THE 2014 BIG QUESTION ASSESSMENTS

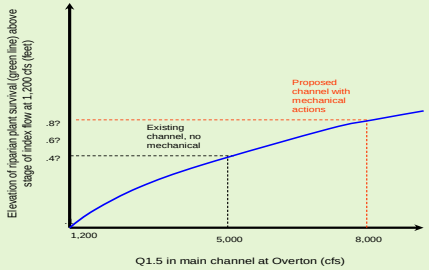
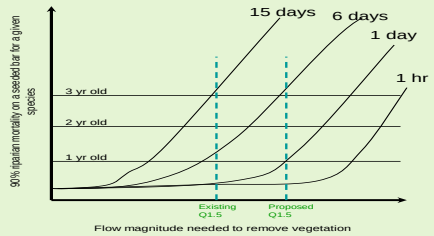
APPENDIX B

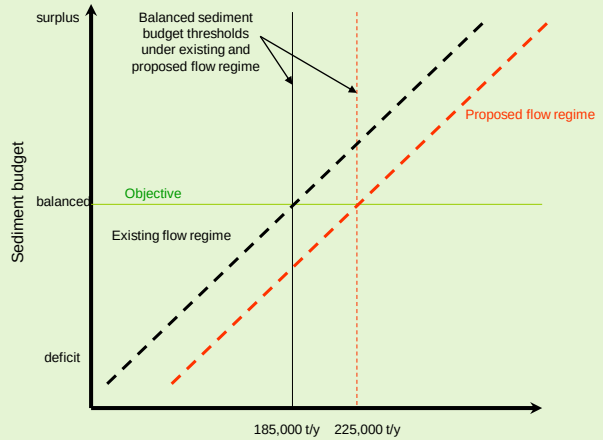
2014 TECHNICAL COMMENT AND RESPONSE TABLE

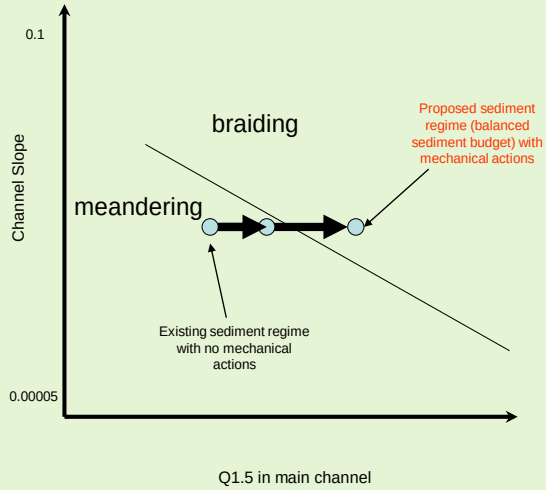
APPENDIX C

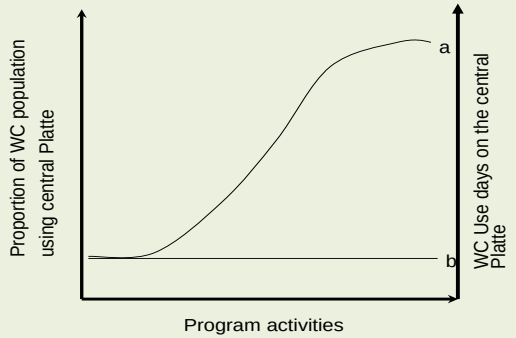
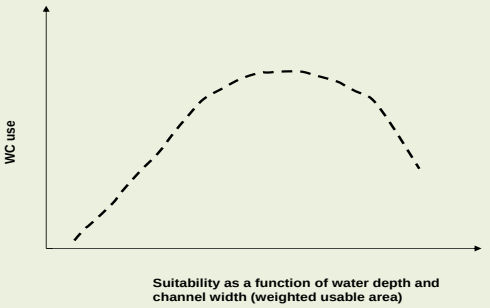
TIER 1 PRIORITY HYPOTHESES & ASSOCIATED X-Y GRAPHS

