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Platte River SDM: On-Channel Fledge Ratio Expert Judgment Elicitation Process

January 2016

Background and Context

- The Platte River SDM process is in progress and preparations are ongoing for the upcoming TAC meeting on February 10 and 11, 2016.
- Preliminary alternatives and performance measures have been developed for presentation at the TAC meeting.
- The EDO is refining the Tern and Plover Habitat and Population Model (the Model) to enable the evaluation of alternatives.
- A key uncertainty that has emerged in the Model is the on-channel fledge ratios for piping plover and interior least tern. Within the Program monitoring data set, there are substantially fewer observations for on-channel breeding pairs and fledges compared to off-channel (see Appendix 2 – Table 1 for summary of this data). Due to the limited data set, EDO has suggested that on-channel fledge ratio parameters should be determined in consideration of fledge ratios from both Program monitoring data and studies outside of the Platte River Associated Habitat Reach (AHR).
- In order to provide TAC and GC members with the best available information about Tern and Plover on-channel fledge ratios, a structured expert elicitation was conducted using EDO's subject matter expert (D. Baasch). The elicitation produced a range of values for tern and plover fledge ratios, as well as most likely values. The most likely values from the D. Baasch elicitation were used as the initial parameters in the Model. A sensitivity analysis was conducted and the results were reviewed with the TAC on February 10, 2016.
- If warranted, this structured elicitation process could be replicated with a broader set of subject matter experts. However, after reviewing the results of the analysis done to date, the TAC concluded that further analysis was not necessary.

Objectives of the Expert Judgment Elicitation Process

The goals of the expert judgment elicitation process were to:

- Elicit expert(s)' views on the range of plausible values for on-channel fledge ratios for piping plover and interior least tern in the AHR;
- Clarify and build common understanding about the factors that influence on-channel fledge ratios;
- Provide a transparent and defensible basis for selecting a fledge ratio to use in calculating performance measures in the Model;
- Clarify the current state of agreement and disagreement among experts and the implications for decisions about managing habitat for piping plovers and least terns.

Steps

Based on established best practices for expert elicitation, the process included the following recommended steps (see references). The process was designed so that it could be replicated if necessary with a broader set of experts.

1. **Preparation.** The elicitation questions are developed and refined for clarity. A pre-reading package containing a summary of data and literature are developed. Expert(s) are asked to review other relevant material in preparation for the interview.
2. **Selection.** Expert(s) are identified, according to an agreed set of criteria.
3. **Elicitation.** Expert(s) participate in an individual questionnaire and interview to provide responses and document the rationale for their responses.
4. **Synthesis and Aggregation.** Results are synthesized (and aggregated across experts if there are multiple experts). Experts are given an opportunity to modify their responses/reasons. Sensitivity and other analyses are done, and key issues are identified for discussion among participating experts.
5. **Group Discussion and Refinements.** Experts are given an opportunity to review the synthesized / aggregated results, and to discuss areas of agreement and difference across experts and the reasons for them. They are given an opportunity to modify their judgments if desired, based on what is learned.
6. **Recommendations and Next Steps.** Key messages for decision makers are summarized. Depending on the implications of residual uncertainty for the decision at hand, experts may make recommendations on whether further analysis or expansion of the expert process is warranted.

Elicitation Questions and Format

The elicitation protocol used the Speirs-Bridge et al (2010) four-point methodology for eliciting point-value estimates in a one-on-one interview format. This technique has been shown to provide superior results in counteracting the well documented tendency of experts to be overconfident in their judgments. The format of the four-point elicitation, modified slightly after recent correspondence with one of the authors, was as follows:

- What is the highest plausible value of X?
- What is the lowest plausible value of X?
- What is the most likely plausible value of X?
- How confident are you the truth will lie between your nominated highest and lowest estimate? (As a percentage, i.e., >50%)

The elicitation questions are presented in Appendix 1.

