HOW TO DEAL WITH UNCERTAINTY AND OBJECTIVES:
PALLID STURGEON CASE STUDY

Eric Laux
Chief, Environmental Section Planning Branch
Omaha District
U.S. Army Corps of Engineers

NCER 2018
National Conference on Ecosystem Restoration
Building connections from the local to the landscape scale

Session 11
28 August 2018

U.S. ARMY

US Army Corps of Engineers ®

Presentation Topics

- Brief explanation of key USACE Endangered Species Act responsibilities on the Missouri River
- 2003 Amended Biological Opinion approach
- Impetus for change from this approach
- 2018 Biological Opinion – increased focus on adaptive management
- Focus on the approach for pallid sturgeon

USACE has responsibilities under the Endangered Species Act related to listed species affected by operation and maintenance of the Missouri River system (in particular least tern, piping plover, and pallid sturgeon). The Missouri River Recovery Program (MRRP) is charged with meeting these responsibilities.

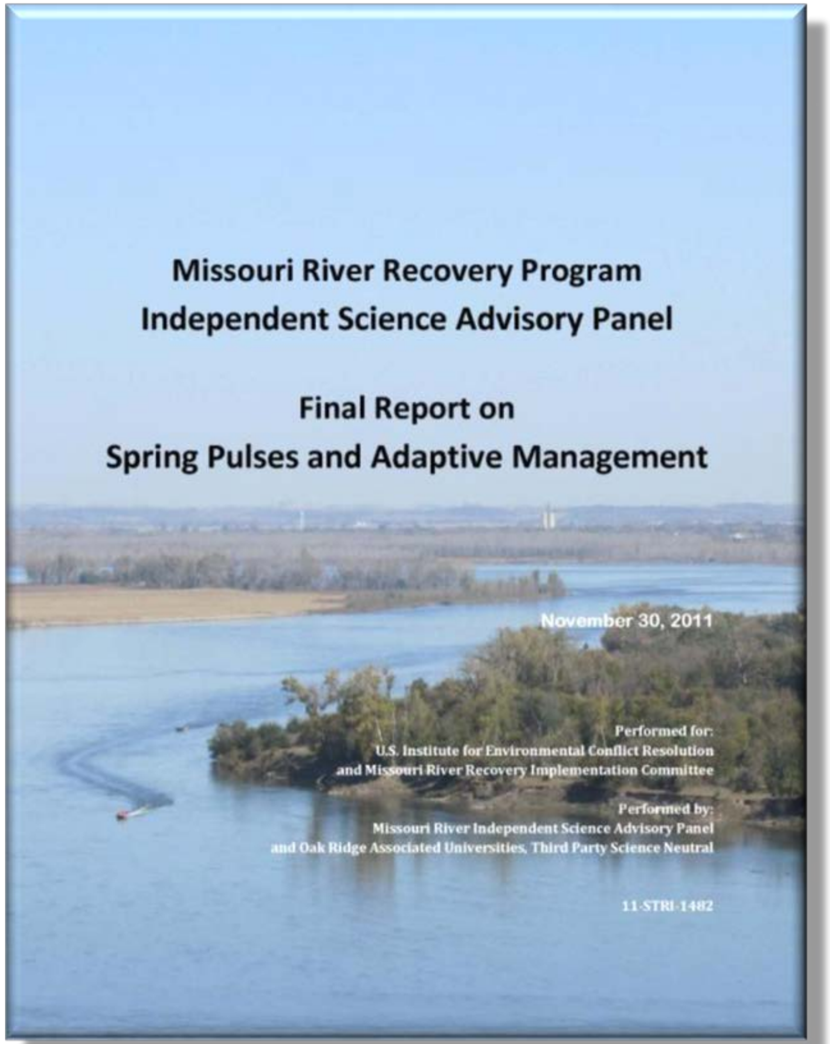
The 2003 BiOp prescribed actions including the creation of 12,000-20,000 acres of shallow water for pallid sturgeon.

