Decision Summary

Below is a brief summary of the key outcomes of the decision process to date, with the intent to provide context for the remaining decisions to be addressed at the June GC meeting.

Decision Scope & Framing

Given the two-thumbs-down assessment for Big Question #1, what's the best combination of management actions to take, for the remainder of the First Increment (assumed to be 2016 to 2019), for the purpose of maintaining or enhancing habitat for interior least terns and piping plovers?

Within this framing of the decision, there are several important considerations:

- The focus is on evaluating alternative ways of maintaining or enhancing habitat for terns and plovers, but implications for other objectives (e.g., whooping cranes, sediment supply, pallid sturgeon, etc.) will be evaluated;
- Alternatives will be feasible within existing water, land, and financial budgets.
- There are a range of other actions that the Program is or will be do doing anyway that will not be influenced by this SDM process.

The TAC and GC have considered 3 rounds of alternatives to date. The GC has made several important decisions, supported by the TAC, that have constrained the range of alternatives currently under consideration:

- Do not consider alternatives that make use of on-channel habitat only,
- Do not consider alternatives that make use of the "conventional" method of constructing mechanical on-channel habitat,
- Do not consider alternatives that require land acquisition beyond a $1.5 million budget,
- Do not consider the use of flows for terns and plovers during the brood rearing period.

There are three outstanding decisions, which the GC will address in June:

1. How much off-channel habitat to commit to and whether and how to acquire new land,
2. Whether the benefits of an on-channel MCA component to the Whooping Crane and Sediment Supply PMs are worth the additional cost and effort to implement it, and
3. Whether and how to include a flow component during the nesting initiation period for terns and/or plovers.

The alternatives and consequences relevant to each these decisions are address in turn below.

Objectives and Performance Measures

Over the course of four meetings between December 2015 and April 2016, The GC and TAC iteratively refined the set of decision objectives and associated performance measures. The refinements struck a

balance between including all relevant concerns (by refining objectives as they were clarified) and eliminating redundant information (by eliminating unnecessary PMs).

The current set of decision objectives and PMs is summarized in Table 1. **Since the March GC meeting, the only change is to the Management Cost PMs.** Based on input from the TAC, land acquisition and habitat construction and maintenance costs have been combined for both long- and short-term PMs. The long-term cost PM now reflects the net present value over 50 years of all direct costs associated with an alternative implemented and maintained for that time period. It provides a basis for comparing the total financial implications of management actions with different spending schedules. The short-term cost PM reflects the total impact on the remaining First Increment budget of all direct costs associated with implementing the given alternative between 2016 and 2019. The two PMs are not additive (the short term costs are included in the long term cost PM). This change was instigated by the consideration of land leasing options, which required long-term consideration of leasing costs.

Table 1. Objectives and performance measures

Objective	Sub-Objective	Performance Measures	Units	PM Description
Piping Plovers and Least Terns[1]. The primary goal and driver of the decision process is to maximize the reproductive success of terns and plovers.	Reproductive Success	PRRIP Breeding Pairs	#/year	The number of breeding pairs nesting on Program habitat in the Associated Habitat Reach (AHR) in a year. The PM reports the average for the 50-year simulation period.
		PRRIP Total Fledglings	#	Alternate PM: The total number of fledglings produced on PRRIP habitat over the 50-year model simulation period. The PM indicates the PRRIP contribution to the global population over time.
Management Cost. This objective reflects a concern for the wise use of resources. Money and water used for terns and plovers are not available for use for other purposes and thus these objectives reflect the opportunity cost associated with using resources for terns and plovers.	Total Long-term Cost	Long-term cost (net present value over 50 years)	$	The net present value of the sum of habitat creation and maintenance costs and land acquisition costs, assuming the alternative is implemented over a 50-year period. This PM provides a basis for comparing the financial implications of management actions with different spending schedules.
	Total Short-term Cost	First Increment cost (total over 2017-2019)	$	The total cost of implementing an alternative for the period of the First Increment (2016-2019), including habitat creation and maintenance costs and land acquisition costs. This PM serves as an indicator of the impact on the Program budget, and provides an understanding of the short-term financial opportunity cost of investing in plover/tern habitat during the First Increment rather than other Program projects.
	Long Term Water Use	Proportion of Program water used	%	The opportunity cost of water used for flow-related actions. This PM reports the average annual proportion of Program water used over the 50-year simulation period for normal water years, which serves as a proxy for other year types.
Whooping Cranes. This objective reflects a desire to assess the effect of management actions designed for terns and plovers on the availability of suitable whooping crane habitat, and the potential use of that habitat.	WC Habitat Use	Habitat Suitability Scale (*changes* to habitat suitability)	7-point scale -3 to +3	Changes to the availability of suitable whooping crane habitat in the AHR during migratory periods, relative to current conditions, reported using a 7-point scale. This PM is a proxy for habitat use and ultimately migratory survival. The relationship between availability of suitable habitat and habitat use is unknown / unquantified.