Expert Pre-Reading

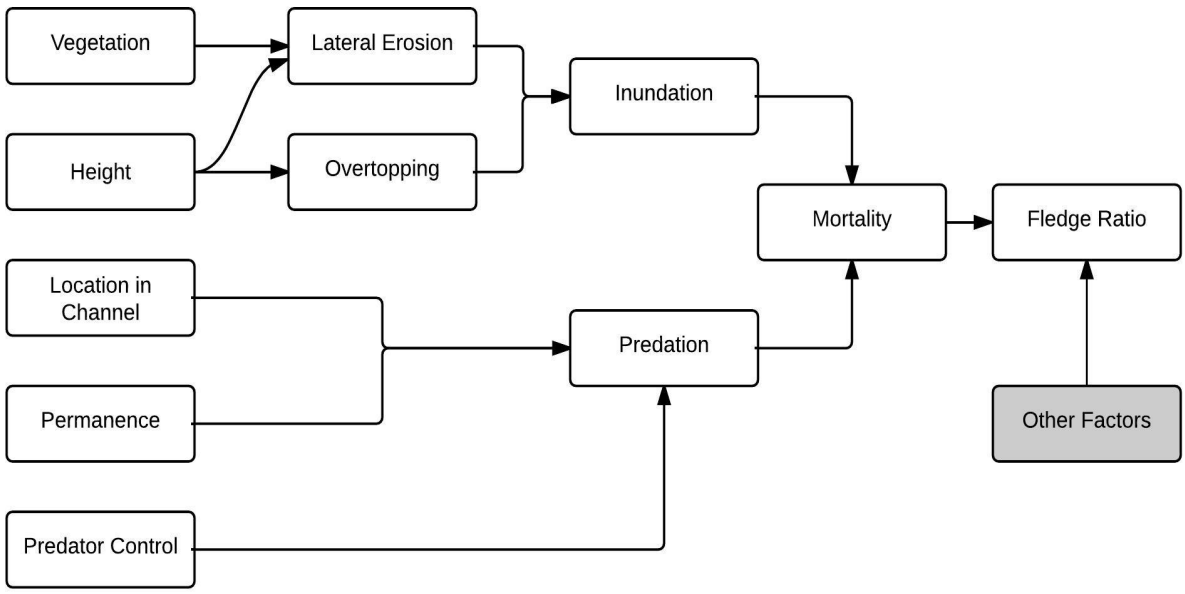
D. Baasch was asked to compile and review fledge ratio data from the Platte River and other locations prior to the interview. Relevant information is presented in Appendix 2, and includes:

- Summary of central Platte River fledge ratios for on- and off-channel habitats, 2001-2015 (Table 1 in Appendix 2);
- EDO literature review of interior least tern sandpit and sandbar fledge ratios (Table 2 in Appendix 2);
- EDO literature review of piping plover sandpit and sandbar fledge ratios (Table 3 in Appendix 2).

Results

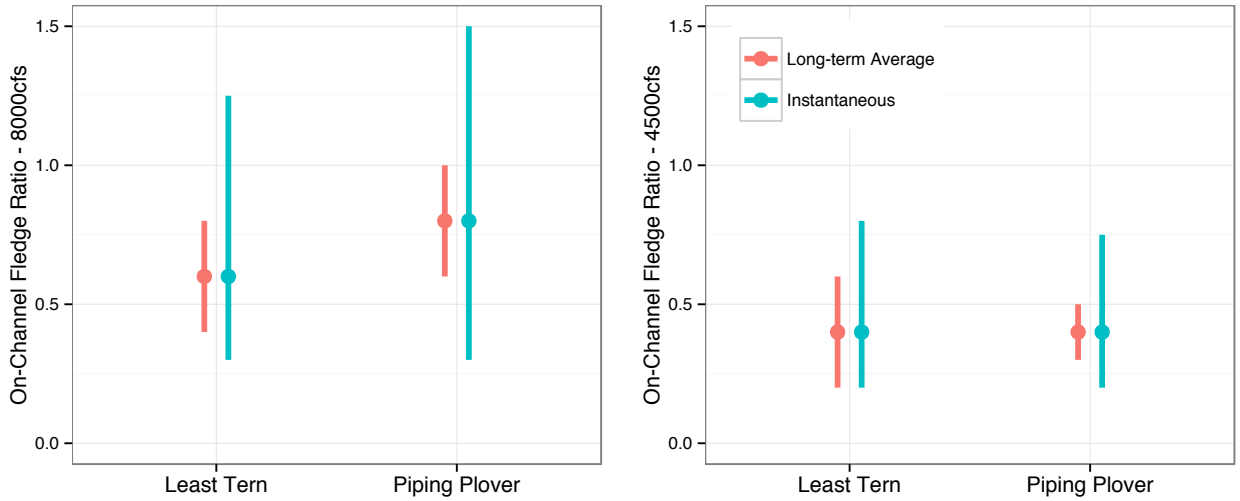
The elicitation exposed key factors driving fledge ratio (Figure 1). In particular, island height was identified as a key determining factor. As a result, two separate judgments were elicited, under different conditionalizing assumptions, one at 4500 (the Program minimum standard for attracting birds) and another at 8000, the current standard used for managed Program islands.

