The Role of Evidence in Adaptive Management: Examples from the Missouri River and Columbia River Estuary Restoration Programs

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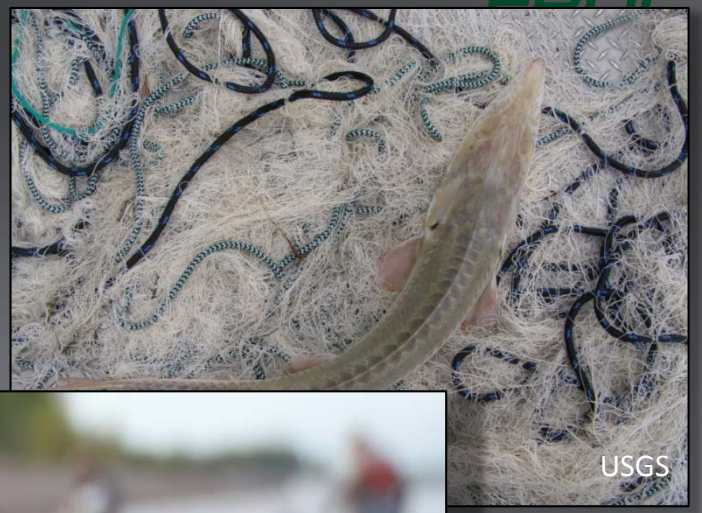
Independent Socio-Economic Technical Review: Dermot Hayes, John Loomis, Sarah Michaels

Knowledge

Uncertainty

Knowledge



Knowledge

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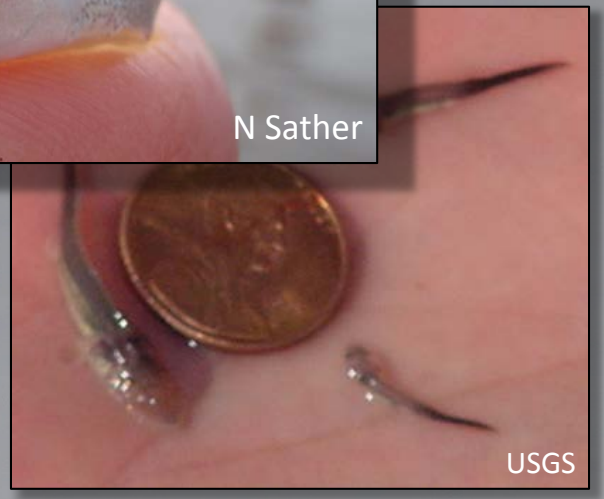


Knowledge

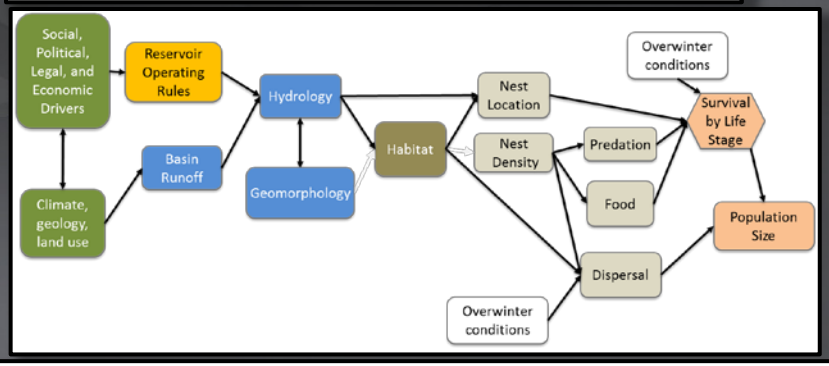
Effects Analysis

Uncertainty

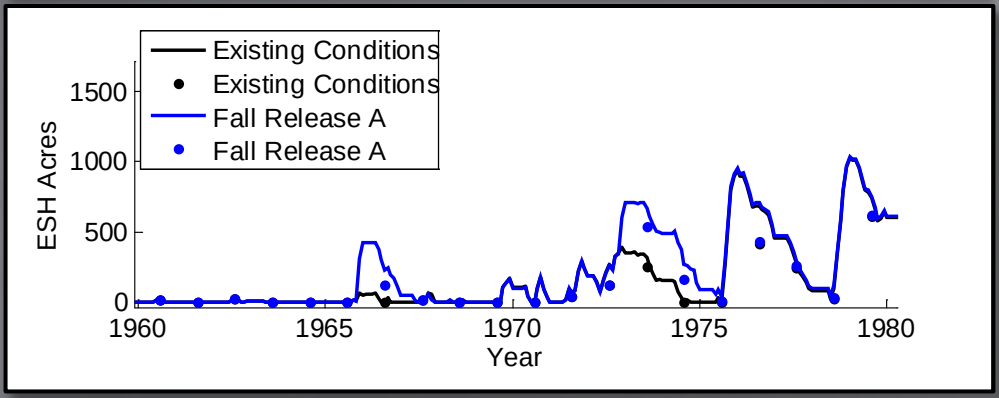
Science Information to Support Missouri River Piping Plover and Least Tern Effects Analysis

October 2015

KE Buenau[1] CR Vernon[1]
V Cullinan[1] CJ Huber[2]

