Independent Science Panel Observations

on

Appendix E (and presentations from 9 July 2018)

and

Pallid Sturgeon Population Assessment Program v. 2.0
as presented on 9 July 2018

Presented to Fish Monitoring Webinar
20 August 2018

Overarching Comments

Need to link the monitoring approaches back to the explicit program goals and objectives throughout Appendix D and E (example below).

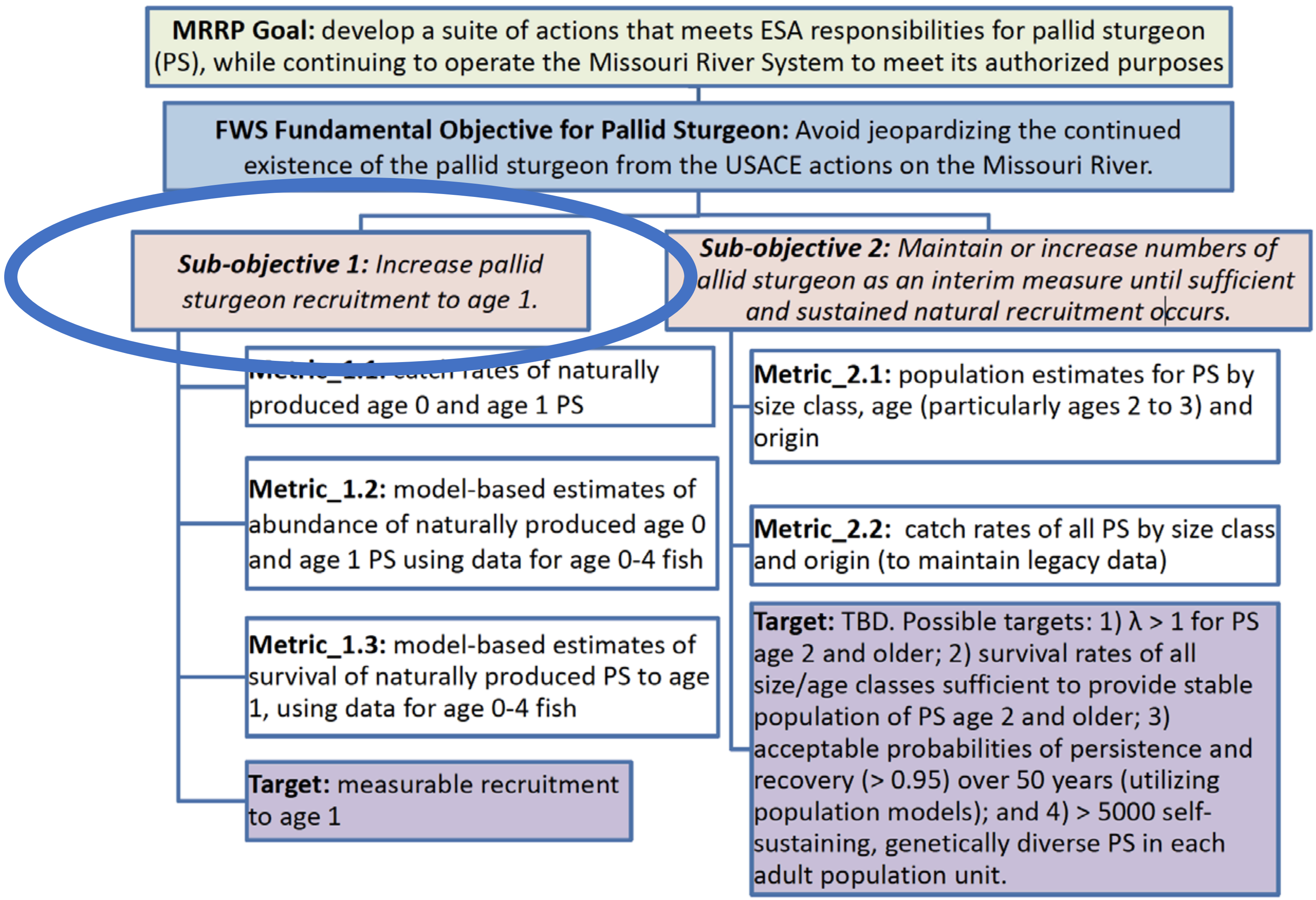
Cross reference Appendix D and E — design both to maximize AM learning; both appendices should call out the hypotheses that they contribute to evaluating, identify hypotheses in common, and identify hypotheses that they uniquely address (example below).

Prioritize the proposed monitoring activities to maximize data collection efficiencies and capacity to evaluate the management hypotheses; it is obvious and acknowledged that the monitoring budget will be limited (example below).

Describe how monitoring will be adapted when it becomes clear that data collection schemes are not accurately reflecting the effects of management actions or effective at evaluating hypotheses; how does the program identify and institute new sampling efforts that may even require new indicators.

Appendix D acknowledges the need to engage data collection in the Mississippi River, but it refers to inclusion of the Mississippi River into the PSPAP as an “ancillary objective;” rather it is a fundamental and essential element in the design of the survey scheme.

Slides 3-19 are used to illustrate whether the actions and monitoring link to sub-objective 1 and the target, with a focus on IRC/rehab SWH. The example includes several screen-shots from the presentations and appendix E.



Four implementation levels of MRRP actions

- **Level 1**: foundational science
- **Level 2**: field experimentation
- **Level 3**: initial implementation of an action to a level where a population response is expected – minimum to avoid jeopardy
- **Level 4**: full implementation

- Short-term monitoring is used as an approach to some science components at level 1.
- Most of monitoring and assessment described here is for assessment of implementation at levels 2, 3 and 4.
  - What are effects of actions? What is learned?
  - Do actions have positive population-level effects?