Figure 1 Factors affecting on-channel fledge ratio



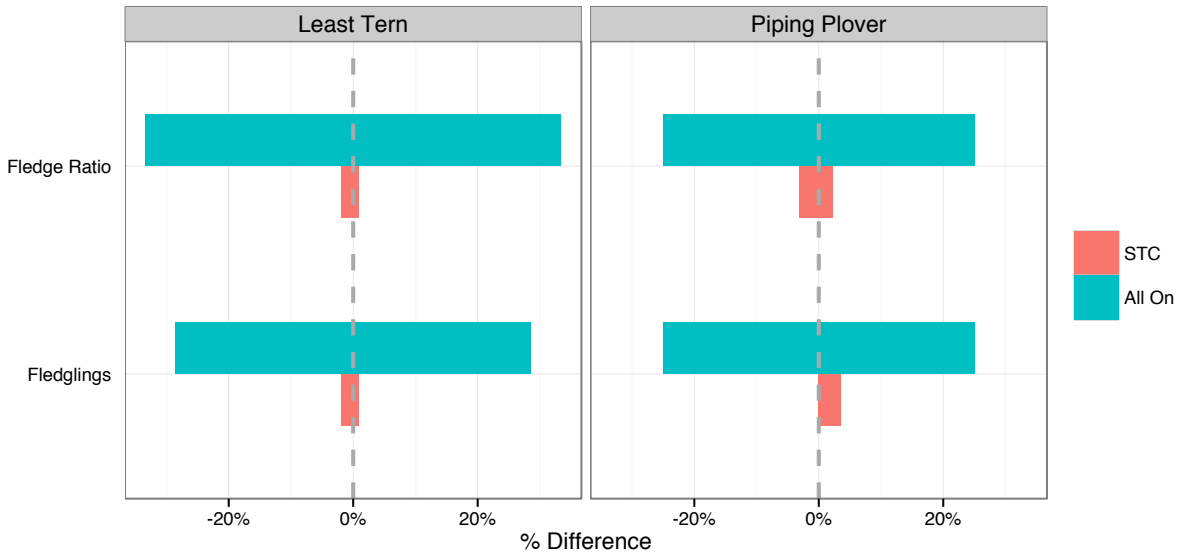
The results of the elicitation are shown in Figure 2.

Figure 2 Minimum, maximum and most likely values for tern and plover on-channel fledge ratios



To determine whether the uncertainty warrants additional analysis, the sensitivity of the Model outcomes to the uncertainty was examined. Figure 3 shows how the modelled fledge ratio and # fledglings varies across the range of plausible values for on-channel fledge ratio for two alternatives – Stay The Course (STC) in red which has both on and off channel habitat, and another alternative (All On) in blue that only has on-channel habitat. The width of the colored bar in Figure 3 demonstrates how sensitive the PM is to the range of uncertainty in fledge ratio.

Figure 3 Sensitivity of performance measures to range of values in on-channel fledge ratio



Conclusions

At the February 10 meeting, the TAC reviewed the results of the elicitation and sensitivity analysis. The TAC concluded:

- The TAC supports the use of the estimates of on-channel fledge ratio provided by D. Baasch for the purposes of the SDM process, and views refining estimates of on-channel fledge ratio (expansion of the expert process) as a low priority at this time.

It further noted:

- While productivity is sensitive to fledge ratio, the effect of on-channel fledge ratio is dwarfed by off-channel for any alternatives that have an off-channel habitat component;
- On-channel fledge ratio is strongly dependent on island height;
- The conclusion that further refinement of the on-channel fledge ratio is unnecessary should be revisited if the GC considers the use of either a) alternatives that are all on-channel (no off) or b) alternatives that result in the construction of low islands.

References

Burgman M. and M.F. McBride (2012) What Is Expert Knowledge, How Is Such Knowledge Gathered, and How Do We Use It to Address Questions in Landscape Ecology? in Expert Knowledge and Its Application in Landscape Ecology.

Perera, A.H., C.A. Drew and C.J. Johnson (eds.). Springer, New York, NY.

Hammond J.S., R.L. Keeney, H. Raiffa (1999) Smart Choices. Harvard Business School Press, Boston, MA.

Speirs-Bridge A., F. Fidler, M. McBride et al. (2010) Reducing overconfidence in the interval judgments of experts. Risk Anal 30:512–52.

Appendix 1 Elicitation Questions

Part A. Fledge Ratio – Short-term Average

1. Assuming equal and annual use of on- and off-channel habitat, what is the **highest plausible value for Piping Plover** on-channel fledge ratio that could be achieved in the AHR **in any given year?**
   a. Document the conditions under which you think these values would be achieved.
   b. Document the rationale for your response, including key assumptions (e.g., about island / sandbar height, vegetation, location within the channel, permanence, etc.) and/or comparisons (e.g., ways in which the AHR is different/similar to other rivers, etc
2. Assuming equal and annual use of on- and off-channel habitat, what is the **lowest plausible value for Piping Plover** on-channel fledge ratio that could be achieved in the AHR **in any given year?**
   a. As above, document associated conditions
   b. As above, document rationale and assumptions
3. Assuming equal and annual use of on- and off-channel habitat, what is the **most likely plausible value for Piping Plover** on-channel fledge ratio that could be achieved in the AHR **in any given year**?
   a. As above, document associated conditions
   b. As above, document rationale and assumptions
4. **How confident** are you that the truth will lie between your nominated highest and lowest estimate (as a percentage > 50%)? You can think of this percentage as a confidence interval: "I am x% confident that the truth will lie between my highest and lowest plausible values