[1] Separate PMs will be reported for Least Terns and Piping Plovers, but their descriptions are identical.

Sediment Supply. This objective reflects a belief that maintaining an abundance of sediment in the channel is an important contributor to a river form used by the Program's target species.	Contribution to Sediment Supply	Sediment Supply Scale	5-point scale -2 to +2	The likely effect of management action on channel sediment supply. The PM is reported using a 5-point scale. It is a proxy for a range of broader ecological benefits that are generally associated with increased sediment supply in a large braided river. The relationship between sediment supply and these broader benefits is unknown / unquantified.
Pallid Sturgeon. This objective reflects an interest in having a check in place to confirm the assumption that management actions taken for terns and plovers will not affect risks to pallid sturgeon.	Pallid Sturgeon Risk	Change in risk to Pallid Sturgeon	Y/N/ Maybe	A flag that indicates whether a management action involves a change in risk to Pallid Sturgeon. A "No" indicates no changes are expected as a result of an alternative. A "Yes" suggests further analysis may be warranted if the alternative is considered further. A "Maybe" indicates that the effects (positive or negative) on Pallid Sturgeon are unknown.
Implementation Effort This objective reflects an interest in ensuring that management actions are practical and feasible to implement.	Implementation Costs and Risks	Implementation Scale	5-point scale: 0 to -4	This PM reflects the effort and risks associated with permitting, negotiating with landowners, and coordinating with other agencies for the use of land and/or water. It reflects a range of implementation considerations, including permitting cost ($), neighbor relations and the probability of successful implementation. A score of 0 reflects an alternative requiring minimal effort with little risk of implementation failure, and -4 reflects high effort accompanied by a risk of not achieving full implementation.
Learning This objective reflects an interest in continual learning to improve the benefits from management actions.	Learning Potential – Plover and Tern Reproductive Success	Learning Potential Scale	3-point scale: 0 to 2	The potential to evaluate differences in plover and tern use and reproductive success from different plover and tern habitat creation and maintenance activities. In particular, the scale considers the ability to learn about incremental performance differences between on-channel and off-channel habitat.

Decision 1 – Off-Channel Habitat

Off-Channel Habitat Alternatives

In the SDM process, alternatives are iteratively developed, evaluated and refined. The consequences of the alternatives are estimated using available data, models, and analysis. The first round of alternatives and consequences (Round 1) were presented to the TAC at their February meeting. The TAC refined and revised the alternative set, and those Round 2 alternatives were presented to the GC at its March meeting. The GC then made several key decisions regarding the construction of on-channel habitat and land acquisition for off-channel habitat, which led to another round of refinements. The Round 3 alternatives were presented to the TAC in April. The TAC recommended the consolidation of three different approaches to land acquisition into one hybrid alternative (combining use of existing Program land, plus leasing and purchasing new land). They also recommended that two other alternatives remain on the table for GC consideration – one that adds no new off-channel habitat and another that adds the maximum amount of off-channel habitat within the specified budget. The Round 4 alternatives are shown in Table 2.

Please note the following:

- Alternatives are modeled over a 50-year simulation period in order to accurately represent performance over a range of hydrologic conditions.
- Non-Program off-channel habitat management is assumed to continue at the current level over the whole simulation period. This includes renewing existing leases that the Program maintains.
- Program activities that are not related to Tern/Plover management (e.g., channel widening, sediment augmentation, Water Plan-Land Plan-AMP implementation) are assumed to continue at the level described in the 2016 PRRIP Work Plan.
- Changes to the model between rounds of alternatives mean that Round 4 alternatives cannot be directly compared with alternatives from Rounds 1 or 2.