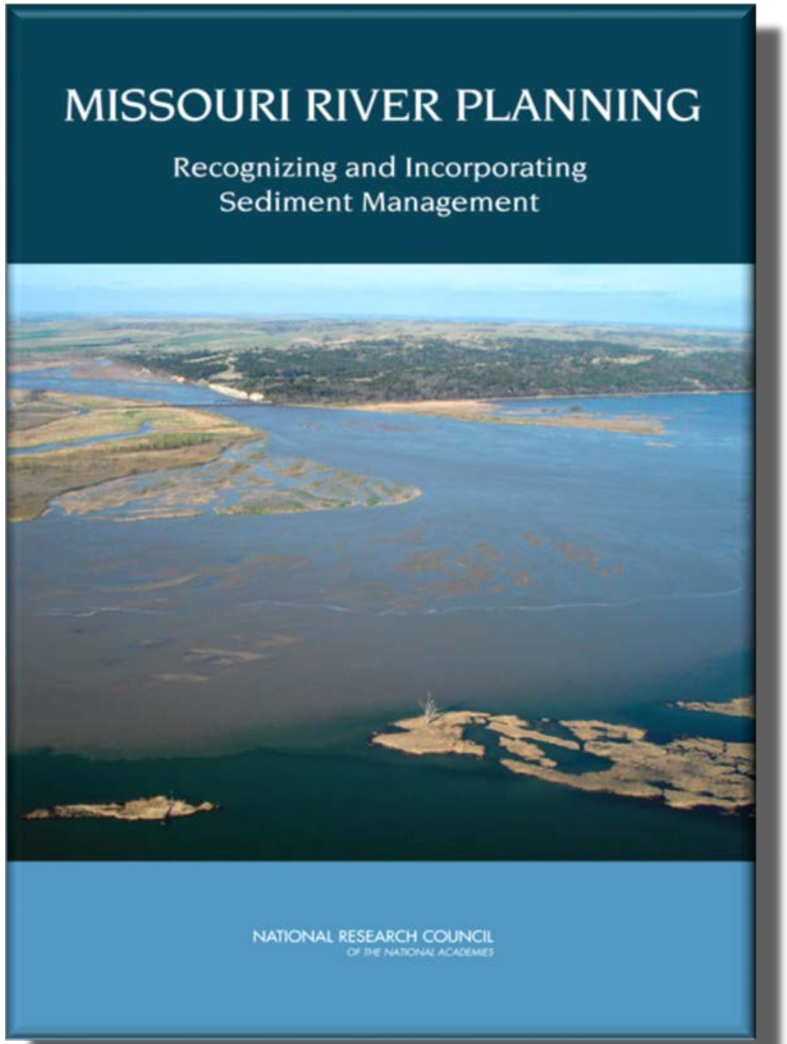
The uncertainty regarding the benefits of this action for sturgeon was not explicitly considered in the BiOp or during its implementation.

U.S. Fish and Wildlife Service 2003 Amendment to the 2000 Biological Opinion
on the
Operation of the Missouri River Main Stem Reservoir System,
Operation and Maintenance of the Missouri River Bank Stabilization
and Navigation Project,
and
Operation of the Kansas River Reservoir System

December 16, 2003

An adaptive management approach was recommended by an Independent Science Advisory Panel (ISAP) and the National Research Council (NRC) in 2011 to guide management and science given these uncertainties.





A Science and Adaptive Management Plan was developed for the MRRP by a multi-disciplined team in close collaboration with USACE, USFWS, and stakeholders, and with frequent review from the ISAP.

Authors:

J. Craig Fischenich (*Environmental Laboratory, U.S. Army Engineer Research and Development Center Vicksburg, MS)*

Kate E. Buenau (*Marine Science Laboratory, Pacific Northwest National Laboratory, U.S. Department of Energy Sequim, WA)*

Joseph L. Bonneau and Craig A. Fleming *(U.S. Army Corps of Engineers, Omaha District Gavins Point Project Office Yankton, SD)*

David R. Marmorek, Marc A. Nelitz, Carol L. Murray and Brian O. Ma (*ESSA, Vancouver, BC Canada)*

Graham Long (*Compass Resource Management Ltd, Vancouver, BC Canada)*

Carl J. Schwarz (*Department of Statistics and Actuarial Science, Simon Fraser University, Burnaby, BC Canada)*

ERDC/EL TR-18-DRAFT

Environmental Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Science and Adaptive Management Plan

Missouri River Recovery Program

Draft/Pre-decisional/For Review and Comment

May 2018

Draft Document for Review

Current makeup of the Independent Science Advisory Panel

Robb Turner, Ph.D. (Third Party Science Neutral): Oak Ridge Associated Universities

-Chris Guy, Ph.D. (pallid sturgeon specialist): USGS, Montana State University

-Adrian Farmer, Ph.D. (piping plover, least tern specialist): Wild Ecological Solutions, Fort Collins