Least Terns

5. Assuming equal and annual use of on- and off-channel habitat, what is the **highest plausible value for Least Tern** on-channel fledge ratio that could be achieved in the AHR **in any given year?**
   a. As above, document associated conditions
   b. As above, document rationale and assumptions
6. Assuming equal and annual use of on- and off-channel habitat, what is the **lowest plausible value for Least Tern** on-channel fledge ratio that could be achieved in the AHR **in any given year?**
   a. As above, document associated conditions
   b. As above, document rationale and assumptions
7. Assuming equal and annual use of on- and off-channel habitat, what is the **most likely plausible value for Least Tern** on-channel fledge ratio that could be achieved **in any given year?**
   a. As above, document associated conditions
   b. As above, document rationale and assumptions

8. **How confident** are you that the truth will lie between your nominated highest and lowest estimate (as a percentage > 50%)?

Part B. Fledge Ratio – Long-term Average

4. Assuming equal and annual use of on- and off-channel habitat, what is the **highest plausible value for Piping Plover** on-channel fledge ratio that could be achieved in the AHR **in a 50 year timeframe**?
   a. Document the conditions under which you think these values would be achieved.
   b. Document the rationale for your response, including key assumptions (e.g., about island / sandbar height, vegetation, location within the channel, permanence, etc.) and/or comparisons (e.g., ways in which the AHR is different/similar to other rivers, etc
5. Assuming equal and annual use of on- and off-channel habitat, what is the **lowest plausible value for Piping Plover** on-channel fledge ratio that could be achieved in the AHR **in a 50 year timeframe?**
   a. As above, document associated conditions
   b. As above, document rationale and assumptions
6. Assuming equal and annual use of on- and off-channel habitat, what is the **most likely plausible value for Piping Plover** on-channel fledge ratio that could be achieved in the AHR **in a 50 year timeframe?**

   a. As above, document associated conditions
   b. As above, document rationale and assumptions
9. **How confident** are you that the truth will lie between your nominated highest and lowest estimate (as a percentage > 50%)? You can think of this percentage as a confidence interval: "I am x% confident that the truth will lie between my highest and lowest plausible values

Least Terns

10. Assuming equal and annual use of on- and off-channel habitat, what is the **highest plausible value for Least Tern** on-channel fledge ratio that could be achieved in the AHR **in a 50 year timeframe?**
    a. As above, document associated conditions
    b. As above, document rationale and assumptions
11. Assuming equal and annual use of on- and off-channel habitat, what is the **lowest plausible value for Least Tern** on-channel fledge ratio that could be achieved in the AHR **in a 50 year timeframe?**
    a. As above, document associated conditions
    b. As above, document rationale and assumptions
12. Assuming equal and annual use of on- and off-channel habitat, what is the **most likely plausible value for Least Tern** on-channel fledge ratio that could be achieved **in a 50 year timeframe?**

    a. As above, document associated conditions
    b. As above, document rationale and assumptions

13. **How confident** are you that the truth will lie between your nominated highest and lowest estimate (as a percentage > 50%)?

Appendix 2

Platte River Recovery Implementation Program
Fledge Ratio Memo

Office of the Executive Director
4111 4th Avenue, Suite 6
Kearney, Nebraska 68845

January 13, 2016

Summary of Observed and Reported Fledge Ratios for Interior Least Terns and Piping Plovers

We calculated interior least tern and piping plover fledge ratios observed on the central Platte River sandbars and sandpits, 2001-2015 (Table 1). We found tern fledge ratios on on-channel habitat averaged 0.43 (range = 0.0 – 0.90) and off-channel habitat averaged 1.17 and (range = 0.75 – 1.83; Table 1). Plover fledge ratios on on-channel and off-channel habitat averaged 1.08 (range = 0.17 – 4.00) and 1.54 (range = 0.90 – 2.40), respectively.