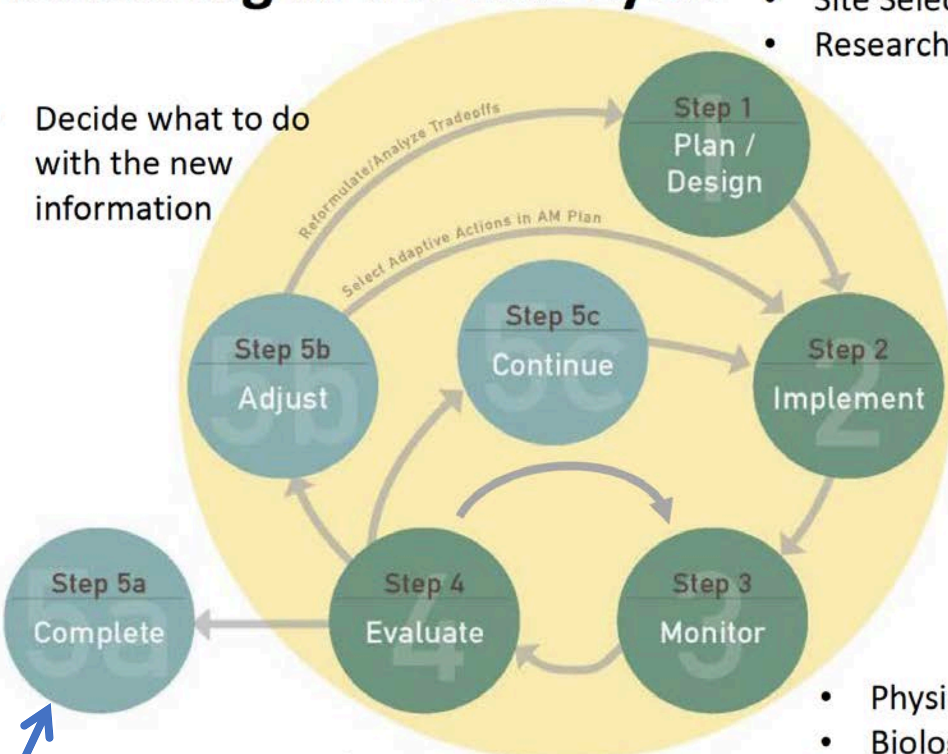
Increase pallid sturgeon recruitment to age 1?

Management Actions and Monitoring in the AM Cycle

- Hypotheses
- Sampling Design
- Site Selection
- Research to support design

Levels 1 and 2

- Decide what to do with the new information

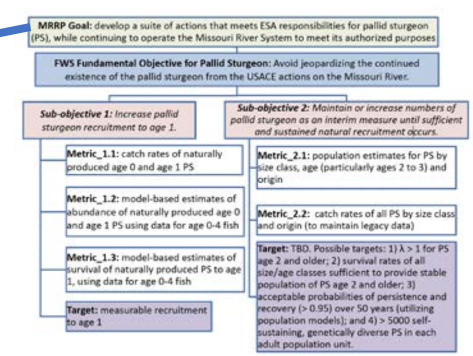


- Implement management actions

Levels 3 and 4

- Physical monitoring
- Biological monitoring

- Short-term learning
- Long-term evaluation



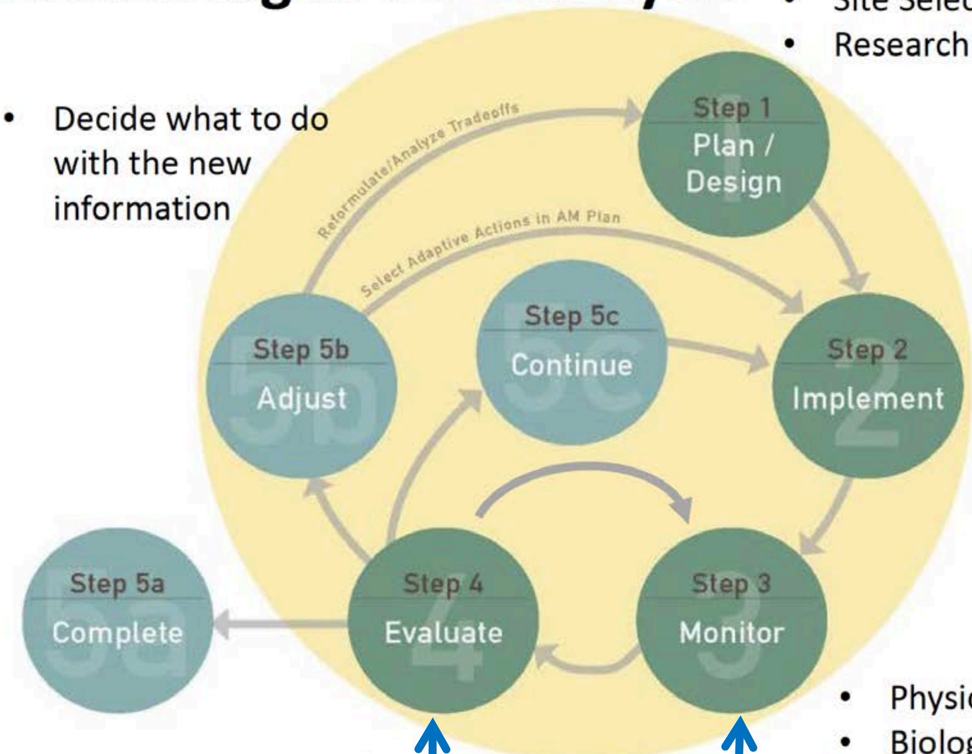
Management Actions and Monitoring in the AM Cycle