Table 2. Round 4 Alternative Descriptions for adding off-channel habitat (habitat shown in acres).

#	Alternative Description	On-channel	Off-channel
STC	Stay the Course – build and maintain habitat at current levels on Program-owned land – including on and off-channel habitat. Build and maintain current levels of permitted on-channel and off-channel habitat for the remainder of the First Increment and for the rest of the simulation period. This involves maintaining existing off-channel habitat and creating /maintaining on-channel habitat at the target of 42 acres. On-channel habitat is created using the current approach (i.e. raising islands up to an 8,000 cfs elevation within habitat complex areas). No flow actions are included.	42	102
"A" Alternatives – Off channel habitat that is achievable with no new land acquisition			
A1	Maintain existing off-channel habitat only on Program-owned land. This alternative relies on the existing Program off-channel habitat, and discontinues the creation and maintenance of on-channel habitat islands.	0	102
"C" Alternatives – require land acquisition through purchase or lease.			
C1	Purchase 90 acres of off-channel habitat. This alternative was developed by acquiring new off-channel habitat by purchasing land (fee title) until the remaining land acquisition budget ($1.5M) was used, and using the lowest-cost habitat construction method. The 90 acres includes: • 102 acres of existing off-channel • 3 additional mine sites for a total of 90 acres of mined-off channel habitat that comes on line over first 18 years of the simulation.	0	192
C6	Hybrid Approach to acquiring 60 acres, with the following make up: • 20 ac. on existing PRRIP land, and habitat built using new construction • 20 ac. purchased, and habitat built using mine-operator agreements • 20 ac. leased, and habitat built using rehab methods.	0	162

Consequences

In this section we present the results from modeling the Round 4 Alternatives. In the consequence tables that follow (figures 1 and 2), green cells indicate performance that is better than the alternative highlighted in blue. Red cells are worse than the highlighted alternative. White cells perform similarly to the highlighted alternative (less than 10% different). "Dir" indicates the preferred direction of change for that performance measure (H, or higher, means higher numbers are better than lower numbers). The alternatives and consequences relevant to each decision are separated into two sets to help simplify and focus on some of the key messages. These results incorporate the feedback from all previous meetings.

Figure 1 compares STC (Stay the Course) with alternatives A1, C1, and C6. Some key messages from these alternatives are summarized below.

Figure 1: Round 4 Alternatives – Off-channel Habitat

Objective	Performance Measure	Units	Dir	STC: 42 / 102	A1: 0 / 102	C6: 0 / 162 (hybrid)	C1: 0 / 192
Piping Plovers							
Program Repro Success	Average Breeding Pair (BP)	#/year	H	22	18	28	31
	Total Fledglings over 50 yr	#	H	1,420	1,271	1,964	2,175
Interior Least Terns							
Program Repro Success	Average Breeding Pair (BP)	#/year	H	97	91	139	155
	Total Fledglings over 50 yr	#	H	5,187	4,992	7,669	8,546
Management Cost							
Total Long Term Cost	NPV (50 yrs)	1000$	L	$3,000	$532	$1,835	$2,229
Total Short Term Cost	2017-2019 Cost	1000$	L	$123	$34	$941	$1,477
Implementation Effort							
Implementation Costs/Risks	Implementation Scale	-4 to 0	H	0	0	-2	-1

Legend

Better than selected
Worse than selected
Selected

Terns and Plovers

Relative to Stay the Course, alternatives that add off-channel habitat (C1 and C6) show an increase in average breeding pairs and total fledglings for both plovers and terns. A1, which relies on existing habitat, shows a decrease in plover populations, and no change (a slight decrease but within the MSIC[2]) for terns.

Management Cost

Based on feedback from the March GC meeting and the introduction of leasing options for land acquisition, the management cost PMs have been revised slightly to enable fair long-term comparisons between leasing and purchasing land. *Total Short-term Costs* describe the impact to the 1st Increment budget, and comprises short-term management cost (habitat construction and maintenance) and short-term land acquisition costs (purchases or initial lease costs). *Total Long-term Costs* describe the total amount of money spent (and discounted) over time, which enables cost-efficiency estimates. This figure comprises management cost (habitat construction and regular maintenance) and long-term land acquisition (purchases or on-going annual lease payments).