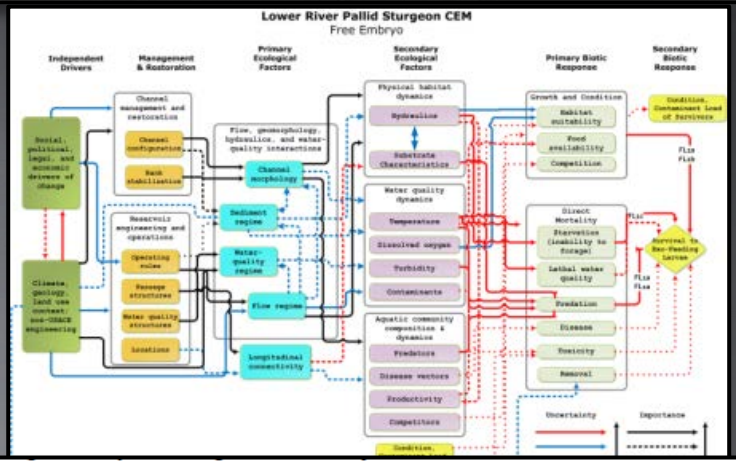


Plover biotic hypotheses/pathways	Intermediate hypotheses/mechanisms
Steady or decreasing reservoir levels/river stage during the nesting season increases survival from eggs to chick by reducing inundation risk.	
	Higher water levels early in the nestin season increases elevation of nest sites plovers tend to select nesting sites nea water level.

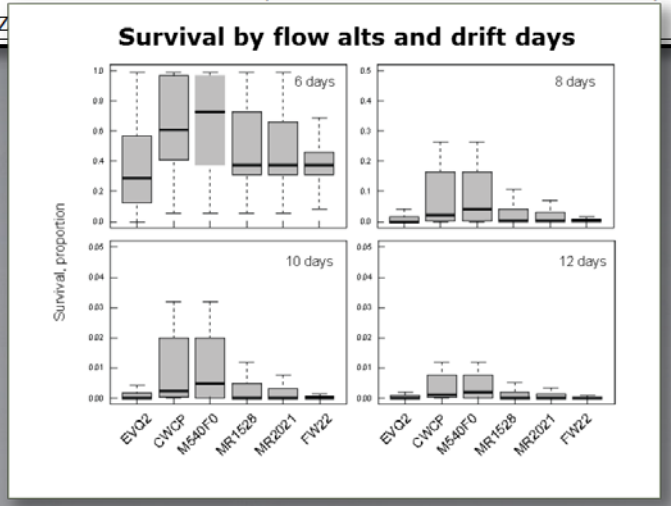


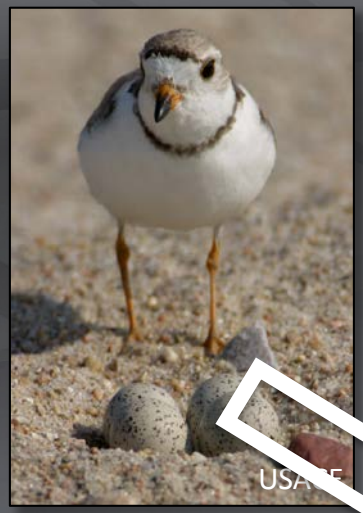
Prepared in cooperation with the Missouri River Recovery Program

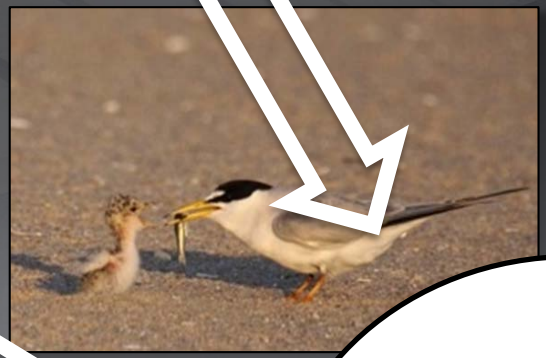
Science Information to Support Missouri River *Scaphirhynchus albus* (Pallid Sturgeon) Effects Analysis

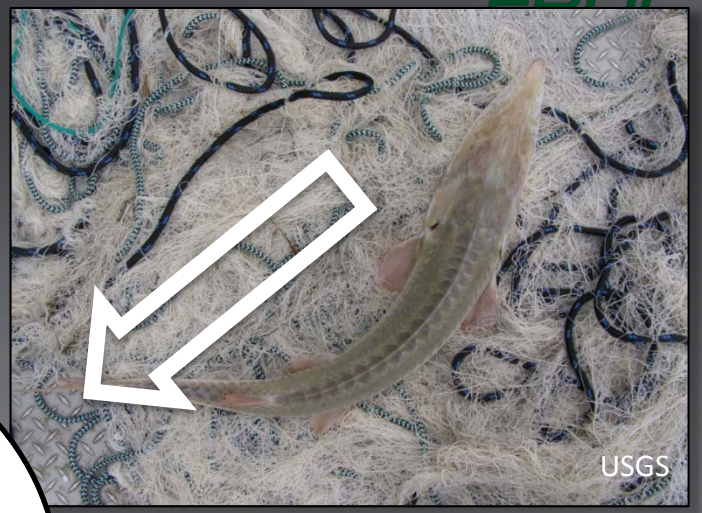


20	Naturalization of the flow regime at Gavins Point will decrease velocities and bioenergetic demands, resulting in increased growth and condition for exogenously feeding larvae and juveniles.
21	Alteration of the flow regime at Gavins Point can be optimized to decrease main-stem velocities, decrease effective drift distance, and minimiz