-Dennis Murphy, Ph.D. (conservation biologist): University of Nevada, Reno

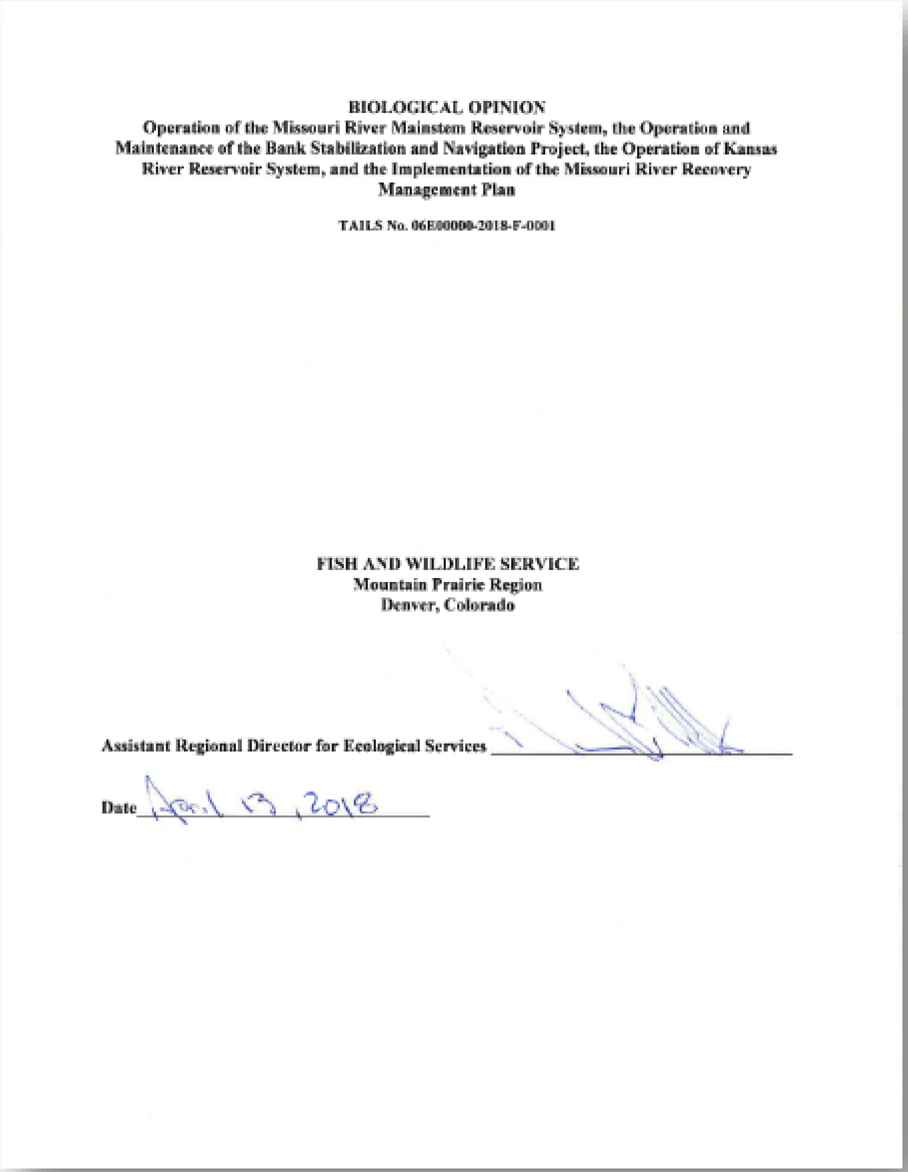
-Steve Bartell, Ph.D. (quantitative ecologist): Cardno ENTRIX

-Gary Lamberti, Ph.D. (aquatic/riverine ecologist): Notre Dame University

-Will Graf, Ph.D. (geomorphologist, river hydrologist): University of South Carolina

Ad Hoc panelist(s): Barry Noon, Ph.D. (landscape ecologist): Colorado State University

This Science and Adaptive Management Plan was an integral part of the USACE Proposed Action during recent Section 7 consultations on the Operation and Maintenance of the MO River System. **This Plan was an important consideration in the "no jeopardy" finding by the USFWS because it demonstrates commitment to make progress toward stated objectives.**