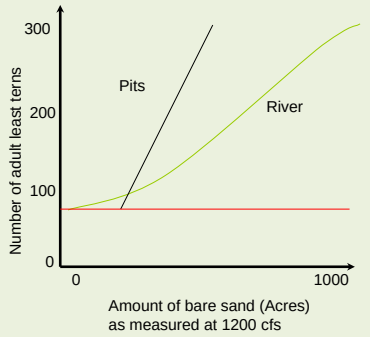
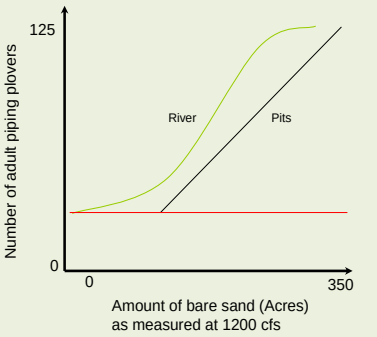
PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
<u>Implementation</u> – Program Management Actions and Habitat			
1. Will implementation of SDHF produce suitable tern and plover riverine nesting habitat on an annual or near-annual basis?	**Flow #1:** ↑ the variation between river stage at peak (indexed by Q1.5 flow @ Overton) and average flows (1,200 cfs index flow), by ↑ the stage of the peak (1.5-yr) flow through Program flows, will ↑ the height of sandbars between Overton and Chapman by 30% to 50% from existing conditions.	Flow magnitudes and channel compilations are insufficient to generate bars high enough to provide habitat for ILT and PP. Bars may become quickly vegetated, making them poor habitat for target species. Bars can be created or maintained by mechanical or other means.	Flow 1: Increasing river stage variation will increase sand bar height  Increasing the variation between river stage at peak flow (indexed by $Q_{1.5}$ flow at Overton) and average flows (1,200 cfs index flow), by increasing the stage of the peak (1.5-yr) flow through Program flows, will increase the height of sand bars between Overton and Chapman by 30% to 50% from existing conditions, assuming balanced sediment budget.

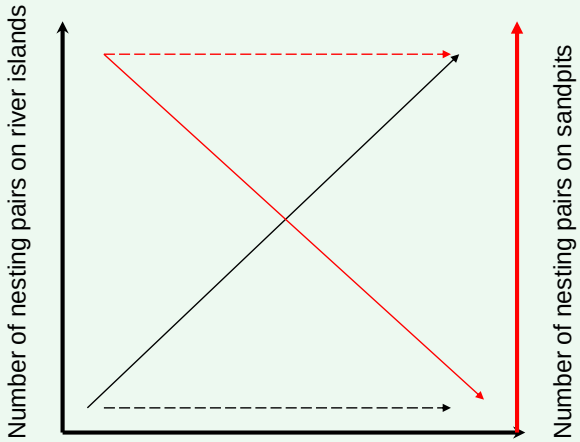
PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
<u>Implementation</u> – Program Management Actions and Habitat			
2. Will implementation of SDHF produce and/or maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis?	**<u>Flow #3</u>**: ↑ 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.	Insufficient Program flows to adequately increase shear stress on banks. Plant mortality can be achieved by other means.	Flow 3: Increased peak (1.5 yr) flow = raised green line (the lowest elevation at which vegetation can establish on river banks and sand bars) = more exposed sand bar area and wider unvegetated main channel.  Increasing the 1.5-yr peak flow regime (indexed by $Q_{1.5}$ flow at Overton) with Program flows will increase the local boundary shear stress and frequency of inundation at the existing green line (elevation at which riparian vegetation can establish). These changes will increase plant mortality along the margins of the channel, raising the elevation of the green line. A raised green line results in more exposed sand bar area and wider unvegetated main channel.
	<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.	Insufficient Program flows to adequately increase shear stress on banks. Plant mortality can be achieved by other means.	Flow #5: Increased magnitude and duration of flow increases riparian plant mortality  Increasing magnitude and duration will increase riparian plant mortality along the margins of the river. There will be different relations (graphs) for different species.

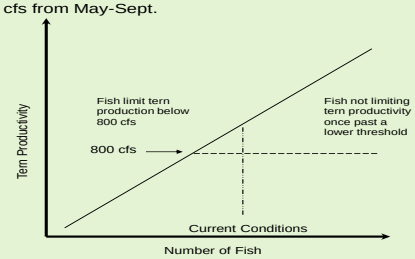
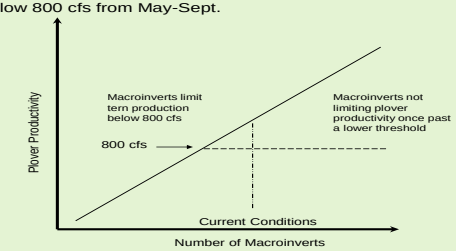
PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
<u>Implementation</u> – Program Management Actions and Habitat			
3. Is sediment augmentation necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?	**<u>Sediment #1</u>**: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