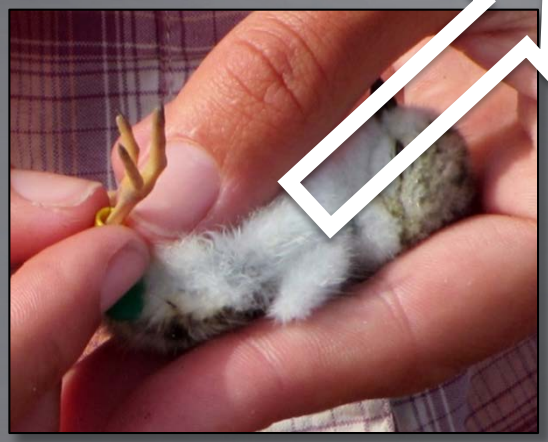


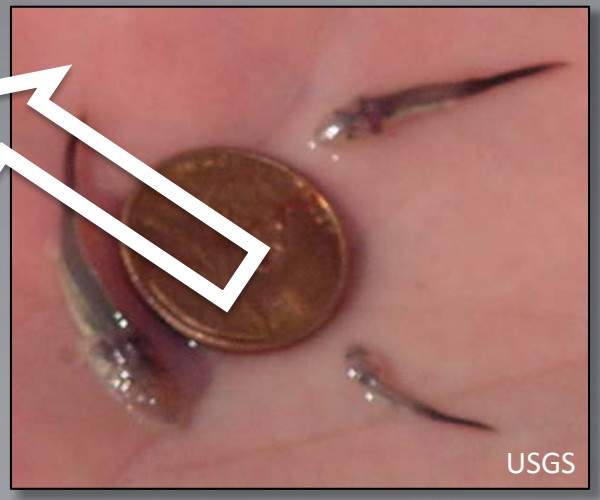


Integrated
Adaptive
Management

Knowledge

Uncertainty





Missouri River Management Plan
Adaptive Management – Draft Bird Example

Kate Buenau, PNNL
Craig Fischenich, USACE-ERDC
May 11, 2015

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LMR Pallid Sturgeon Framework, Targets, and Decision Criteria

Science and Adaptive Management Plan

Missouri River Recovery Program

J. Craig Fischenich, Kate E. Buenau, Robert B. Jacobson, Joseph L. Bonneau, and Craig A. Fleming — August 2015

Developmental Draft Version 4

Science and Adaptive Management Plan

Missouri River Recovery Program

Draft/Pre-decisional/For Discussion Purposes Only — December 2015

Missouri River Management Plan
Adaptive Management – Draft Bird Example

Kate Buenau, PNNL
Craig Fischenich, USACE-ERDC
May 11, 2015

TO: SAM Work Group, Management Plan Development Team, MRRIC

FROM: Independent Science Advisory Panel (ISAP)

RE: ISAP Evaluation of MRRMP v3 AM Plan and Pallid Level 3 Actions

DATE: 9 November 2015

Developmental Draft Version 4

Science and Adaptive Management Plan

Missouri River Recovery Program

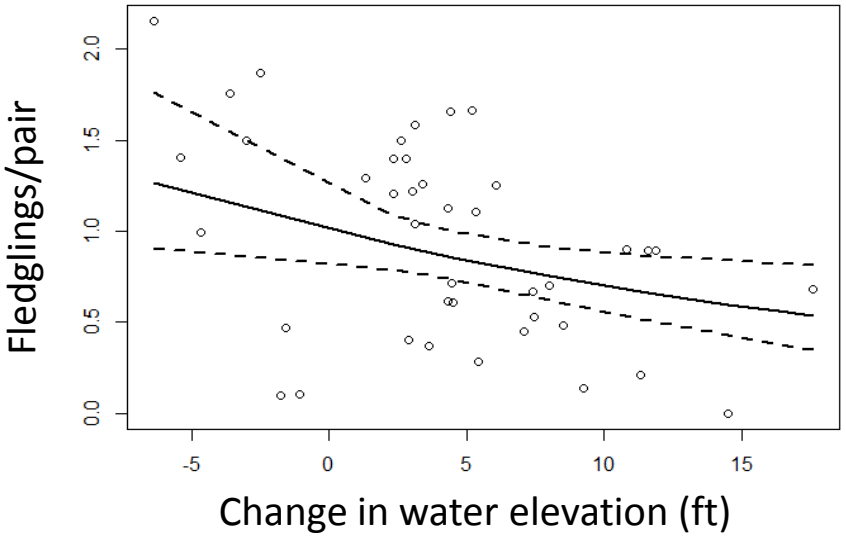
Draft/Pre-decisional/For Discussion Purposes Only December 2015

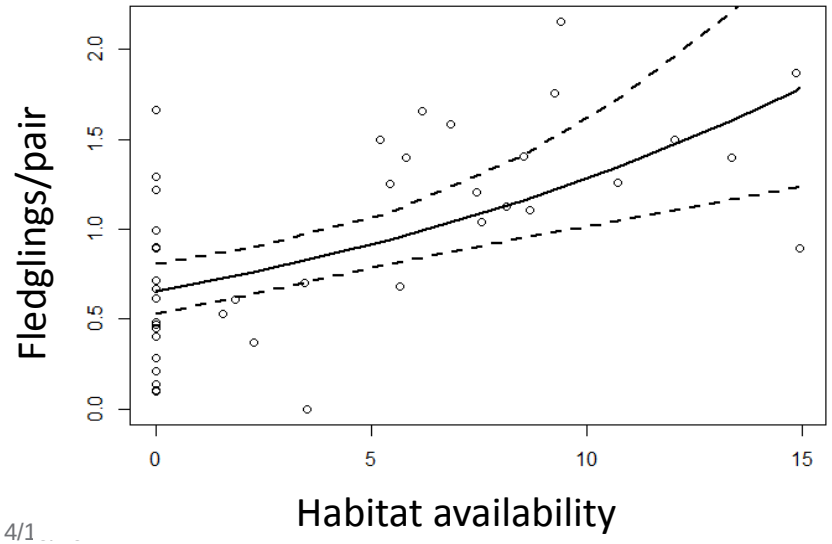
Overarching Critical Uncertainties—Birds

- How much habitat is needed to maintain a resilient population of plovers and how should it be distributed?
- How are the Missouri River populations affected by migratory and metapopulation dynamics?
- How will changes in climate and channel morphology affect management effectiveness?
- How can the AM program buffer against natural (especially hydrologic) uncertainty?
- How can the AM program buffer against institutional and socioeconomic uncertainty?