BIOLOGICAL OPINION
Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan

TAILS No. 06E00000-2018-F-0001

FISH AND WILDLIFE SERVICE
Mountain Prairie Region
Denver, Colorado

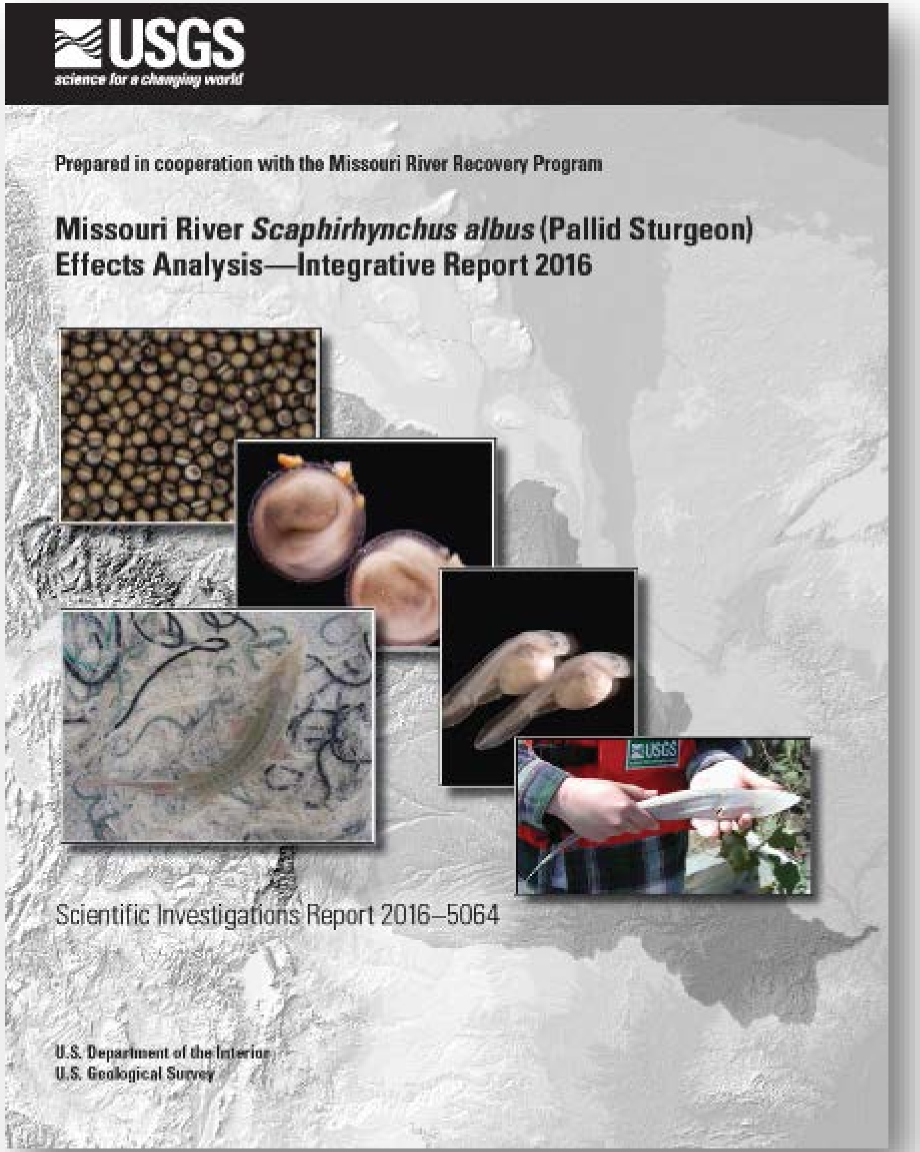
Assistant Regional Director for Ecological Services ____________

Date April 13, 2018

Synthesis of best available information

-comprehensive, transparent, and peer reviewed

The **Effects Analysis** provides an integrated assessment of the potential benefits of management actions for pallid sturgeon in the Missouri River, **and documents uncertainties in that assessment.**



Based on this synthesis (EA), results of input from sturgeon experts, and USACE authorities, priority management hypotheses were identified (this is an example from the Science and Adaptive Management Plan)