- Hypotheses
- Sampling Design
- Site Selection
- Research to support design

Levels 1 and 2

These should relate to MRRP goal and sub-objectives

- Decide what to do with the new information

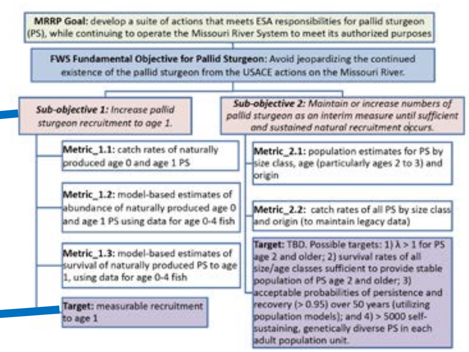


- Implement management actions

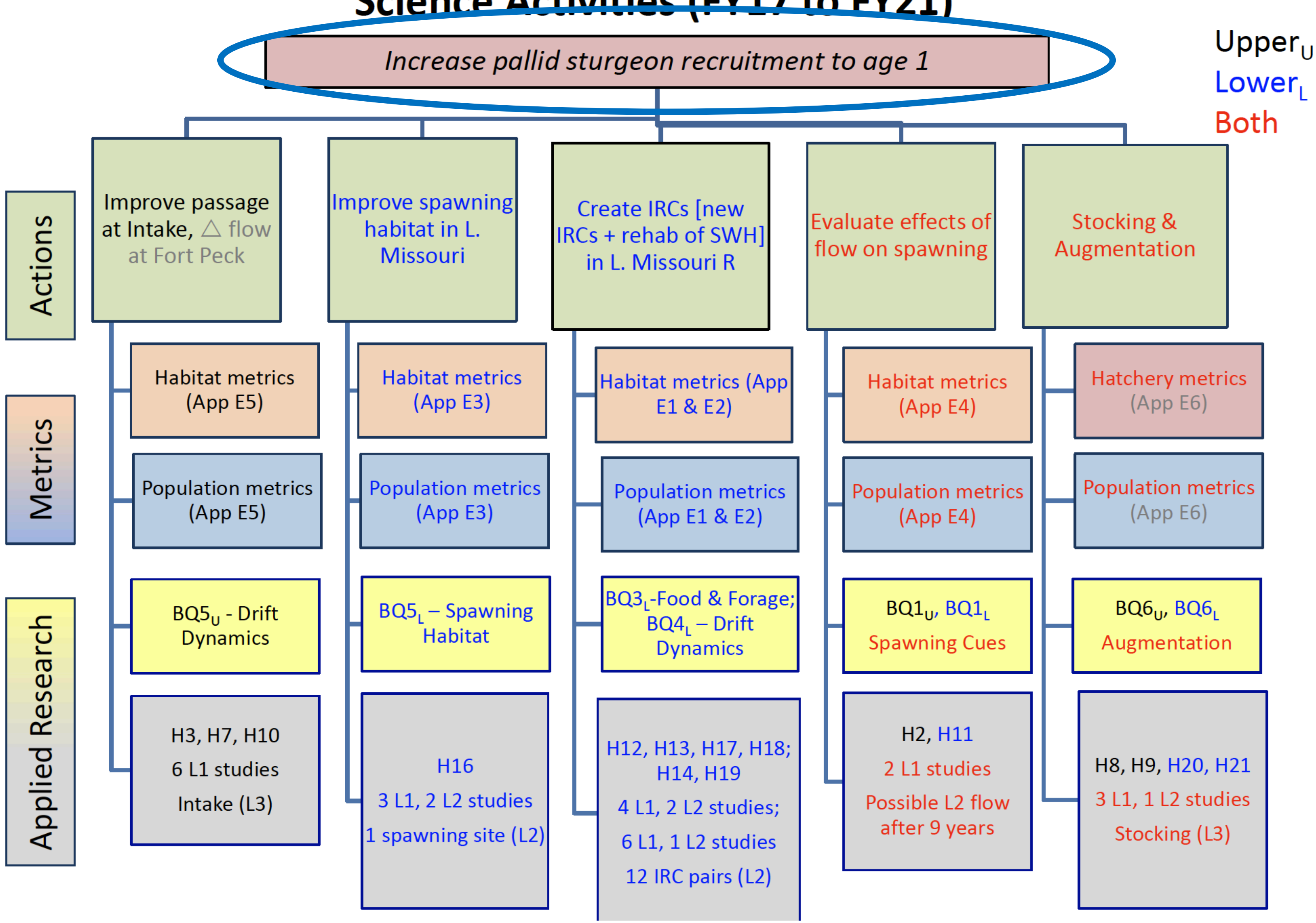
Levels 3 and 4

- Physical monitoring
- Biological monitoring

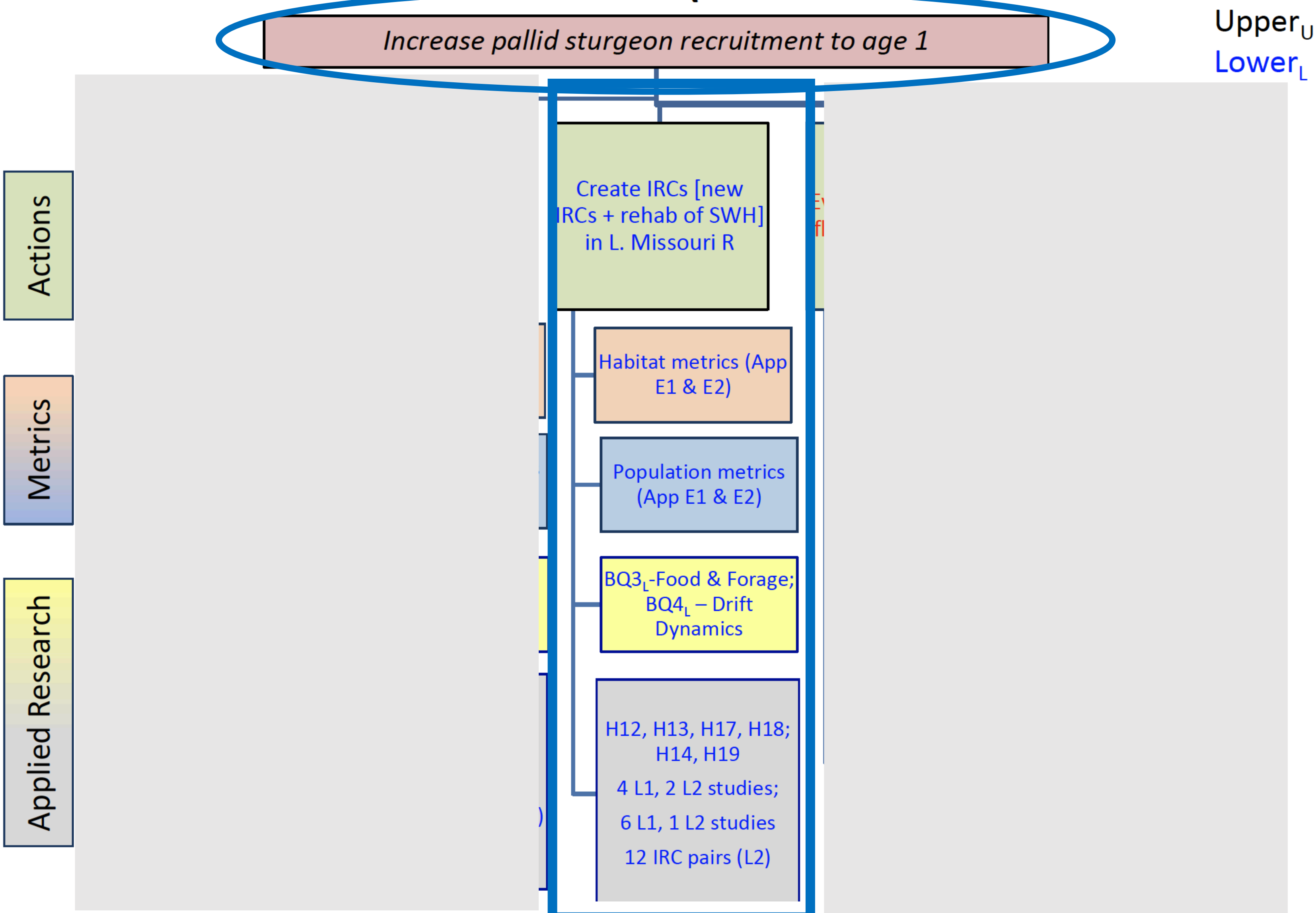
- Short-term learning
- Long-term evaluation