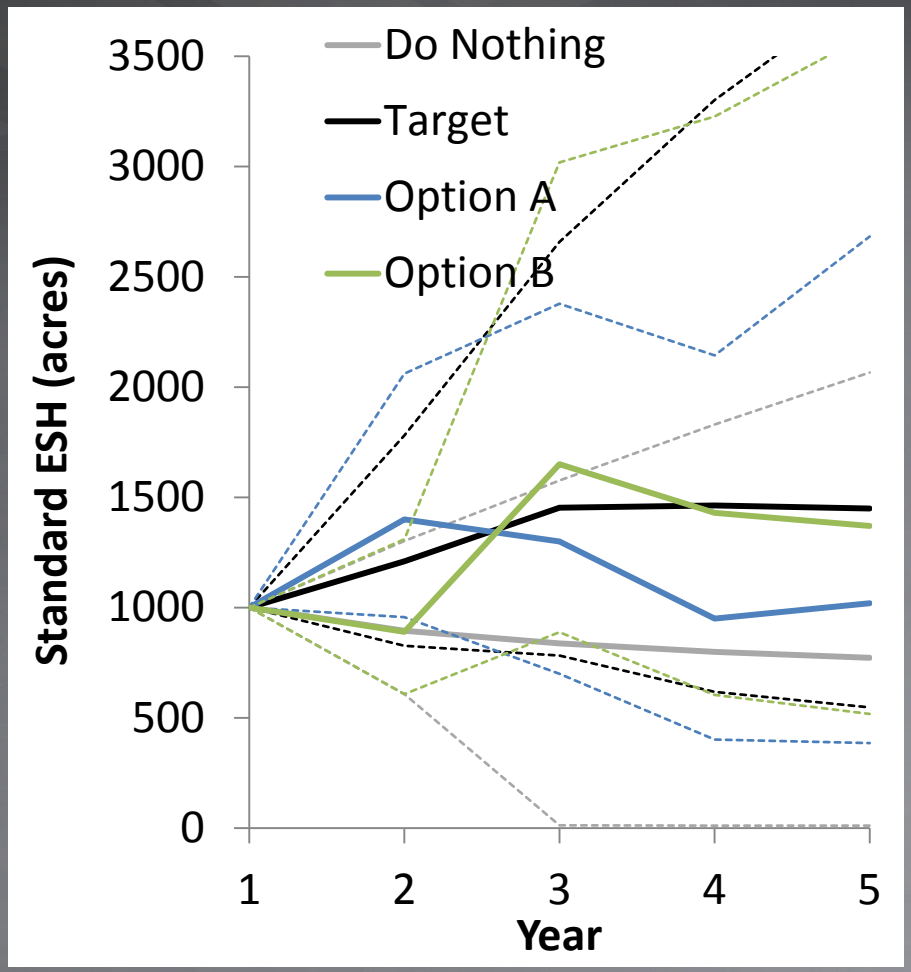
- Management uncertainties: are actions necessary and effective?