Action location	Action	Number	Management Hypothesis	Findings	Potential Routing
Lower Missouri River	Channel Reconfiguration	17	Channel reconfiguration to increase food-producing habitats will increase growth and survival of age-0 pallid sturgeon, through increased channel complexity and improved bioenergetic conditions to increase prey density	Theoretical support, inference from hydrodynamic models, but data are equivocal as limiting factor and population response	Implemented in part, comparative field experiment, validate with monitoring, assessment
		18	Channel reconfiguration to increase availability and quality of foraging habitat will increase survival of age-0 pallid sturgeon, through increased channel complexity and minimized bioenergetic requirements for resting and foraging.	Theoretical support, inference from hydrodynamic models, but data are equivocal as limiting factor and population response	Implemented in part, comparative field experiment, validate with monitoring, assessment

Shifting to a program driven by species objectives

(versus a program driven by habitat acreage objectives with unknown links to species)

MRRP Goal: develop a suite of actions that meets ESA responsibilities for pallid sturgeon (PS), while continuing to operate the Missouri River System to meet its authorized purposes

FWS Fundamental Objective for Pallid Sturgeon: Avoid jeopardizing the continued existence of the pallid sturgeon from the USACE actions on the Missouri River.

Sub-objective 1: *Increase pallid sturgeon recruitment to age 1.*

- **Metric_1.1:** catch rates of naturally produced age 0 and age 1 PS
- **Metric_1.2:** model-based estimates of abundance of naturally produced age 0 and age 1 PS using data for age 0-4 fish
- **Metric_1.3:** model-based estimates of survival of naturally produced PS to age 1, using data for age 0-4 fish
- **Target:** measurable recruitment to age 1

Sub-objective 2: *Maintain or increase numbers of pallid sturgeon as an interim measure until sufficient and sustained natural recruitment occurs.*

- **Metric_2.1:** population estimates for PS by size class, age (particularly ages 2 to 3) and origin
- **Metric_2.2:** catch rates of all PS by size class and origin (to maintain legacy data)
- **Target:** TBD. Possible targets: 1) $\lambda > 1$ for PS age 2 and older; 2) survival rates of all size/age classes sufficient to provide stable population of PS age 2 and older; 3) acceptable probabilities of persistence and recovery (> 0.95) over 50 years (utilizing population models); and 4) > 5000 self-sustaining, genetically diverse PS in each adult population unit.

Level 1: Research	Population Level Biological Response <u>IS NOT Expected</u>	Studies without changes to the system (Laboratory studies or field studies under ambient conditions)
Level 2: In-river Testing		Implementation of actions at a level sufficient to expect a measurable biological, behavioral, or physiological response in pallid sturgeon, surrogate species, or related habitat response.
Level 3: Scaled Implementation	Population Level Biological Response <u>IS</u> Expected	In terms of reproduction, numbers, or distribution, initial implementation should occur at a level sufficient to expect a meaningful population response progressing to implementation at levels which result in improvements in the population. The range of actions within this level is not expected to achieve full success (i.e. Level 4).
Level 4: Ultimate Required Scale of Implementation		Implementation to the ultimate level required to remove as a limiting factor.

Supplemental lines of evidence strategy for triggering Level 3 implementation

	Question	Y	U	N
1	Is this factor limiting pallid sturgeon reproductive and/or recruitment success?			
2	Are pallid sturgeon needs sufficiently understood with respect to this limiting factor?			
3	Do one or more management action(s) exist that could, in theory, address these needs?			
4	Has it been demonstrated that at least one kind of management action has a sufficient probability of satisfying the biological need?			
5	Have other biological, legal, and socioeconomic considerations been sufficiently addressed to determine whether or how to implement management actions to Level 3?			