We also conducted an extensive literature review to assess range-wide fledge ratios for terns and plovers. Our literature review resulted in individual and multi-year reports of fledge ratios on sandbars, sandpits, bays, coastline, reservoirs, lakes, wetlands, and unknown habitat types and resulted in >550 reported fledge ratios. For our summary, we generally included multi-year averages for sandpit and sandbar habitats. This resulted in 19 fledge ratios for sandbar habitat and 6 fledge ratios for sandpits for terns (Table 2). Our investigation also included fledge ratio estimates at 16 sandbar, 8 sandpit, 1 combination, and 1 shoreline (McConaughy) location for plovers (Table 3). Although we found several reports that included multi-year average fledge ratios, there was a lot of variability in fledge ratios that were reported for on-channel (range = 0.00 – 1.23) as well as off-channel habitat for terns (range = 0.49 – 1.60). Similarly, the sources that provide information on fledge ratios for plovers on sandbar habitat ranged from 0.29 – 1.46 and off-channel fledge ratios ranged from 0.72 – 1.93.

Table 1. Summary of central Platte River fledge ratios for on- and off-channel habitats, 2001-2015.

Interior Least Tern

Year	Off-Channel Fledges	Off-Channel Breeding Pair	Fledges/Pair	On-Channel Fledges	On-Channel Breeding Pair	Fledges/Pair
2001	42	23	1.83	0	0	0.00
2002	59	41	1.44	0	0	0.00
2003	57	54	1.06	0	0	0.00
2004	60	45	1.33	0	0	0.00
2005	62	49	1.27	0	0	0.00
2006	27	36	0.75	0	0	0.00
2007	38	33	1.15	2	11	0.18
2008	35	30	1.17	9	10	0.90
2009	42	40	1.05	4	6	0.67
2010	64	51	1.25	0	0	0.00
2011	89	62	1.44	0	0	0.00
2012	84	66	1.27	0	0	0.00
2013	64	63	1.02	0	0	0.00
2014	91	98	0.93	0	0	0.00
2015	146	133	1.10	0	8	0.00
Total	**960**	**824**	**1.17**	**15**	**35**	**0.43**

Piping Plover

Year	Off-Channel Fledges	Off-Channel Breeding Pair	Fledges/Pair	On-Channel Fledges	On-Channel Breeding Pair	Fledges/Pair
2001	24	10	2.40	0	0	0.00
2002	28	18	1.56	0	0	0.00
2003	24	15	1.60	0	0	0.00
2004	25	15	1.67	0	0	0.00
2005	28	17	1.65	0	0	0.00
2006	29	19	1.53	0	0	0.00
2007	18	20	0.90	7	4	1.75
2008	7	11	0.64	3	3	1.00
2009	11	10	1.10	1	2	0.50
2010	36	18	2.00	6	6	1.00
2011	45	28	1.61	0	0	0.00
2012	55	29	1.90	4	1	4.00
2013	28	27	1.04	0	0	0.00
2014	55	29	1.90	4	2	2.00
2015	51	35	1.46	1	6	0.17
Total	**464**	**301**	**1.54**	**26**	**24**	**1.08**

Table 2. Summary of interior least tern sandpit and sandbar fledge ratios reported in EDO literature search.

Species	System	System Type	Years	Fledge Ratio	Source
LETE	Central Platte River, NE	River	2001-2015	0.43	PRRIP unpublished data
LETE	Central Platte River, NE	River	1986-1990	0.49	Kirsch and Sidle 1999
LETE	Central Platte River, NE	River	1991-2005	1.09	Jenniges and Pletner 2008
LETE	Niobrara River	River	1996-1997	0.69	South Dakota Academy of Science 2001
LETE	Lower Platte River, NE	River	1986-1990	0.49	Kirsch and Sidle 1999
LETE	Platte River, NE	River	2003	0.47	Committee on Endangered and Threatened Species in the Platte River Basin, NRC, 2004; Reed 2003; Smith & Renken 1993)
LETE	Missouri River Constructed Island	River	2009	1.10	Stark et al. 2011
LETE	Missouri River Natural Island	River	2009	0.00	Stark et al. 2011
LETE	Garrison River Reach	River	2006-2009	1.13	Shaffer et al. 2013
LETE	Ft Peck Missouri River	River	2002-2004	0.64	Montana interior least tern management plan 2006
LETE	Yellowstone River,	River	1994-1996	0.65	Kirsch and Sidle 1999
LETE	Cimarron River, Kansas and Oklahoma	River	1980-1982	0.75	Kirsch and Sidle 1999
LETE	Cimarron River, Kansas and Oklahoma	River	1990, 1992	0.25	Kirsch and Sidle 1999
LETE	Arkansas River, Oklahoma	River	1986-1988, 1990-1991, 1995-1996	0.67	Kirsch and Sidle 1999
LETE	Arkansas River, Oklahoma	River	1992-1993	0.59	Kirsch and Sidle 1999
LETE	Canadian River, Oklahoma	River	1987, 1991-1996	1.23	Kirsch and Sidle 1999
LETE	Lower Mississippi River	River	1986-1993	0.58	Dugger et al 2002
LETE	Lower Mississippi River	River	1995-1996	1.00	Kirsch and Sidle 1999
LETE	Mississippi River Valley	River	1986-1989	0.70	Smith & Renken 1993
LETE	Central Platte River, NE	Managed Sandpits	2001-2015	1.17	PRRIP unpublished data
LETE	Central Platte River, NE	Unmanaged Sandpits	1991-2005	0.56	Jenniges and Pletner 2008
LETE	Central Platte River, NE	Managed Sandpits	1991-2005	1.31	Jenniges and Pletner 2008
LETE	Lower Platte River, NE	Sandpit	1987-1990	0.49	Kirsch 1996
LETE	Council Bluffs, Iowa	Sandpit	1984-1991	0.70	Kirsch and Sidle 1999
LETE	Sioux City, Iowa	Sandpit	1995	1.60	Kirsch and Sidle 1999