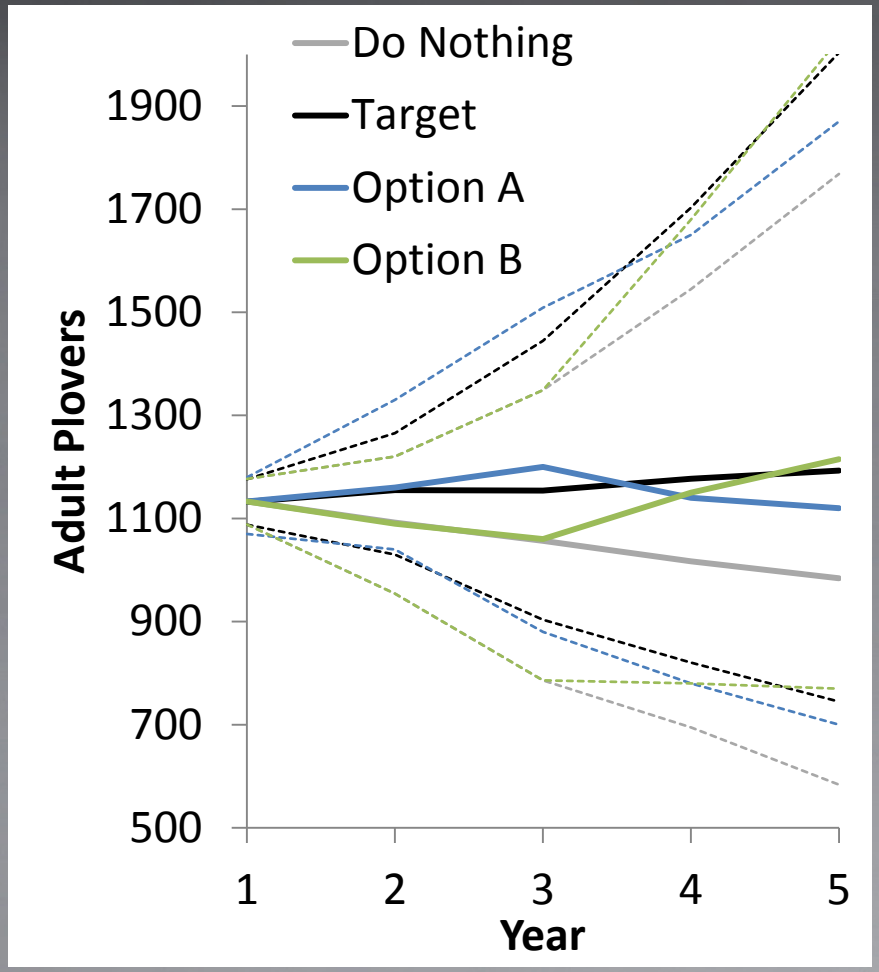
Evidence—plovers and habitat





Evidence → models





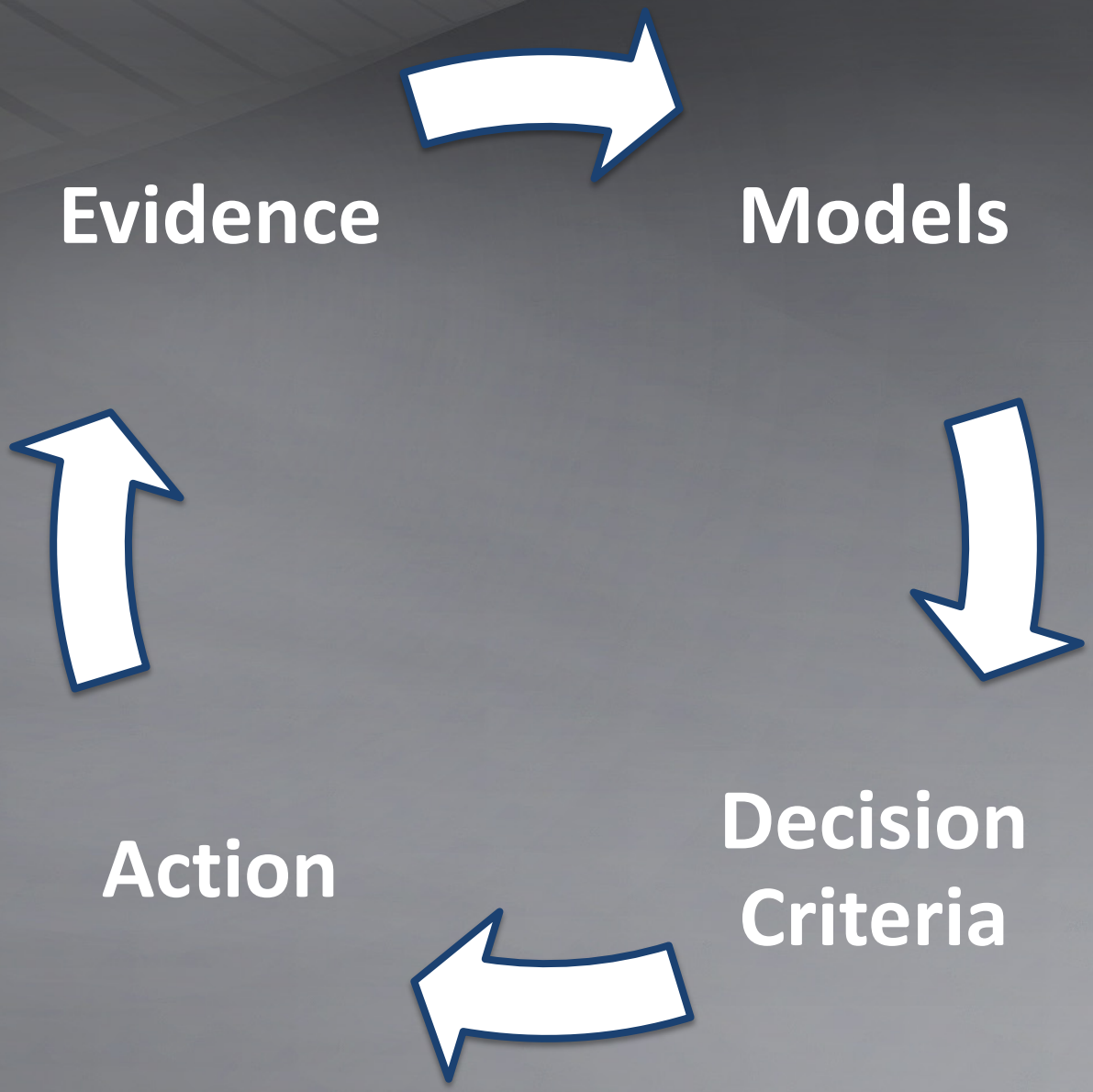
Quantitative decision criteria

- **Increase likelihood of meeting targets under uncertainty**
- Reduce likelihood of adverse impacts
- Make trade-offs explicit
- **Make scientific findings actionable**
- Increase efficiency of resource use
- Facilitate decisions that must be made quickly
- Provide justification for actions
- **Account for multiple factors in single decisions**

Decision criteria examples

Habitat-forming flows will not be used more frequently than once every **4 years** , nor within **4 years** of any naturally-occurring flow that created **250 acres** or more of standardized ESH. They will not be used when ambient ESH levels exceed **25%** of target, or when system storage **< 42MAF** for a spring release or the service level **< 35 kcfs** for a fall release.

If use of vegetation managed sandbars is < **50%** and/or fledgling production **< 80%** that of new/unvegetated sandbars, use of methodologies should be reevaluated or discontinued.


Evidence
Models
Decision Criteria
Action

Overarching Critical Uncertainties—Sturgeon

- Are flow manipulations necessary to cue spawning, contribute to effective dispersal of free embryos?
- Are water temperature manipulations necessary for reproductive cues, or increased productivity and growth?
- Is dispersal distance limiting for age-0 pallid sturgeon survival, and if so, what combination of flow manipulation and other engineering actions would remove that limit?
- Are food-producing or foraging habitats limiting for age-0 pallid sturgeon, and if so, what combination of flow manipulation and channel reconfiguration would remove that limit?
- Are spawning habitats limiting for successful reproduction, and if so what combination of flow manipulation and channel reconfiguration would remove that limit?
- Is sediment augmentation necessary to achieve recruitment?
- What approaches to population augmentation are necessary to maintain the population temporarily and will do so with least harm to genetic diversity?