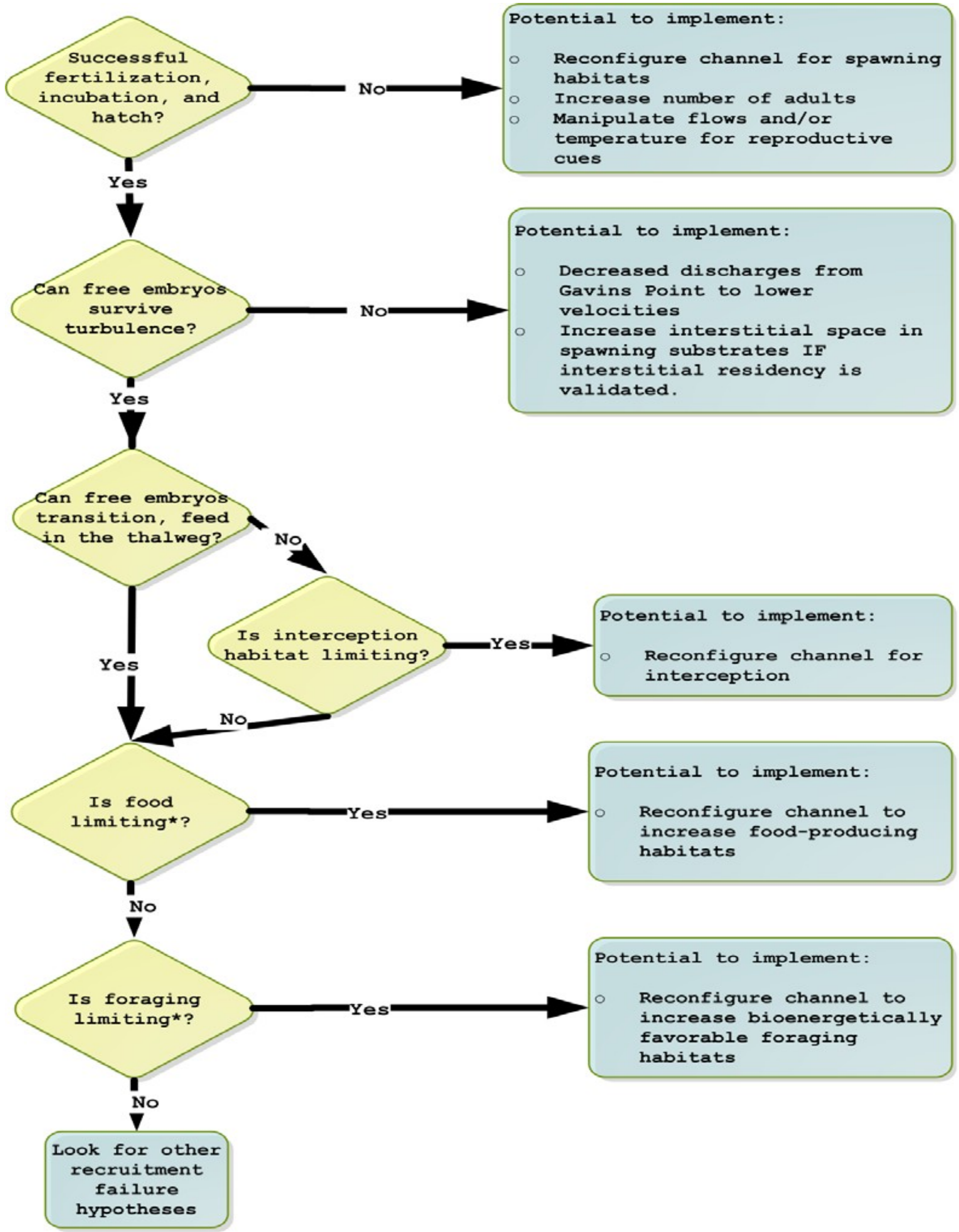
Criteria for Level 3 implementation
1 - A "Yes" to all five questions triggers Level 3 implementation
2 - A "Yes" to four of five, with an "Uncertain" for either #1 or #2 triggers a two-year clock to either reject the hypothesis or implement at Level 3

Question, Level and Study Components	Key Metrics	Simplified IF - THEN Decision Criteria	Degree of Certainty*	Concurrent / Dependent Components
Big Question 3 – Food and Forage: Can naturalization of the flow regime or channel reconfiguration (alone or in combination) contribute to increased food production, foraging habitat, and survival of age-0 sturgeon?				
Associated Hypotheses: **H12.** Naturalization of the flow regime at Gavins Point Dam will improve connectivity with channel-margin habitats and low-lying flood plain lands, increase primary and secondary production, and increase growth, condition, and survival of exogenously feeding larvae and juveniles. **H13.** Naturalization of the flow regime at Gavins Point Dam will decrease velocities and bioenergetic demands, resulting in increased growth, condition, and survival for exogenously feeding larvae and juveniles. **H17.** Re-engineering of channel morphology in selected reaches will increase channel complexity and bioenergetic conditions to increase prey density (invertebrates and native prey fish) for exogenously feeding larvae and juveniles. **H18.** Re-engineering of channel morphology will increase channel complexity and minimize bioenergetic requirements for resting and foraging of exogenously feeding larvae and juveniles.				
BQ3/L1/C1 - Screening: limitations of food or forage habitats	Indicators of starvation or impending death of age-0 sturgeon based on stomach contents (empty/full) or physiological indicators (lipid content).	IF results indicate bioenergetic constraints, THEN this provides more support for L2 experiments.	3	BQ3/L1 -C1, C2, and C3 done concurrently
BQ3/L1/C2 – Engineering study: Technology development for IRC sampling, modeling, measurement	Density, transport, and flux of food items (chironomid larvae) and estimates of age-0 survival rates in prospective IRCs obtained through measurement and modeling.	IF results demonstrate a spatial relationship between food and forage habitats AND food flux is a significant factor in growth and survival within and among IRCs, THEN this provides more support for L2 experiments.	2	BQ3/L1 -C1, C2, and C3 done concurrently
BQ3/L1/C3 - Field studies: food and forage habitat gradients	Depths, velocities, substrate, and spatial complexity of habitat, as well as whether habitats are occupied by food items (chironimids) and foragers (age-0 sturgeon).	IF results demonstrate a systematic spatial relationship between habitat characteristics and selection by food sources and age-0 fish, this provides more support for L2 experiments.	3	BQ3/L1 -C1, C2, and C3 done concurrently