Management Actions, Monitoring, and Science Activities (FY17 to FY21)



Management Actions, Monitoring, and Science Activities (FY17 to FY21)

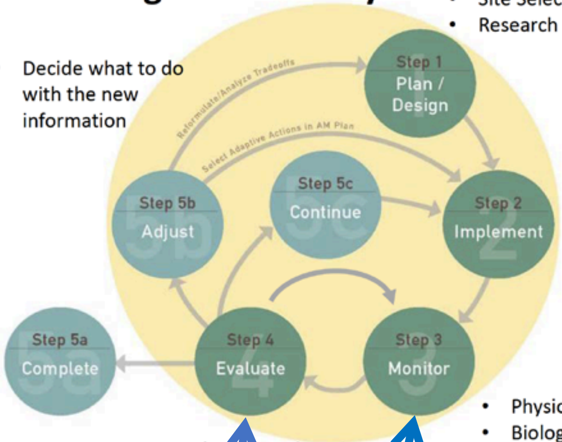


Management Actions and Monitoring in the AM Cycle

- Hypotheses
- Sampling Design
- Site Selection
- Research to support design

IRC & rehab SWH (Level 2)

- Decide what to do with the new information



- Implement management actions

Monitoring Appendix	Key questions of interest
App E.1: Interception and rearing complexes (IRCs)	Do IRCs / SWH-IRCs increase interception, retention, abundance, and growth of age-0 sturgeon, and increase the available acre-days of foraging and food-producing habitat for age-0 sturgeon?
App E.2: Modifications to existing SWH projects (SWH-IRCs)	

- Physical monitoring
- Biological monitoring

- Short term learning
- Long term evaluation

2

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.

Assumptions required to directly link actions to sub-objective 1:

Abundance (CPUE) of age-0 sturgeon is positively associated with abundance of age-0 pallid sturgeon,

abundance of age-0 pallid sturgeon is positively associated with abundance of age-1 sturgeon,

age-1 pallid sturgeon are not in the Mississippi River (thus not missing from the sampling scheme),

therefore, an increase in abundance of age-0 sturgeon equals an increase in abundance of age-1 pallid sturgeon in the Missouri River.

retention components of age-0 sturgeon biology within a site. The underlying assumption of this response metric is that the abundance of age-0 *Scaphirhynchus sp.* strongly correlates with the abundance of age-0 pallids. Using age-0 *Scaphirhynchus sp.* as the primary response metric helps to deal with the challenge of the very low numbers of age-0 pallid sturgeon present in the lower Missouri River. The 2018 Biological Opinion (USFWS 2018, page 31) notes that "there should be careful consideration when using the shovelnose sturgeon as a surrogate for the pallid sturgeon in scientific studies of natural history and physiology". Page 517 draft SAMP appendix E

The effectiveness monitoring described in Appendices E.1 through E.5 is focused on implementation monitoring (i.e., was the management action implemented as intended?) and process based monitoring (i.e., did the management action achieve desired changes to ecological processes thought to lead to increased growth and survival?). These Appendices are not focused on population level monitoring and assessing the population-level response to the actions (i.e., did the effect of the management action propagate to age-1 recruitment in the short term and population growth in the longer term?), since population monitoring is the focus of Appendix D.

Page 505, Appendix E

PSPAP v. 2.0 Fundamental Objectives

1. Quantify pallid sturgeon recruitment to age 1 (from natural reproduction) **[Sub-objective 1]**
2. Quantify pallid sturgeon population status and trends, natural and hatchery origin **[Sub-objective 2]**
3. Maintain compatibility with PSPAP v. 1.0 data to extent possible
4. Provide relevant demographic data for pallid sturgeon population model inputs.
5. Evaluate monitoring information in a benefit:cost or utility:cost framework