Overarching Critical Uncertainties—Sturgeon

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Frequently Asked Questions

Why have you made this so freaking complicated?

channel reconfiguration would remove that limit?

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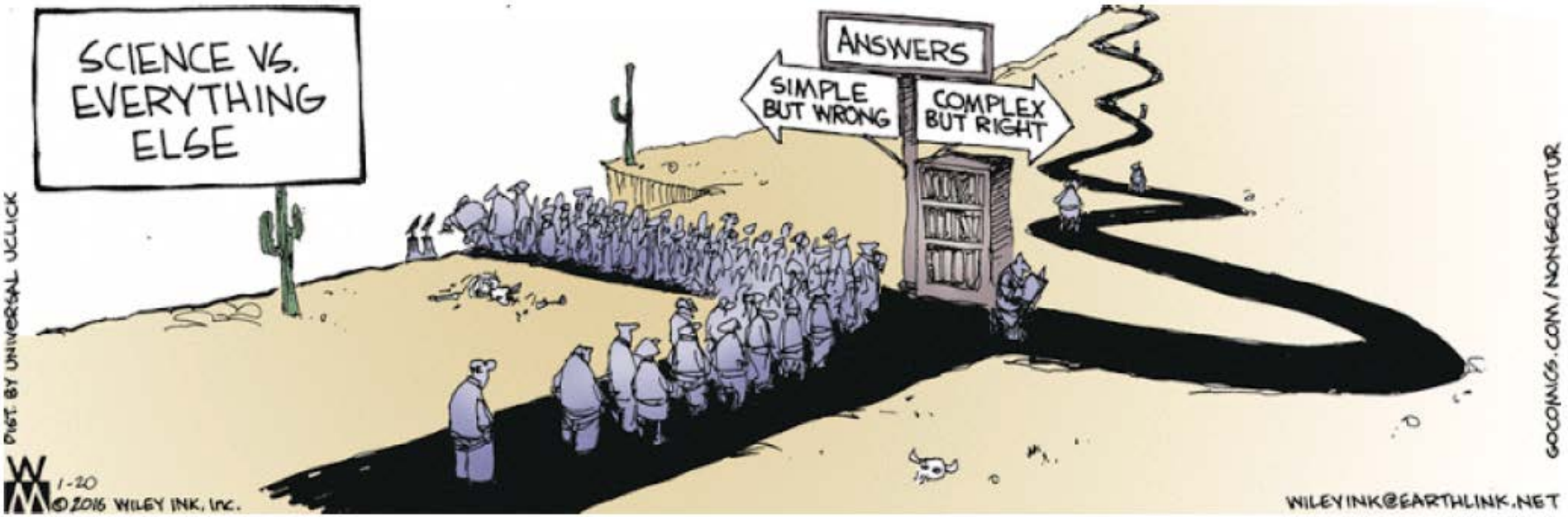
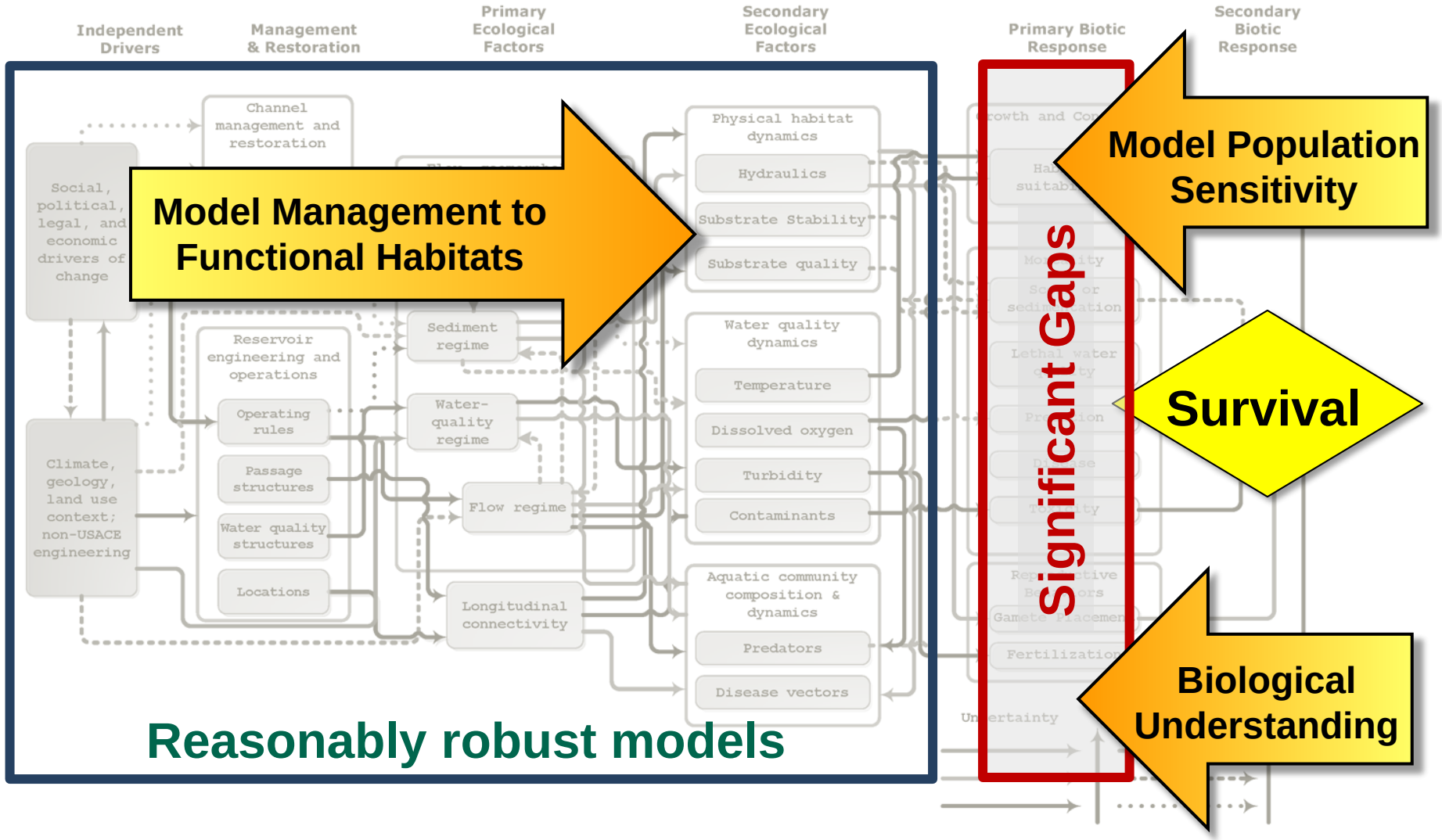