Table continued…

BQ3/L1/C4 - Mesocosm studies: quantitative habitat-survival relations	Depths, velocities, substrate, and spatial complexity of habitat, as well as relative growth rates and survival as a function of habitat characteristics.	IF results demonstrate a systematic relationship between habitat characteristics and growth/survival, THEN this provides more support for L2 experiments.	1	Complete this component unless BQ3/L1/C2 provides alternative methods of estimating survival in the field
BQ3/L2/C5 - Design studies: effect of channel reconfigurations on IRCs	Relative performance of designs, measured as areas of functional habitat, using linked hydraulic and biological models.	IF demonstrated ability to increase habitat components benefiting growth and survival without unacceptable risks to other authorized purposes, THEN proceed to C6 field experimentation.	4	Develop concurrently with BQ3/L1 studies
BQ3/L2/C6 - Manipulative field experiments: effect of channel reconfigurations on IRCs	Area of food-producing habitat, area of foraging habitat, catch per unit effort of age-0 sturgeon, stomach contents, and lipid content.	IF results support the hypothesis that channel reconfigurations can provide increased functional habitats, THEN move to L3 implementation.	4	Described in section 4.2.6.3

Big Question 3: Food and Forage	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Level 1											
C1 Screening: limitations of food or forage habitats											
C2 Technology development for IRC sampling, modeling, measurement											
C3 Field studies along gradients, food and forage habitats											
C4 Mesocosm studies: quantitative habitat – survival relations											
Level 2											
C5 Design studies for IRC experiments											
C6 Build IRCs in staircase design & refurbish SWHs											
Level 3											
Implement more IRCs if found to be successful											



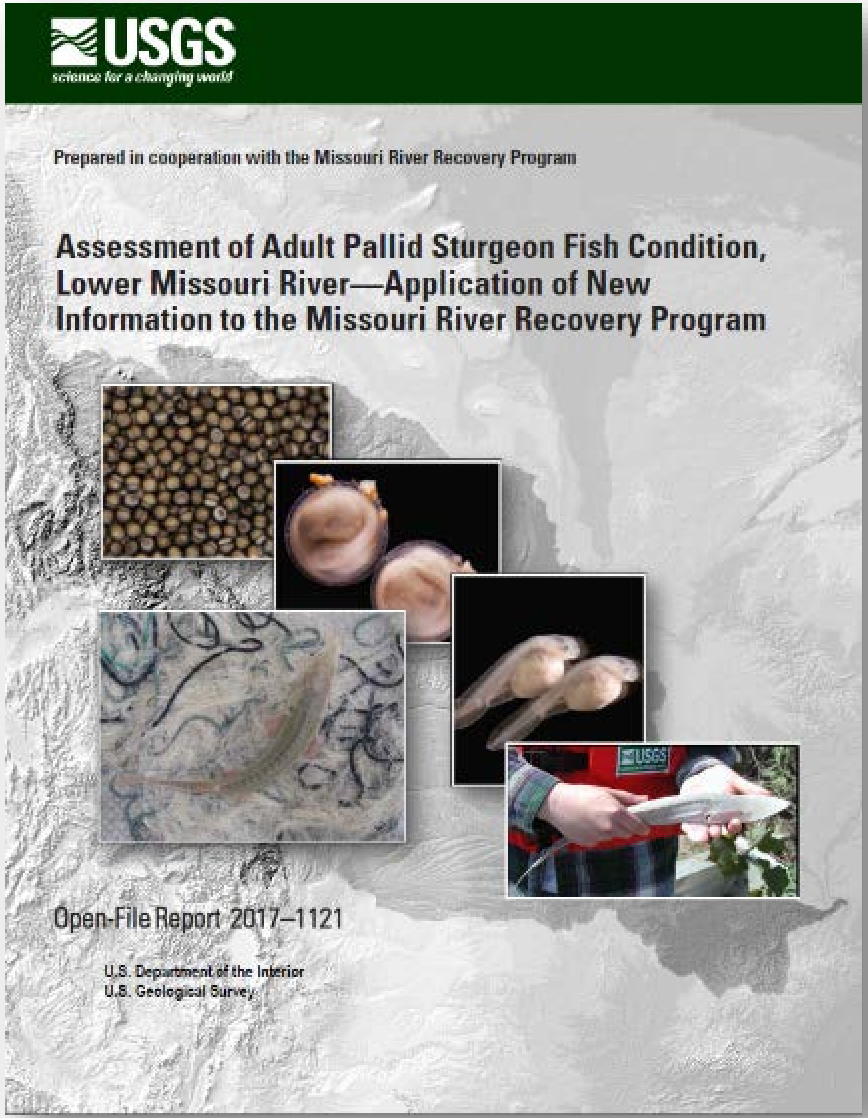
* Note that a habitat type may be limiting at one point in time and not at another. For example, food-producing habitat may not be limiting at low population numbers but may become limiting as population size increases.