Relative to STC, all alternatives show improvements in long-term management cost. This is a result of discontinuing the conventional on-channel habitat component of STC. C1 and C6 show greater spending in the short-term because they involve the construction of new habitat and/or a combination of land leases and purchases.

Whooping Crane

[2] Minimum significant increment of change

Though all alternatives represent an improvement for Whooping Cranes over Stay the Course (because of the elimination of conventional on-channel habitat that causes visual obstructions), the level of improvement is identical across alternatives (all are scored as 1), and therefore this objective does not help to discriminate among these alternatives and is not shown in the table.

Pallid Sturgeon

None of the alternatives involve flow management actions.

Sediment

None of the alternatives involve on-channel components.

Implementation

Alternative A1, which relies on existing Program property, has no significant implementation effort. Alternative C1 requires one-time negotiations to support land purchases and scores a -1. Alternative C6 requires more regular and more extensive lease negotiations (the outcomes of which are not certain), and therefore scores slightly worse (-2).

Learning

All alternatives represent a loss in learning potential relative to Stay the Course, but the level of decline is identical across alternatives (all are scored as 0), and therefore this objective does not help to discriminate among these alternatives and is not shown in the table.

Discussion Questions

Does the GC support the TAC's recommendations regarding the use of a combination of land acquisition methods (none, leasing, purchasing) to reach a habitat acreage target? At its April meeting, the TAC considered three possible ways of achieving 162 acres of off-channel habitat – using Program land, leasing and purchasing. They concluded that the differences were small (Figure 2) and that once the GC sets a habitat acreage target, the best acquisition strategy will depend on the availability of particular parcels, and is likely to be guided by more fine-grained considerations not included in the consequence table (such as improving dispersion of habitat throughout the reach, minimizing conversions from high-value land uses, maximizing site size, etc.). Therefore, the TAC recommended that the GC set an acreage target, and provide EDO with the guidance and flexibility to find a combination of parcels that strike the best balance across those other considerations. Alternative C6 reflects this input.

Note that alternative C6 is a representative example of a hybrid approach to land acquisition; other hybrid configurations could be specified. The performance of all such alternatives would lie between C5 and A6 (Figure 2), which represent the low and high extremes for land acquisition and habitat construction methods. The costs to implement these hybrid alternatives would fall within a range of $576,000 to $1.2 million in the short-term, and $1.69 million to $1.98 million in the long-term. Average breeding pairs would differ by a single breeding pair for both plovers and terns while total fledglings would have a range in the tens for plovers and the low hundreds for terns. Different hybrids could be specified, although there is a practical limit to the amount of leasing options available.

Figure 2. Performance of the Hybrid Alternative C6 relative to other means of acquiring 60 acres

Objective	Performance Measure	Units	Dir	A6: 0 / 162	C3: 0 / 162 (lease)	C5: 0 / 162 (buy)	C6: 0 / 162 (hybrid)
Piping Plovers							
Program Repro Success	Average Breeding Pair (BP)	#/year	H	28	28	27	28
	Total Fledglings over 50 yr	#	H	1,988	1,988	1,915	1,964
Interior Least Terns							
Program Repro Success	Average Breeding Pair (BP)	#/year	H	140	140	137	139
	Total Fledglings over 50 yr	#	H	7,698	7,698	7,523	7,669
Management Cost							
Total Long Term Cost	NPV (50 yrs)	1000$	L	$1,965	$1,854	$1,685	$1,835
Total Short Term Cost	2017-2019 Cost	1000$	L	$1,252	$574	$997	$941
Implementation Effort							
Implementation Costs/Risks	Implementation Scale	-4 to 0	H	0	-2	-1	-2