For every complex problem there is an answer that is clear, simple, and wrong.

- H. L. Mencken (1917)

USGS

Component-level Conceptual Model



Pallid sturgeon AM framework

Level 1: Research	Population Level Biological Response IS NOT Expected	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 IS Expected	Initial implementation should occur at a level sufficient to expect a meaningful population response progressing to implementation at levels that result in improvements in the population; not expected to achieve full success.
Level 4: Ultimate Required Scale of Implementation		Implementation to the ultimate level required to remove a limiting factor.

Criteria for advancing sturgeon actions

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	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

Sturgeon monitoring, research, and evaluation

- **EA process yields 21 action hypotheses**
- **Recognize 4 levels of implementation:**
  - **Level 1**: foundational science
  - **Level 2**: field experimentation
  - **Level 3**: initial implementation -> population response
  - **Level 4**: full implementation
- **Science components address level 1 and level 2**
  - 74 components, 2016 – 2032
- **Levels 2-4: Hypothesis-driven monitoring (piloting updated concepts of channel reconfigurations:**
  - Implementation – action completed?
  - Process, action effectiveness – ecological response?
  - Population –growing, attaining the right size?

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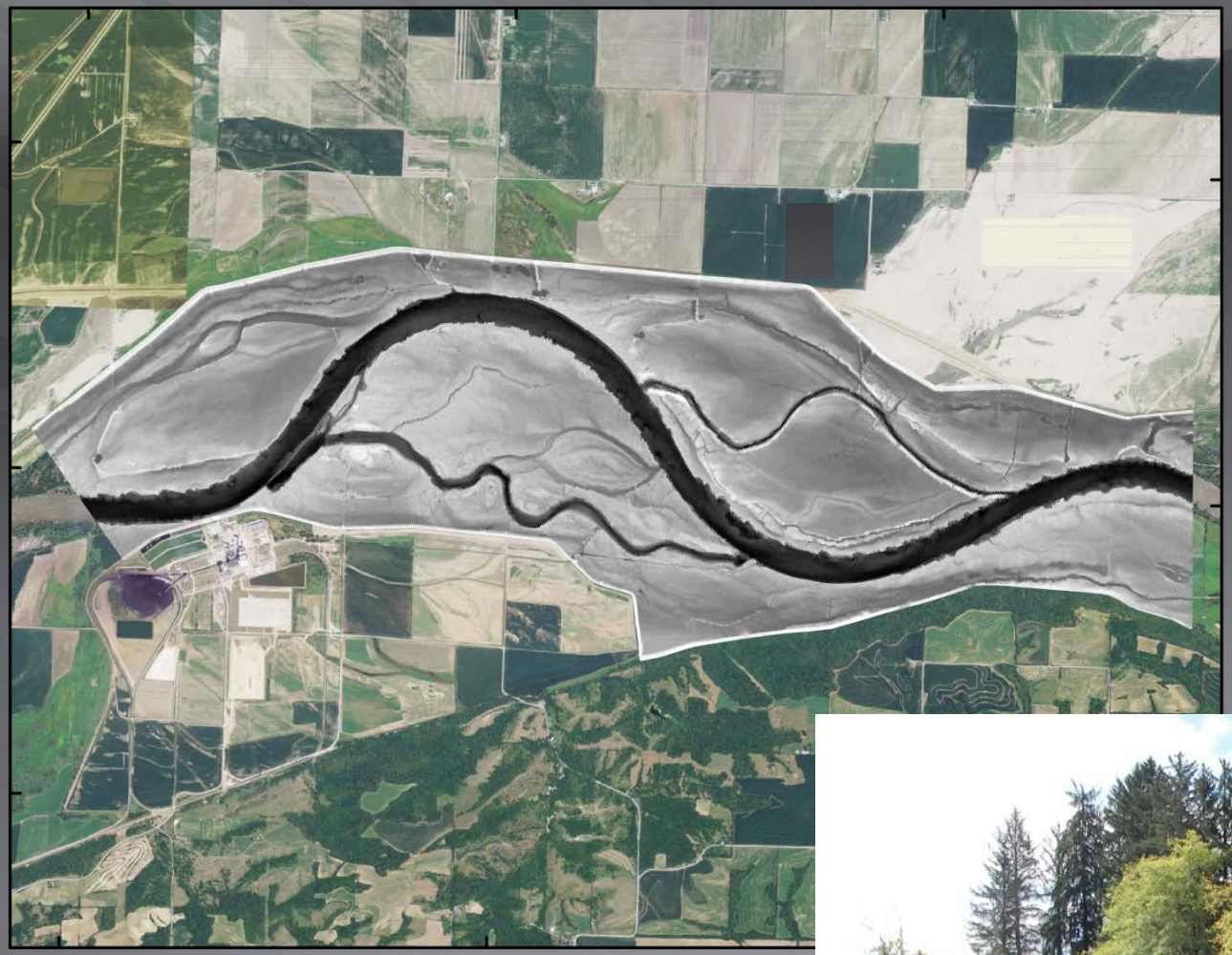
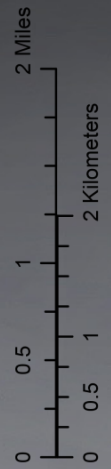
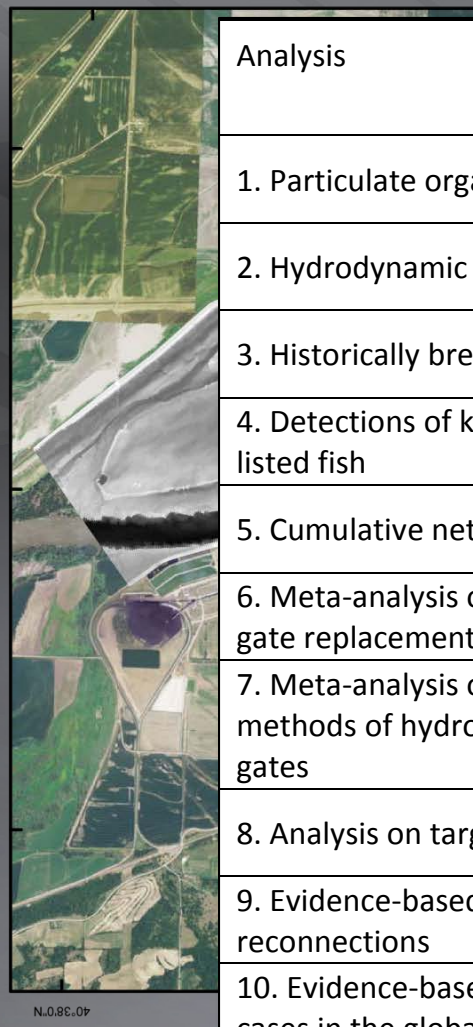
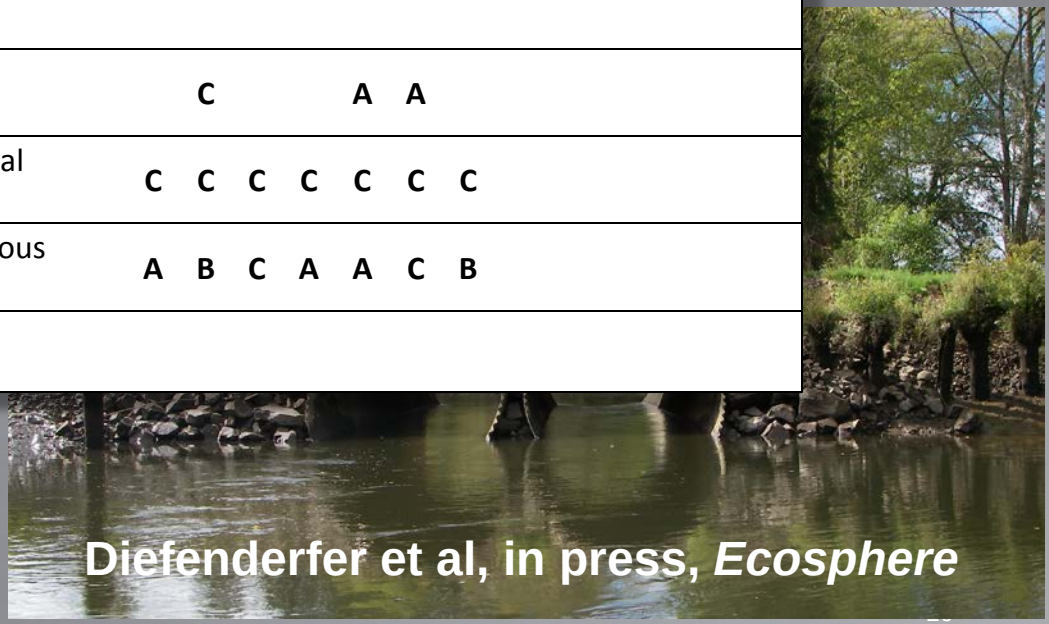