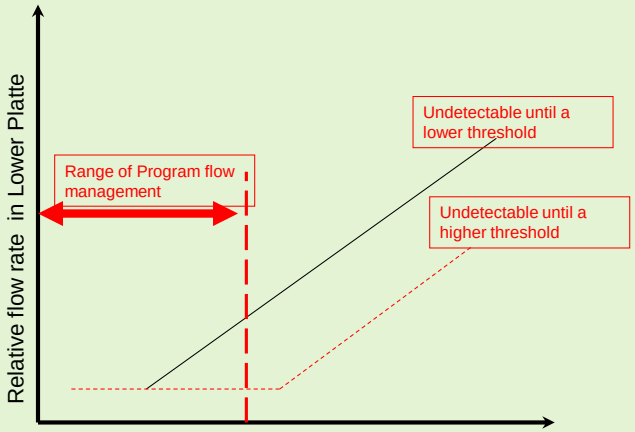
PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
<u>Implementation</u> – Program Management Actions and Habitat			
4. Are mechanical channel alterations (channel widening and flow consolidation) necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?	**<u>Mechanical #2</u>**: Increasing the Q1.5 in the main channel by consolidating 85% of the flow, and aided by Program flow and a sediment balance, flows will exceed stream power thresholds that will convert main channel from meander morphology in anastomosed reaches, to braided morphology with an average braiding index > 3.	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.

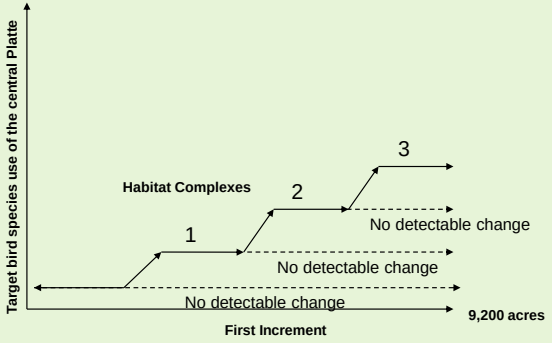
PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
<u>Effectiveness</u> – Habitat and Target Species Response			
5. Do whooping cranes select suitable riverine roosting habitat in proportions equal to its availability?	**<u>WC1</u>**: Whooping crane use will increase as function 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.
	<u>WC3</u>: 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
<u>Effectiveness</u> – 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?	**<u>T1</u>**: Additional bare sand habitat will ↑ number of adult least terns. **<u>P1</u>:** Additional bare sand habitat will ↑ number of adult piping plovers.	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
<u>Effectiveness</u> – 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?	**<u>TP1</u>:** 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.

PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
<u>Effectiveness</u> – Habitat and Target Species Response			
8. Does forage availability limit tern and plover productivity on the central Platte River?	**<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.	Prey fish do not limit tern production at 799 cfs or tern production is limited by summer flows of < 50 cfs.	T2. Tern productivity is related to the number of prey fish (<3 inches) and fish numbers limit tern production below 800 cfs from May-Sept.  One of the USFWS target flows is related to fish populations for tern prey base. If the prey base is limiting terns, and flows are released to increase the prey base, tern numbers should increase. If fish numbers are not limiting the tern population, increased numbers of fish will not increase tern numbers. Factors that may limit fish populations include: temperature, nutrients, ambient air temperature, solar energy, fish movement, species composition, etc.
	<u>P2</u>: Plover productivity is related to the number of suitable macroinverts and macroinverts limit plover production below 800 cfs from May-Sept.	Macroinverts do not limit plover production at 799 cfs or plover production is limited by summer flows of < 50 cfs.	P2. Plover productivity is related to the number of suitable macroinverts and macroinverts limit plover production below 800 cfs from May-Sept.  If the prey base is limiting plovers, and flows are released to increase the prey base, plover numbers should increase. If macroinvert numbers are not limiting the plover population, increased numbers of macroinverts will not increase plover numbers. Factors that may limit macroinvert populations include: temperature, nutrients, ambient air temperature, solar energy, species composition, etc.

PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
<u>Effectiveness</u> – 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?	**<u>PS2</u>**: Program water management will result in measurable changes on flow in the lower Platte River.	Program water management will result in statistically insignificant changes on flow in the lower Platte River.	PS 2: Program water management will result in measurable changes on flow in the lower Platte River.  Program flow management results in measurable change in the lower Platte flows. The probability of detecting flow changes in the lower Platte as a result of Program water management activities (e.g., new depletions plans, summer flow augmentation) is improbable. Program pulse flow management will have the greatest chance of resulting in measurable changes in the lower Platte.

PRRIP "Big Questions"	Priority Hypotheses	Alternative Hypotheses	X-Y Graphs
Larger Scale Issues – Application of Learning			
10. Do Program management actions in the central Platte River contribute to least tern, piping plover, and whooping crane recovery?	**S1b**: Program land management actions (i.e. restoration into habitat complexes) will have a detectable effect on target bird species' use of the associated habitats.	Cannot detect a significant effect on indicators.	S1b Program land management actions (i.e., restoration into habitat complexes) will have a detectable effect on target birds species use of the associated habitats  Achieving habitat features on Program lands with characteristic approximating the guidelines in Table of the Land Plan (Habitat Complexes) and the Mgt. Joint Study will be an efficient and biologically effective long-term land conservation and management strategy on the Platte River for the target bird species. Overall habitat complex approach Distribution – 3 complexes distributed throughout study reach Location – 6,400 ac above Minden; 2,800 ac below Minden Channel – 2 miles long; 1,150 ft channels (overall 30% increase in channels >750 ft); maintained by clear/level/pulse approach Wet Meadows – 640 ac per complex (10% increase in central Platte region) Buffers – Up to 0.5 miles wide but may be variable Restoration – At least 50% of land would undergo restoration
11. What uncertainties exist at the end of the Second Increment, and how might the Program address those uncertainties?	N/A	N/A	N/A

APPENDIX D

PRRIP HABITAT SUITABILITY CRITERIA

WHOOPING CRANES
&
INTERIOR LEAST TERNS/PIPING PLOVERS

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

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
Whooping Crane Habitat Suitability Criteria Descriptions

Terminology for Quantifying Whooping Crane Habitat Availability

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

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

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

Channel Depth

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

Suitable Channel Area

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

Distance to Disturbance

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

Distance to Obstruction

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

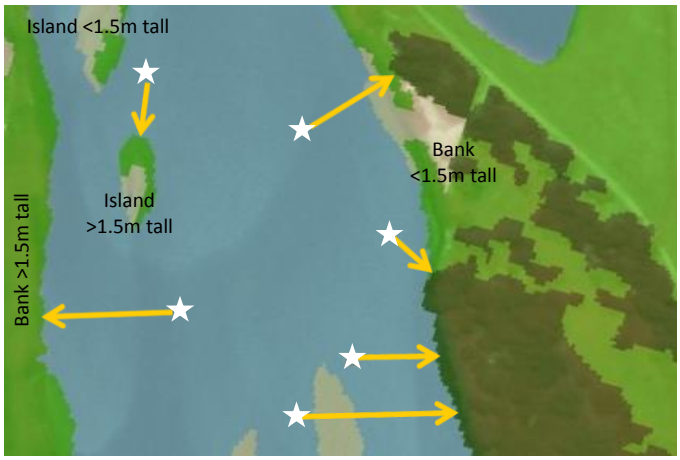


Figure 1. Distance to Obstruction

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

Unobstructed Channel Width

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

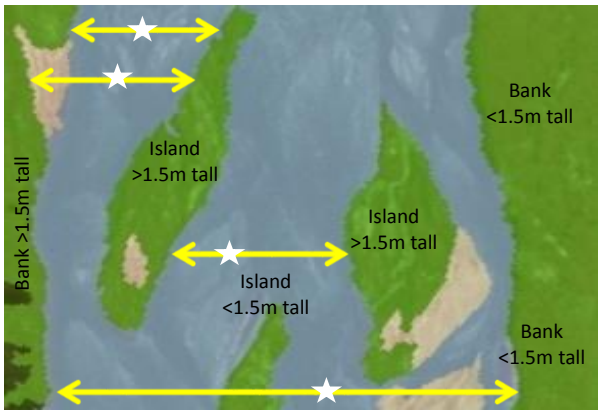


Figure 2. Unobstructed Channel Width

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

Figure 2. Unobstructed Channel Width

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.