Legend

Better than selected

Worse than selected

Selected

What acreage of off-channel habitat does the GC support? In the April TAC meeting, the USFWS indicated that all alternatives other than Stay the Course and A1 meet the plover recovery plan criterion of a "stable or increasing" population. Therefore, some addition of habitat for terns and plovers would be necessary for meeting that criterion, but the amount of habitat still needs to be agreed upon. The main tradeoff is between cost and plover productivity, which in turn is driven by the quantity and speed of habitat development – in addition to more habitat (and therefore more birds) coming at a higher price, habitat that becomes available and produces birds more quickly also costs more. While there is a continuum of habitat options available, the three presented crystallize the choice:

- Maintain existing habitat; do not add more (A1). This preserves First Increment budget but does not meet the plover recovery plan criterion.
- Add the maximum habitat within the budget (C1). This meets the plover recovery criterion and provides maximum benefits for plovers and terns, but uses all the budget.
- Add an intermediate amount of habitat (C6). This alternative represents a midpoint that takes advantage of likely leasing sites. It meets the plover recovery criterion and preserves some of the First Increment budget.

Decision 2 – On-channel Habitat (MCA)

Alternatives

Table 3 provides a summary of alternatives that involve the MCA on-channel component.

Consequences

This consequence table (figure 3) examines the effects on cost and other decision objectives of alternatives that include an on-channel habitat component using the MCA approach. To demonstrate these effects, only a subset of alternatives is shown. Alternatives A1-M, C6-M, and C1-M, which include the MCA portion, are shown alongside their counterparts that do not include the MCA component (A1, C6, and C1). These three examples were chosen to show the impact of adding MCA to a range of off-channel habitat acreages; MCA can be added to any amount of off-channel habitat with similar results. Green and red highlighting for each MCA alternative is relative to its non-MCA counterpart only (highlighted in blue).

Table 3. Round 4 Alternative descriptions for the addition of on-channel MCA habitat.

#	Alternative Description	On-channel (acres)	Off-channel (acres)
	"M" Alternatives – Adds MCA on-channel component		
A1-M	This alternative is identical to A1, but includes the on-channel MCA habitat component. This alternative includes maintaining existing off-channel habitat plus creating and maintaining 10 acres of on-channel habitat using the MCA approach. MCA involves creating/maintaining on-channel habitat in a reach, allowing the habitat to erode, and then moving on to create/maintain new habitat in a different reach. This differs from the current approach where on-channel habitat is re-constructed in the same habitat complex once it erodes. MCA involves two main activities (1) de-vegetating permanent islands on an ongoing basis throughout the AHR at a rate of 10 acres/year on average, and (2) treating naturally-formed sandbars that meet the Program's minimum habitat criteria to maintain them in a de-vegetated state. Naturally-formed sandbars are modeled with an assumption that approximately 30 acres are formed five times in the 50-year simulation period. The de-vegetated islands and sandbars are left at their natural elevation (i.e. they are not raised to an 8,000 cfs elevation as in the current approach to building on-channel islands). This approach requires entering into management agreements with landowners; due to practical constraints, MCA is limited to 10 acres.	10 +	102
C1-M	This alternative is identical to C1, but includes the on-channel MCA habitat component.	10 +	192
C6-M	This alternative is identical to C6, but includes the on-channel MCA habitat component.	10 +	162

Figure 3: Round 4 Alternatives – MCA Habitat

Objective	Performance Measure	Units	Dir	A1: 0 / 102	A1-M: 10+ / 102	C6: 0 / 162 (hybrid)	C6-M: 10+ / 164	C1: 0 / 192	C1-M: 10+ / 192
Piping Plovers									
Program Repro Success	Average Breeding Pair (BP)	#/year	H	18	19	28	29	31	32
	Total Fledglings over 50 yr	#	H	1,271	1,305	1,964	1,998	2,175	2,210
Interior Least Terns									
Program Repro Success	Average Breeding Pair (BP)	#/year	H	91	93	139	141	155	158
	Total Fledglings over 50 yr	#	H	4,992	5,049	7,669	7,701	8,546	8,603
Management Cost									
Total Long Term Cost	NPV (50 yrs)	1000$	L	$532	$1,218	$1,835	$2,520	$2,229	$2,915
Total Short Term Cost	2017-2019 Cost	1000$	L	$34	$60	$941	$966	$1,477	$1,502
Whooping Crane									
Habitat Use	Habitat Suitability Scale	-3 to +3	H	1	2	1	2	1	2
Sediment									
Contribution to Sediment Supply	Sediment Supply Scale	-2 to +2	H	0	2	0	2	0	2
Implementation Effort									
Implementation Costs/Risks	Implementation Scale	-4 to 0	H	0	-3	-2	-3	-1	-3
Learning									
Learning Potential	Learning Potential Scale	0 to 3	H	0	1	0	1	0	1

Legend
Better than selected
Worse than selected
Selected

Terns and Plovers

The addition of MCA habitat to any of the off-channel habitat alternatives has a negligible effect (the difference is within the MSIC), due to the small amount of MCA habitat.