PSPAP v. 2.0 Redesign Process

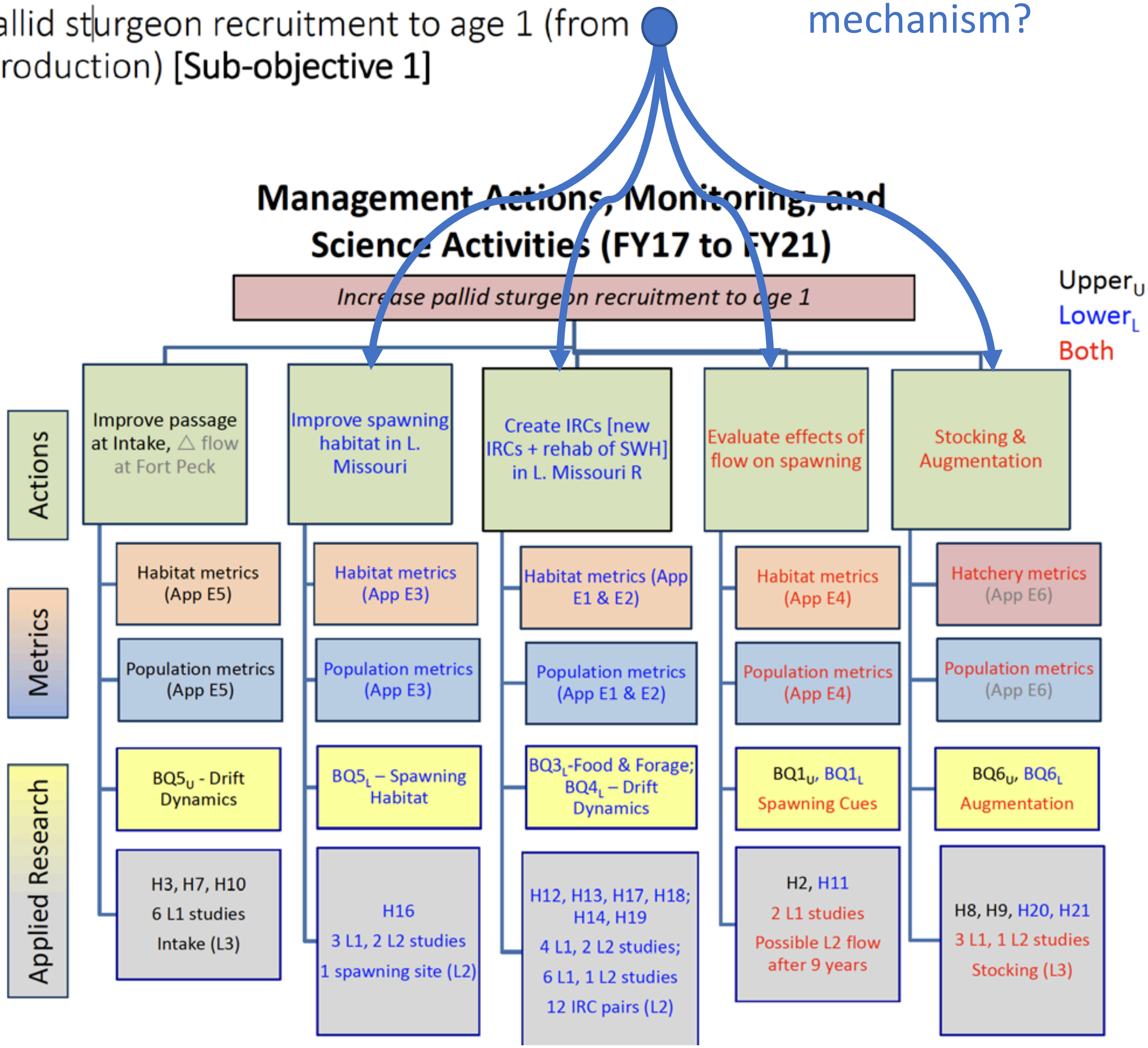
Complementarity: PSPAP v. 2.0 is part of a framework; it does not do all the evaluation needed to inform decision making.

1. PSPAP v. 2.0 – abundance and trends, some linkages of actions to population responses (augmentation).
2. Effectiveness monitoring – ecological effectiveness of management actions, but not necessarily to population responses
3. L1 and L2 research – develop process understanding of linkages from actions to demographic rates.
4. Collaborative Population Model (CPM)–tool to integrate information, demographic rates, predict population response.

PSPAP v. 2.0 Fundamental Objectives

1. Quantify pallid sturgeon recruitment to age 1 (from natural reproduction) **[Sub-objective 1]**

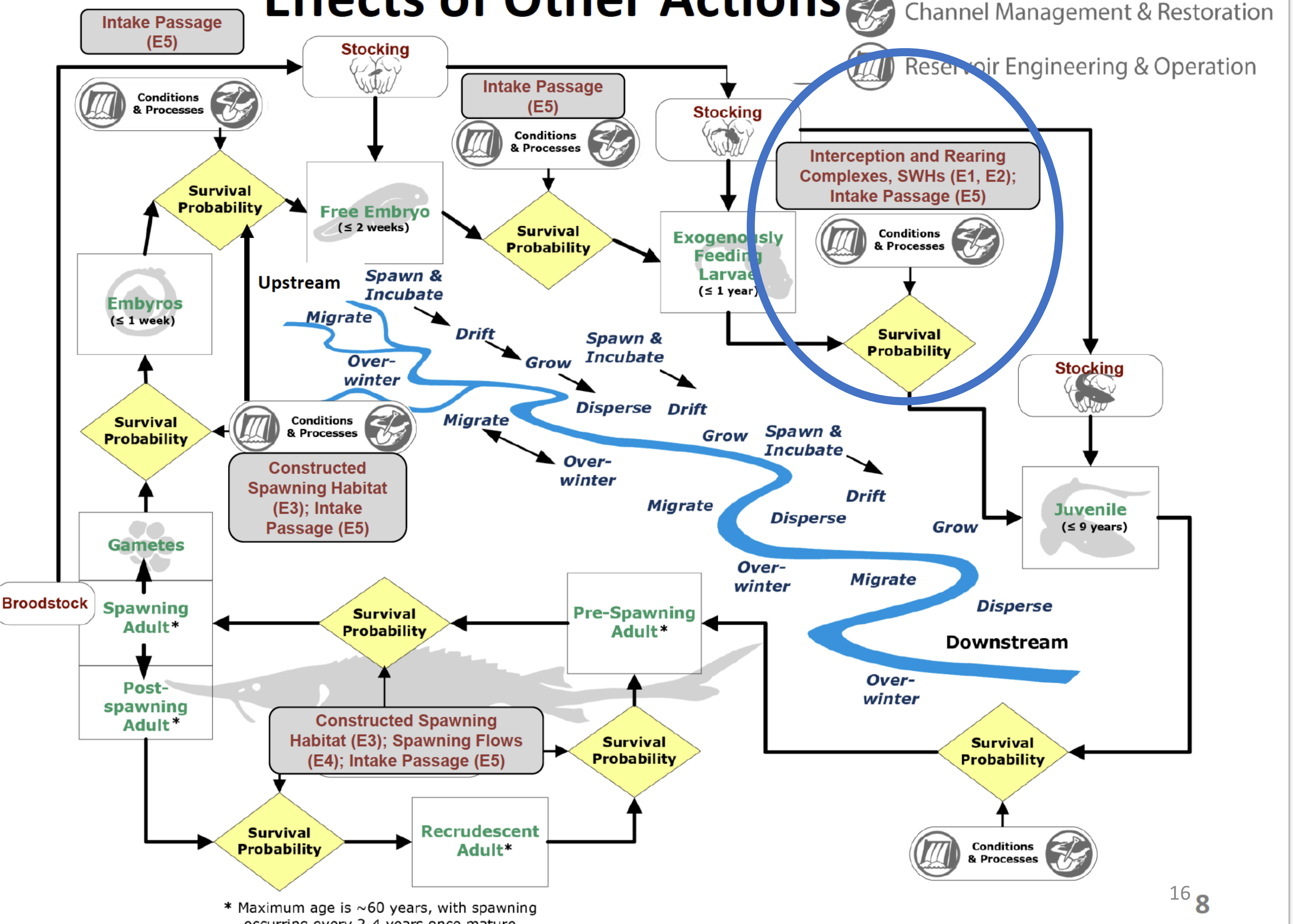
For example, you detect an increase in CPUE of age-1 pallid sturgeon…what was the mechanism?