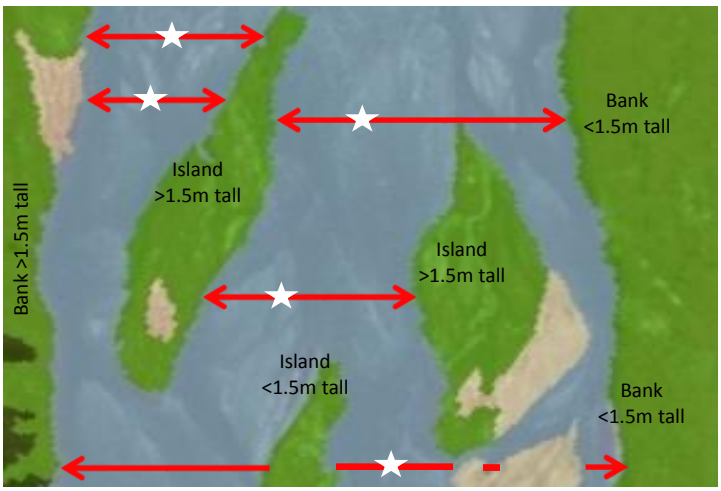


Figure 3. Wetted Channel Width

- *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.

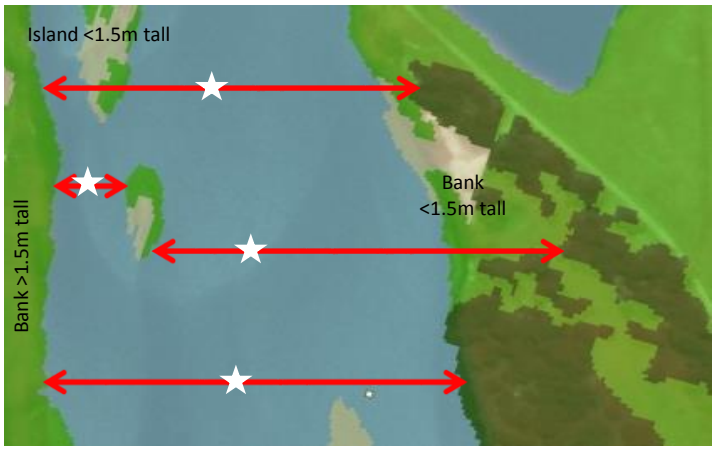


Figure 4. Unobstructed View Width

- *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).

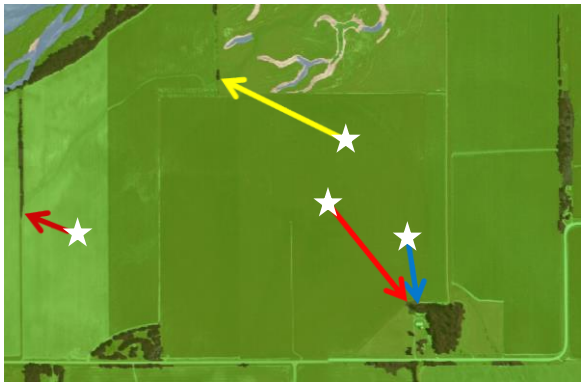


Figure 5. Distance to Obstruction

- *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.

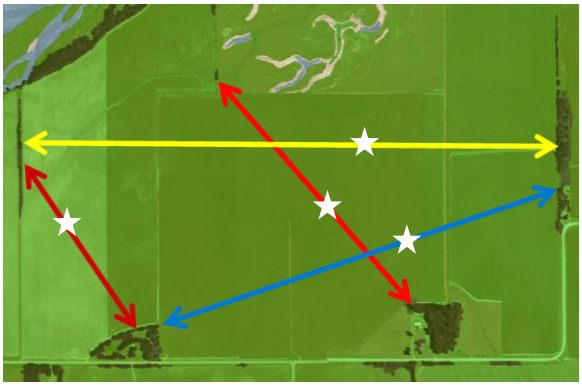


Figure 6. Unobstructed View Width

- *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.