Management Costs

The total difference in short term cost (i.e., for the period 2017-2019) from adding MCA is ~$26,000. The cost is consistent across alternatives because they all use the same amount and type of on-channel habitat. Whether this represents a significant difference (above the MSIC, in this case, 10%) depends on the total level of costs.

Long-term costs are higher for alternatives that use MCA relative to their counterparts because of the regular and on-going habitat construction. The NPV of the incremental cost over 50 years is just under $700,000, and again, is consistent across the alternatives.

Whooping Crane

Alternatives using MCA (A1-M, C6-M, and C1-M) outperform their counterparts with respect to habitat suitability, because MCA improves unobstructed channel width. This occurs because it de-vegetates permanent islands on a regular basis, and allows them to erode, thus eliminating visual obstructions.

Pallid Sturgeon

None of the alternatives involve flow management components or water diversions during the critical period.

Sediment

Alternatives using MCA (A1-M, C6-M, and C1-M) outperform their counterparts with respect to sediment supply. The score of +2 indicates that they are expected to deliver long-term benefits. These occur because under these alternatives, islands are de-vegetated on a regular basis.

Implementation Effort

MCA requires substantially more effort to coordinate and negotiate with landowners. The score of -3 for Alternatives A1-M, C6-M, and C1-M indicates an intense level of effort, but little risk of implementation failure.

Learning

All alternatives using MCA (A1-M, C6-M, and C1-M) represent a slight increase in learning potential relative to their counterparts due to the small amount of on-channel habitat. However, this is a coarse scale and should this objective prove to be a key discriminating factor between alternatives, specific learning objectives should be articulated, and the ability of MCA to address those objectives should be more carefully considered.

Discussion Questions

Is the cost and additional effort associated with MCA offset by the estimated benefits? Specifically, in comparing the paired alternatives in figure 2, do the gains in Whooping Crane habitat suitability and contribution to sediment supply outweigh the short and long-term costs and increased implementation effort?

Can the decision about how much off-channel habitat to build be separated from the decision about whether to include an MCA habitat component? Because the on-channel component is relatively small, it does not contribute substantially to the performance of the alternatives in terms of tern and plover reproductive success, and therefore may not affect the decision about how much off-channel habitat to commit to, but this requires GC confirmation.

Decision 3 – Nest Initiation Flows

For the choice of whether or not to include a flow component, the GC will decide whether to support the TAC's conclusions regarding nest initiation flows, which are:

- That the release of water for plover nest initiation flows is not generally justified on the basis of the estimated benefits for plovers;
- That such releases should in general (in the absence of special circumstances) be considered a lower priority than releases for other purposes (no specific special circumstances were identified);
- That the most efficient use of water for plovers occurs in years immediately after a flood year when there is new naturally-formed habitat;
- That if water is released for plovers, even under the most favorable conditions, the benefits, if any, would not be measurable.

Discussion Questions

Given the TAC's conclusions, should the GC prescribe or recommend a) *specific flow releases*, or b) a set of *rules or triggers* releases that will *dictate* annual flow releases, or c) a set of *guidelines* that will *inform* annual decisions about flow releases? A) involves prescribing a flow release (possibly including "none") that will be implemented every year, regardless of hydrology (or any other factors). This is the way flow augmentation has been considered as part of the alternatives up to this point. In contrast, b) involves defining the conditions under which water will be used, conditional on hydrology (if flows in April are x, then release volume v during period p). C) Involves providing guidelines to be used to inform real-time decisions that are made annually, in consideration of hydrology, and possibly other relevant factors, but leaves the decision maker (in the context of Environmental Account releases, the USFWS) with discretion to make final decisions.