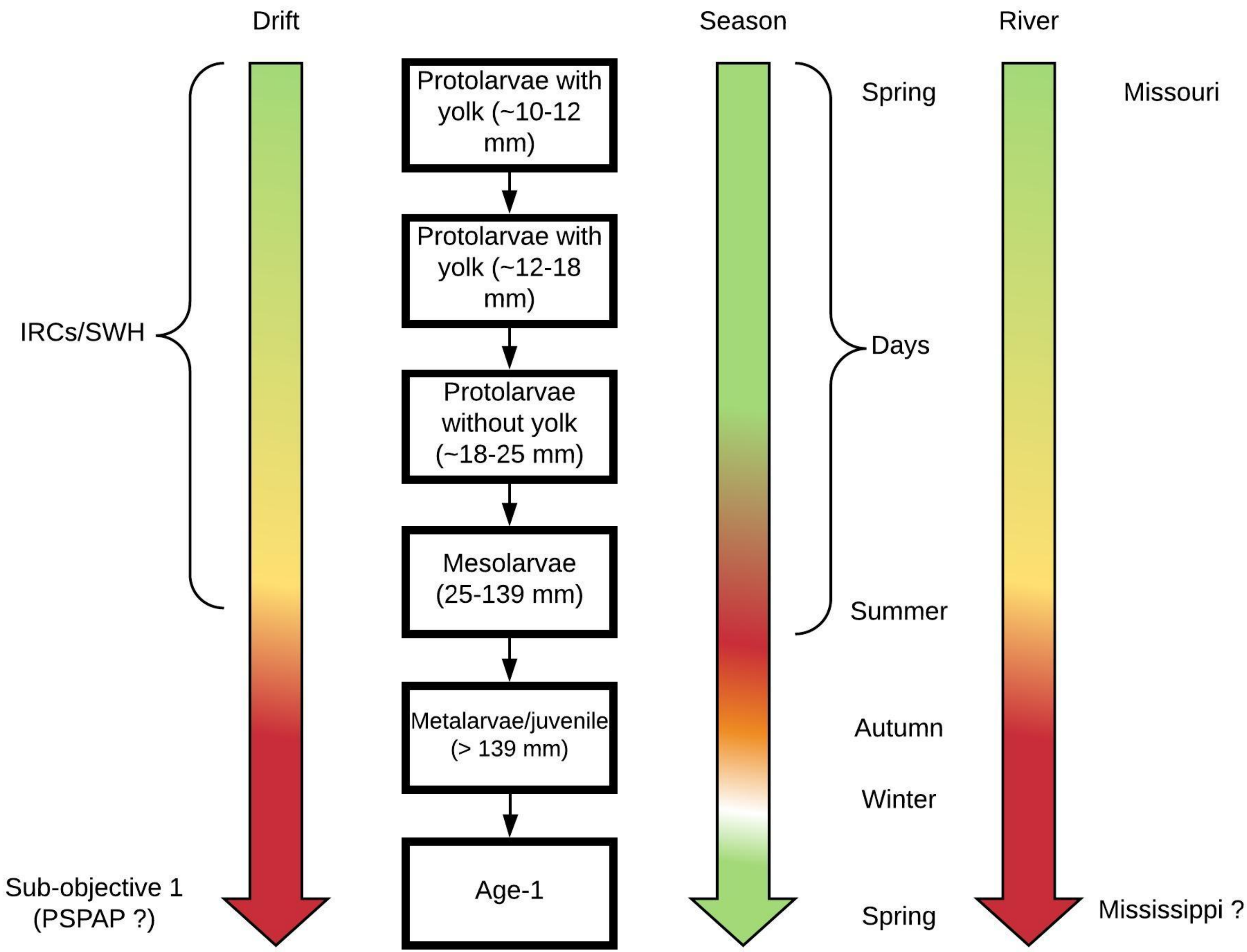
Ultimately, the goal of all management actions, once they have progressed to Levels 3 and 4, is to provide population-level benefits that prevent jeopardy and support recovery of pallid sturgeon in the Missouri River. Since these actions overlap in time and space, and across the life cycle, it will be difficult to evaluate their independent effects on the overall population. Furthermore, although attaining a self-sustaining population is the desired outcome, the population may be decades away from achieving this goal. If natural recruitment were achieved over the next decade, it could still take 20 to 30 years before being able to assess whether the population is self-sustaining due to the late maturity of the species.