Analysis	Fish Responses							Habitat Responses				
	1	2	3	4	5	6	7	8	9	10	11	12
1. Particulate organic matter flux model												**B**
2. Hydrodynamic model of dike breaches								**B**				
3. Historically breached sites	**C**							**A**	**B**	**B**	**B**	
4. Detections of known Interior Columbia basin ESA-listed fish	**B**	**C**										
5. Cumulative net ecosystem improvement model				**A**						**A**		**B**
6. Meta-analysis of action effectiveness: LCRE tide-gate replacements	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**D**	**B**	**D**	**D**	**C**
7. Meta-analysis of action effectiveness: LCRE, methods of hydrological reconnection without tide gates	**B**	**C**	**C**	**C**	**C**	**C**	**C**	**B**	**B**	**C**	**B**	**C**
8. Analysis on target species		**C**			**A**	**A**						
9. Evidence-based literature review: LCRE tidal reconnections	**C**	**C**	**C**	**C**	**C**	**C**	**C**					
10. Evidence-based literature review: analogous cases in the global literature	**A**	**B**	**C**	**A**	**A**	**C**	**B**					



Diefenderfer et al, in press, *Ecosphere*

Lines of Evidence

Conclusions

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Knowledge ⟷ **Uncertainty**

Full implementation of actions to meet quantitative targets

Numerical modeling of population effects and management options

Quantitative decision criteria

Active AM when possible

Tiered implementation with comprehensive science plan, targets to come

Partial modeling → modeling of complete pathways

Decision criteria for advancing implementation

Active AM to accompany directed research


SLINKIES CLIMBING UPSTAIRS TO SPAWN
LIANA
FINCK