Example of a decision tree used to address contingent information – in this case for potential Lower Missouri River Management actions.

Example of part of a decision making tool for evaluating fish passage at Intake

		Decision relevance of answers to questions		
Question	**Detailed questions**	**No [or]**	**Inconclusive [ ]**	**Yes [or]**
Q1. Do motivated spawners and downstream adult migrants successfully move past Intake?	• Q1A: Are the target physical criteria (e.g., depth and velocity) for passage of pallid sturgeon being met?	Assess compliance with biological criteria (Q1B). If biological criteria are met, re-assess physical criteria, and assess upstream movement (Q2). If biological criteria are not being met, investigate deficiencies in passage provided (Q1C-E).	Collect more data. Re-assess design of compliance monitoring. (e.g., location, frequency, and/or timing of sampling).	Assess compliance with biological criteria (Q1B). If biological criteria being met, investigate distance of upstream movement (Q2). If biological criteria not being met, re-assess physical criteria.
	• Q1B: Are the target biological criteria (e.g., number of motivated spawners moving upstream past Intake) being met?	If number of spawners moving upstream is not sufficient, investigate deficiencies of passage (Q1C-E).	Collect more data. Re-assess design of compliance monitoring (e.g., location, frequency, and/or timing of sampling).	If sufficient number of spawners move upstream, investigate distance of upstream movement (Q2).
	• Q1C: Are fish able to approach and navigate the bypass? • Q1D: Is the speed of upstream / downstream movement of adults unimpeded? • Q1E: Does passage lead to injury, stress, or mortality of adult pallid sturgeon migrating downstream?	If problems are detected, modify the passage structure to improve number of adults moving upstream/downstream. Continue to monitor compliance with biological criteria (Q1B).	Collect more data. Re-assess monitoring of behavior and movement of adults through structure (e.g., location, frequency, and/or timing of sampling).	If no problems are detected, re-assess physical and biological criteria. Monitor distance of upstream movement (Q2).

How do we address new, unanticipated information in a scientifically-rigorous manner?



Summary

From the AM Plan: "There is a tradeoff between taking action and decreasing uncertainty. Taking actions at Level 3 or 4 without strong evidence of their effectiveness may be costly, and may use resources which could have been better allocated. On the other hand, there are constraints on how much can be learned from retrospective studies of past data, analyses of the current system, laboratory experiments and mesocosm experiments. Delaying Level 3 or 4 actions that have potential benefits could delay the recovery of pallid sturgeon. The AM strategy needs to find the appropriate balance between three risks: 1) premature implementation of ineffective actions, which waste resources; 2) excessive delay in implementing actions which would have helped the population; and 3) implementation of multiple concurrent actions without an ability to determine which actions are most effective, which makes future management adjustments more difficult."

QUESTIONS???