Page 504, SAMP appendix E

Effects of Other Actions



Example (ISAP)



How will we know what management action to implement at Level 4 to meet sub-objective 1, when the metrics measured for Levels 1 and 2 science and Levels 2 and 3 effectiveness monitoring where not congruent with sub-objective 1?

How will abundance data of age-1 pallid sturgeon from the PSPAP be clearly linked to Level 2 and 3 studies/management actions?

Should clearly link implementation levels 2 and 3 to target metric and sub-objective 1 or clearly state assumptions about relationship(s) among metrics (i.e., the measured metric versus the metric stated in the sub-objective).

Use resources for the PSPAP to assist in directly monitoring responses to level 2 and 3 actions. (Increase in IRCs -> more age-0 sturgeon -> more age-1 pallid sturgeon)

What specific questions/hypotheses do the data collected below address?

Are these prioritized?

Do these efforts detract from program goals?

Why is hatchery ancillary? Why is Mississippi ancillary?

PSPAP V2.0 Ancillary Objectives

1. **Population structure:** Age structure, Size structure, Maximum size, Sex ratio
2. **Reproductive status:** Egg quality, Reproductive cycling, Age at maturity, spawning aggregation & synchrony, fecundity
3. **Fish health status:** Stress, Contaminants, Fish condition, Abnormalities
4. **Demographic rates:** Predation, Survival, Growth
5. **Movement & habitat selection:** Drift & dispersal, Use of Mississippi River and tributaries, Habitat availability and selectin, spawning habitat availability & selection, movement, IRC habitat, foraging habitat
6. **Genetics**: local adaptation, hybridization, effective population size
7. **Other objectives:** forage fish trends, diet, fish community, competition with native fish, zooplankton density
8. **Hatchery:** Stocking location & numbers, broodstock production, hatchery production, fin curl & other diseases

Reactions to Responses to Selected ISAP Comments from Oct-Nov 2017

Comment 4 (particle tracking model): age-0 distribution and abundance monitored in the constructed IRCs should be used to evaluate the accuracy and reliability of the particle tracking model.

Comment 5 (sediment monitoring): need to establish relationship between mainstem monitoring of suspended sediments and associated sediment transport impacts on IRC geomorphometry.

Comment 6 (physical values defining food and foraging habitat): The proposed Level 1 studies of physical conditions used to define food (e.g., benthic invertebrates) production and age-0 foraging habitat should be performed to support IRC planning and construction or clearly explained why such an effort is not needed.

Comment 7 (time lags in general linear model): addressed mainly as extended time required to demonstrate results of management actions in revised Section E.1.3.1.

Reactions to Responses to Selected ISAP Comments from Oct-Nov 2017 (continued)

Comment 9 (biological significance): the identified monitoring thresholds (e.g., increased CPUE per equation 1 and age-0 survival) need to be incorporated into the pallid population modeling currently being used to help design population-level monitoring; the modeling needs to assess the impacts of these endpoints on pallid population dynamics (i.e., ʎ and self-sustaining population).

Comments 13-14 (power analysis): what is the evidence that the anticipated 80% increase in age-0 CPUE is realistic based on mechanistic understanding of IRC functionality? Important because smaller increases are not likely to be measurable at time scales relevant to management and decision-making, given realistic allocation of resources to monitoring efforts.

Comment 15 (site x time interactions): dominance of the site x time interactions in the overall analysis (eq. 1) can undermine the success of effectiveness monitoring and negate the usefulness of sampling regimes suggested by the Collaborative Population Model applications. Need to reduce the effects of site x time interactions by adding more sites and/or increasing frequency of sampling.

Collaborative Population Model (CPM) – Colvin et al. slides

ISAP encouraged by the substantial progress in CPM development and application (i.e., Colvin et al. presentation — however, need to expand the current emphasis on evaluation of monitoring plans to include assessment of the population-level implications of pallid sturgeon management actions (e.g., IRCs, spawning habitats, spawning cues) – do the model results suggest an 80% increase in CPUE associated with IRCs?

The reliability of the CPM for informing monitoring design might be negatively influenced by the large number of parameters that appear minimally supported by data (e.g., age-0 capture efficiency). This underscores the importance of proposed pilot studies to estimate key model parameter values.

ISAP has concerns regarding weeks of computer time required to perform simulations; limits efficient use of CPM in support of AM decision-making? Make use of ERDC super-computing capabilities?

Complex CPM outputs and their presentation are difficult to understand in terms of pallid population dynamics and informed decision-making; need more concise summaries of model results that enter seamlessly into decision-making.

E.0 Effectiveness Monitoring Overview

The likely success of pallid sturgeon adaptive management is inversely proportional to the timeframe required to ascertain population viability. The anticipated 20-30 year time requirement (p. 504) suggests less emphasis on AM and sustained efforts in population augmentation, the effectiveness of which might be more easily monitored over shorter time periods.

What endpoints will be monitored to demonstrate that IRCs will “minimize bioenergetic requirements” for pallid larvae and juveniles (H18)? What is the quantitative relationship between pallid sturgeon bioenergetics and pallid sturgeon management objectives?

For IRCs, Q1 – need to relate monitoring endpoints of CPUE and growth of age-0 pallid sturgeon to management objectives.

In the appendix E.0.2 (p. 504) it is stated that it will be difficult to determine the effects of multiple overlapping management actions through effectiveness monitoring. If monitoring programs cannot be designed to reliably measure the outcomes of separate management actions, the results of such monitoring will not inform the AM process.

E.0 Effectiveness Monitoring Overview (continued)

p. 505 – need to link effectiveness monitoring to population monitoring described in Appendix D by using the CPM to estimate the anticipated outcomes of individual and multiple management actions.

Tables E.5 – E.7 seem redundant to their respective sections in the Appendix and might be removed.

E.1 IRCs Implementation and Monitoring

The hypothesis that monitoring results for age-0 *Scaphirhynchus* spp. will provide useful information to assess the status and trend for age-0 pallid sturgeon needs to be evaluated early in the effectiveness monitoring program.

It would seem advisable to perform Level-1 studies aimed at elucidating velocity and depth criteria for food production and foraging prior to construction of IRCs (or at least in parallel) to help interpret IRC monitoring results.