Table 3. Summary of piping plover sandpit and sandbar fledge ratios reported in EDO literature search.

Species	System	System Type	Years	Fledge Ratio	Source
PIPL	Central Platte River	River	2001-2015	1.08	PRRIP unpublished data
PIPL	Central Platte River	River	1986-1990	0.52	Lingle 1993
PIPL	Garrison River Reach	River	2005-2009	0.88	Shaffer et al. 2013
PIPL	Grand Marais Lonesome Point/East Bay Sucker River	River	1984-1998	1.46	Recovery Plan for the Great Lakes Piping Plover (USFWS) 2003
PIPL	Missouri River	River	1991-1992	0.33	Catlin et al. 2015
PIPL	Missouri River	River	2005-2011	1.01	Catlin et al. 2015
PIPL	Missouri River Constructed Island	River	2009	1.17	Stark et al. 2011
PIPL	Missouri River Constructed Island	River	2009	0.29	Stark et al. 2011
PIPL	Niobrara River	River	1996-1997	0.95	South Dakota Academy of Science 2001
PIPL	Lower Platte River (Protected Nests)	River	1992	0.71	Lackey 1994
PIPL	Lower Platte River (Unprotected Nests)	River	1992	0.44	Lackey 1994
PIPL	Ft Randall to Niobrara	River	1988-2000	0.37	USACE Unpublished Data
PIPL	Lewis and Clark Lake	Lake/River	1988-2000	0.51	USACE Unpublished Data
PIPL	Galvin's Point Dam to Ponca	River	1988-2000	0.75	USACE Unpublished Data
PIPL	Combined Missouri River adjacent to Nebraska	River	1988-2000	0.71	USACE Unpublished Data
PIPL	Upper Platte River	River	1992-2000	1.07	Peyton and Wilson 2000
PIPL	Central Platte River	Sandpit and Artificial Sandbars	1991-2000	1.34	Plettner 2000
PIPL	Central Platte River	Sandpit	2001-2015	1.54	PRRIP unpublished data
PIPL	Lower Platte River Gravel Mines	Sandpit	1999	0.73	Marcus 1999
PIPL	Lower Platte River Gravel Mines	Sandpit	2000	1.50	Marcus 2000
PIPL	Lower Platte River Gravel Mines	Sandpit	2001	1.93	Marcus 2001
PIPL	Lower Platte River Gravel Mines	Sandpit	2002	1.19	Held et al. 2002
PIPL	Lower Platte River Gravel Mines	Sandpit	2003	0.86	Held et al. 2003
PIPL	Lower Platte River Gravel Mines	Sandpit	2004	0.72	Held et al. 2004
PIPL	Lower Platte River Gravel Mines	Sandpit	2005	0.83	Held unpublished data
PIPL	Lake McConaughy	Lake/ shoreline	1992-2000	1.15	Peyton and Wilson 2000

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Platte River SDM: Habitat Construction Costs Expert Panel Input Process

February 29, 2016, version 1.0

Background and Context

- The EDO has developed the Tern and Plover Habitat and Population Model (the Model) to enable the evaluation of alternatives for the Platte River SDM process.
- A key uncertainty that has emerged is the cost of constructing habitat both on and off the channel. The Program's experience with building habitat has been widely variable, and realized costs have been based on specific conditions of the site, of arrangements with contractors, and of the ability of the Program to recoup costs (table 1).
- At the February TAC meeting, an expert panel subgroup of the TAC contributed input to refine this and other uncertainties present in the model.
- This memo outlines the input provided by the panel and the rationale for selecting the high, low, and best guess cost data for each method for habitat construction.