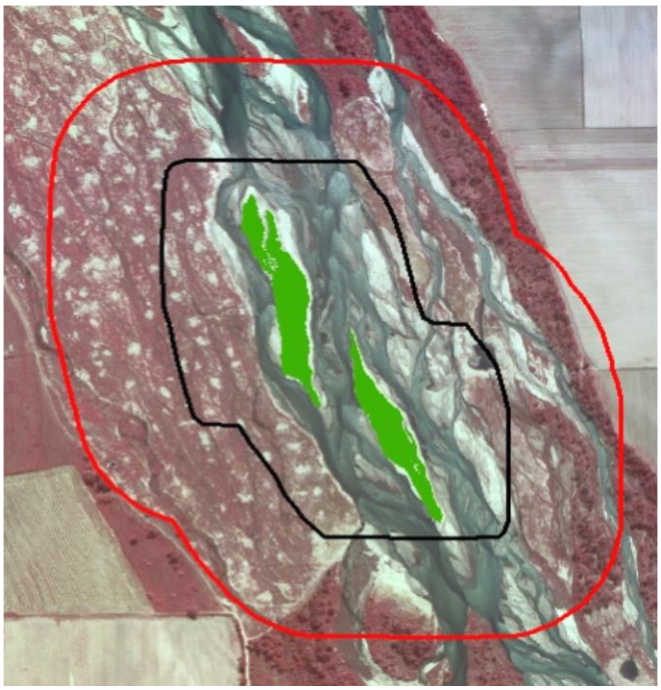


Figure 1. Suitable nesting area (green) with ≥1.5 acres of exposed bare sand within a ¼ mile stretch of channel.

- *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.

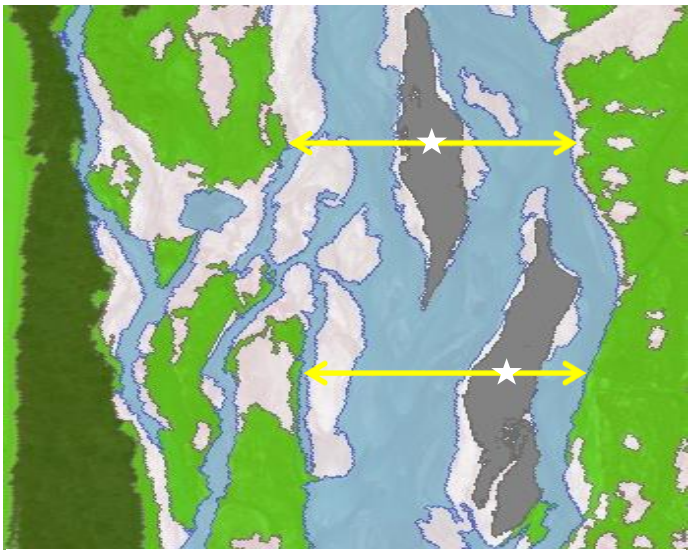


Figure 2. Channel width measured perpendicular to flow from the center of potentially suitable nesting areas.

- *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).

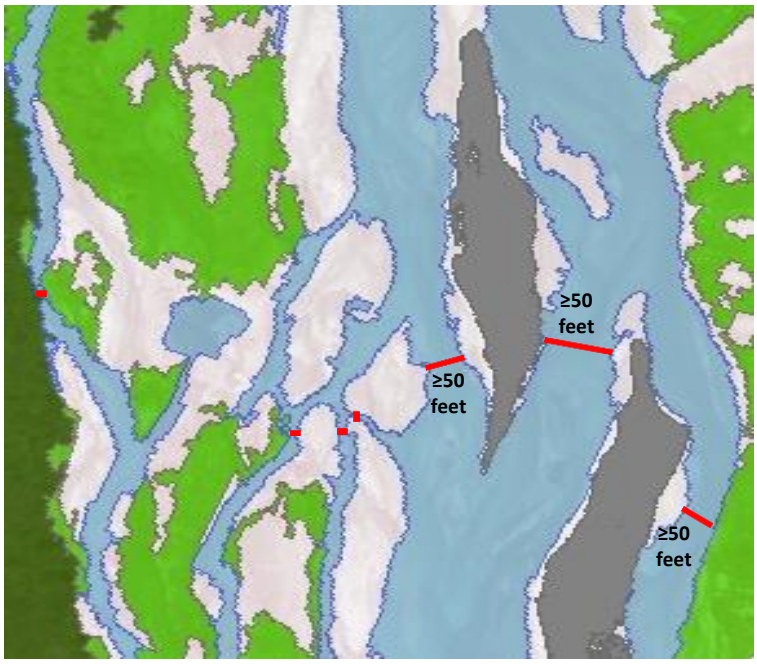


Figure 4. Channel width measured as the shortest distances across water from the edge of potentially suitable nesting areas to the bank lines on each side.

- *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[9]

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.

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[9]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