Table 1. PRRIP experience with Off- and On-channel mechanical habitat creation

Off-Channel Construction Costs		
Rehabilitated Sand Pits		
Dyer	paddle scrape, pack and fence	$1,121.60
Broadfoot S	paddle scrape, pack and fence	$116.67
Broadfoot Newark	fence and pit expansion	$9,750.00
New Construction		
Leaman East	tree removal and fencing	$3,017.24
Cottonwood	earthwork, fence, tree clearing	$33,529.41
On Channel Construction Costs		
Shoemaker Island Complex	50% new 50% built up sandbar	$2,325.00
Shoemaker Island Complex	Island construction portion of project bids ranged from $2150 to $5146 per acre	$2,325.00
Elm Creek Islands	70% new 30% built up sandbar	$2,935.80
Elm Creek Islands	80% new 20% built up sandbar - Rebuild after flood	$4,191.30

Expert Input Process

- The panel was nominated by the TAC and consisted of Matt Rabbe (USFWS), Jim Jenniges (NPPD), Mark Peyton (CNPPID, abstained from providing input for on-channel habitat costs), and Mark Czaplewski (CPNRD).
- The panel reviewed the data shown in table 1 of past PRRIP habitat construction experiences, and reviewed specific site and contract conditions that led to the realized costs, discussed the likelihood of those conditions, and what effect more typical conditions might have on average per acre costs.

- The panel was asked to provide a highest and lowest plausible values, as well as most likely value for the average cost per acre for different habitat construction methods.

Results and Rationale

- Based on the data in Table 1, the panel identified highest and lowest possible costs and agreed that the average costs could not lie outside those boundaries.
- As a group, the panel then identified a highest, lowest, and most likely average per acre cost for each habitat construction method. Table 2 contains the estimates provided by the panel.
- The panel agreed that Most Likely average values should be used in the Model.

Table 2. Expert input for habitat construction cost estimates used in the tern and plover habitat model.

Habitat Method	Lowest Average Cost per acre	Most Likely Average Cost per acre	Highest Average Cost per acre
Mechanical On-Channel	-	$3,500	-
New Mined Off-Channel	-	$0	-
Rehabilitated Off-Channel Sandpit	$1,000	$7,500	$10,000
New Constructed Off-Channel	$10,000	$20,000	$30,000

Platte River SDM: On-Channel Habitat Utilization Function Expert Panel Input Process

February 29, 2016, version 1.0

Background and Context

- The EDO has developed the Tern and Plover Habitat and Population Model (the Model) to enable the evaluation of alternatives for the Platte River SDM process.
- A key uncertainty that has emerged is the relationship between discharge and the utilization of on-channel habitat by plovers and terns. EDO monitoring data indicate higher use of on-channel habitat when flow is above 600 cfs during the nest initiation period for each species (figure 1).
- At the February TAC meeting, an expert panel subgroup of the TAC contributed input to refine this and other uncertainties present in the model.
- This memo outlines the input provided by the panel and the rationale for selecting the best fit to the data shown in figure 1 for use in the model.

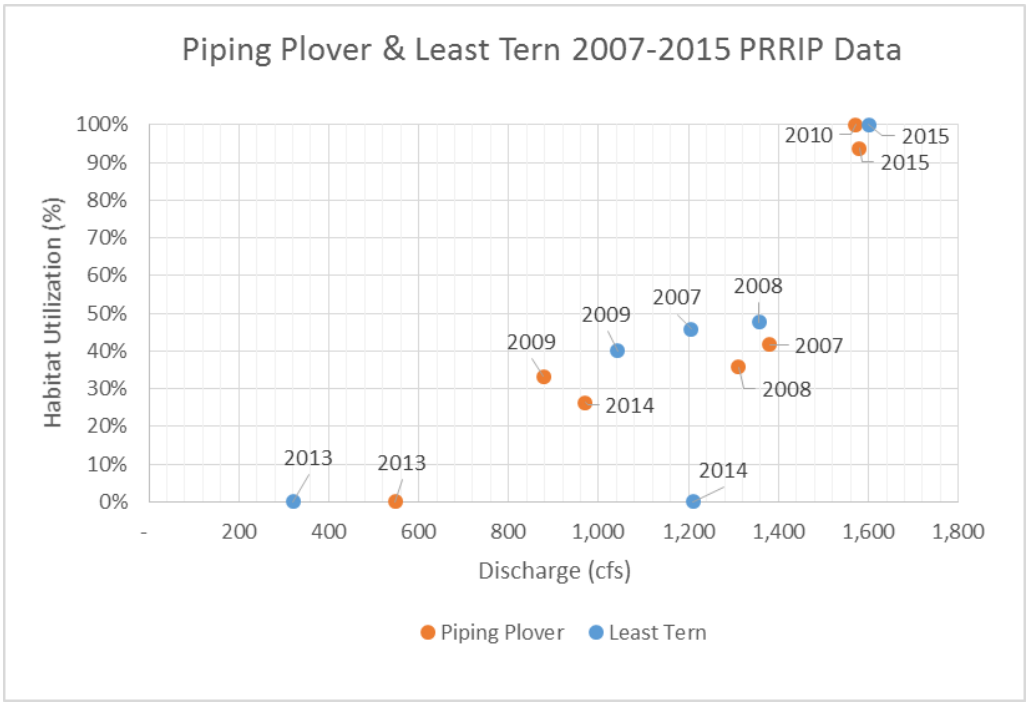

Figure 1. Habitat utilization and discharge conditions for 8 years of PRRIP monitoring data for plover (orange) and tern (blue).

Expert Input Process

- The panel was nominated by the TAC and consisted of Matt Rabbe (USFWS), Jim Jenniges (NPPD), Mark Peyton (CNPPID), and Mark Czaplewski (CPNRD).
- The panel reviewed the data shown in figure 1 for each species separately, and reviewed specific hydrologic conditions (i.e., timing & duration) for the high and low ends of the point spread (2015 and 2013, respectively), as well as other outliers (2014 for Least Tern)

- The panel also discussed theoretical constraints on the upper limit of hydrologic conditions that could increase habitat utilization.
- Lastly, the panel identified hydrologic conditions they believed would lead to (a) 0% habitat utilization and (b) 100% habitat utilization.

Results and Rationale

- The panel identified that habitat utilization is close to 0 at discharges around 600 cfs, and there was widespread agreement about using that as the bottom of the curve.
- The panel also discussed the hydrologic conditions under which habitat utilization reaches 100%. The points in figure 1 where habitat utilization is close to 100% actually occurred at much higher discharges, but after discussion the group agreed that above 1600 cfs, the availability of habitat would not change – and in turn, the utilization of habitat should not increase.
- The panel also discussed whether to define a non-linear function between the low and high points of 600 cfs and 1600 cfs, but agreed that there was no basis for doing so. Figure 2 shows the function that the panel agreed to.

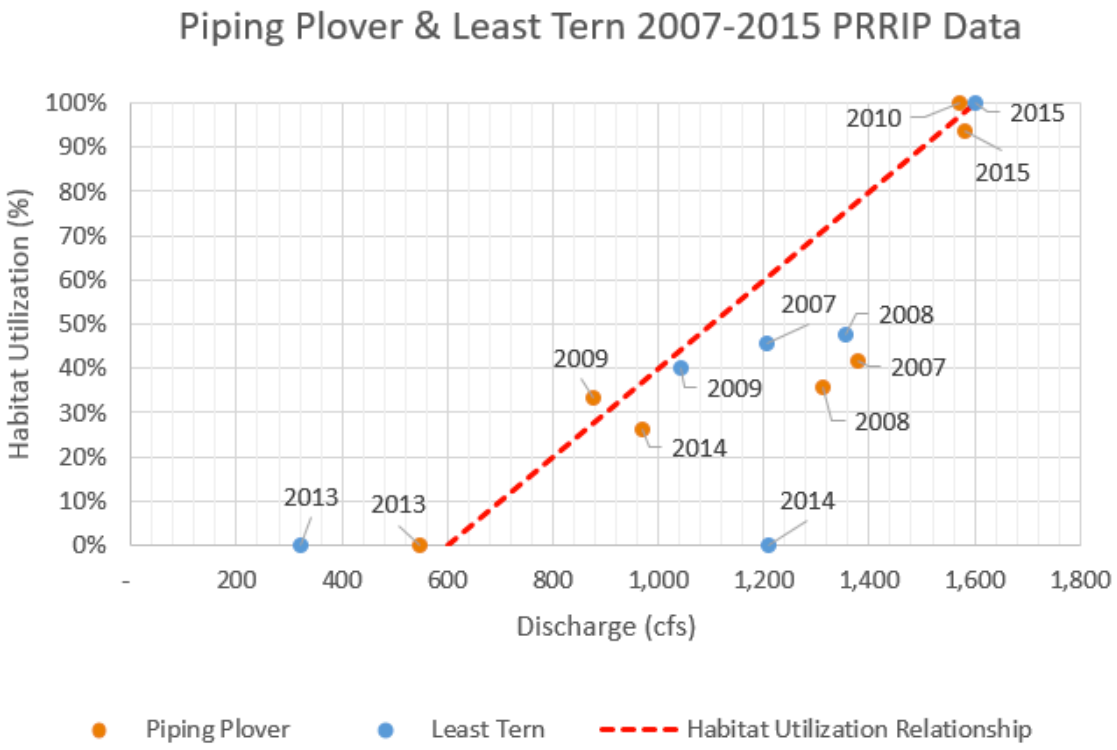

Figure 2. Habitat utilization and discharge conditions for 8 years of PRRIP monitoring data for plover (orange) and tern (blue), and the functional relationship agreed to by the expert panel (dashed red line).