Given the long-time period to obtain powerful monitoring results, detailed (e.g., seasonal, annual) measures of lower trophic level productivity (i.e., chironomids) should be implemented following IRC construction to help evaluate the food-foraging hypotheses.

Need to define the criteria that define an IRC as having achieved a fully developed state (p. 538).

E.1 IRCs Implementation and Monitoring (continued)

The site-year interactions (residual error in the linear model) determine the power of the staircase design (p. 544), but are out of the control of the managers – does this imperil the use of IRCs as a management action that can be reliably evaluated by any effectiveness monitoring program?

The presented power analysis appears comprehensive and compelling, but it also underscores the proximate need to estimate the likely response of pallids (i.e., CPUE) to proposed IRC construction. If responses are much less than 80%, monitoring of the effectiveness of IRCs may prove infeasible given realistic allocation of available monitoring resources. The likely magnitude of response needs to be known sooner than later.

The CPM should be used to determine how many IRCs would likely be required to produce measurable increases in λ and a self-sustaining pallid sturgeon population.

E.2 SWH Modifications and Monitoring

Comments above concerning the IRCs largely pertain to the SWH-IRCs as well.

E.3 Spawning Habitat

Support focal questions and testable hypotheses focus on constructed spawning habitat to increase production of viable embryos.

Need to estimate what reproductive output is necessary per unit spawning habitat, given high early life stage mortality, to measurably affect age-1 CPUE and λ - or how much spawning habitat might be required to measurably affect age-1 CPUE and λ?

Seem to have reasonable understanding of the characteristics of quality spawning habitat, but little mention of the anticipated “signal strength” of a single constructed spawning habitat in producing measurable impacts on pallid population dynamics in the MO River. Integrate CPM with spawning habitat construction to begin to address population-level affects of constructed spawning habitat.

Develop empirical relationships between number and location of released reproductive adults and probability of encountering spawning habitat to evaluate the testable hypotheses regarding spawning habitat – especially given the limited number (e.g., minimally 20 males, 10 females) of available reproductive pallid sturgeon.

E.4 Spring Pulsed Flows

Level 1 observational study: if after nine years of monitoring, there appears to be no relation between river flows and spawning, there are two possible conclusions: 1) river flows do not cue spawning by pallids in the MO River or 2) a sufficiently strong flow required to stimulate spawning was not encountered in the 9-yr timeframe. But the monitoring approach cannot determine which conclusion is correct – that is, no information will have been developed to inform AM decision-making or to guide Level 2 studies.

Determine if there is overlap between the permissible (i.e., HCs) magnitude, timing, and duration of pulsed-flows and the characteristics of pulsed-flows that have cued spawning by other sturgeon species, perhaps in other rivers.

E.4 Spring Pulsed Flows (continued)

Use the CPM as soon as possible to help determine population-level implications of increased spawning as a result of managed flows.

Are there any data supporting the likelihood that the unregulated flow regime (Table E28) will cue pallid sturgeon in a Level 2 study?

P. 618 – do the timing constraints (e.g., HCs, impacts on tern and plover nesting) permit an effective Level 2 design of pulsed-flows that are temporally consistent with the known spawning periods of pallid sturgeon?

E.5 Monitoring Design for Upper MO and Yellowstone Rivers

Monitoring efforts on the upper MO River are generally well-described and technical issues of concern have been previously discussed with the ISAP.

p. 658 lines 17-25: rare species, large river, natural variability – “challenge to discern signal from noise..” can the potential for Type II errors be sufficiently reduced to construct an effective monitoring program for the Yellowstone River?

Table E38 – H3: need to define success criteria and complete spawning habitat assessment for the YR upstream of the Intake Diversion Dam.

Table E38 – H4: need to define male aggregation size in relation to spawning success (note current operational definition is 2 or more males).

p. 676 – lines 1-4: any value in reviewing monitoring activities earlier than 7-8 years post Intake construction?

Statistical Analysis of IRCs and SWH-IRCs

Considerable resources will be devoted to constructing and evaluating IRCs and SWH-IRCs over the next two decades, and so a robust statistical framework is essential.

For IRCs (Appendix E.1), the BACI analysis of the staircase design should yield reasonable statistical power in 10-15 years to detect change in CPUE of age-0 sturgeon for the 12 proposed control-treatment pairs.

For SWH-IRCs (Appendix E.2), uncertainty remains as to whether a BACI or simple Before-After analysis will be performed on a subset of the 29 potential sites (currently chutes), given the perceived challenges of implementation (E.2.3.1).

We recommend that, if possible, a BACI design be employed for SWH-IRCs to complement the IRC design and increase statistical power and inference, which is diminished with a Before-After approach that lacks temporal statistical controls.

Further power analysis (Sub-Attachment E.2.A) will help to resolve this issue, and should be a priority given that chute modifications may outpace IRC construction (E.2.3.1).

Habitat Quality of IRCs and SWH-IRCs

A core hypothesis for the MRRP is that shallow channel margins provide both suitable foraging habitat and adequate invertebrate food for age-0 sturgeon (Attachment E.0).

The constructed IRCs and SWH-IRCs are hypothesized to provide such resources for age-0 pallid sturgeon, in the form of reduced hydraulic stress and preferred chironomid midge food (Appendices E.1 and E.2). For example, H17 explicitly addresses "prey abundance" as a significant issue for IRCs (E.1.2 and E.2.2).

Given that hydraulic and geomorphic characteristics of these habitats will be extensively monitored, we suggest some tandem evaluation of invertebrate food resources to allow evaluation of the 'food-producing hypothesis' for age-0 pallid sturgeon.

While acknowledging the potentially expensive and time-consuming nature of benthic invertebrate sampling and analysis, the use of artificial substrates or rapid assessment approaches may be suitable to meet objectives. We note that Appendices E.1 and E.2 both state that a Level 1 study of benthic invertebrates "could be considered" for IRCs and SWH-IRCs (E.1.2 and E.2.2).

Requisite steps in the design and implementation of effectiveness monitoring

1. Specify objectives in terms of measurable attributes.
2. Identify the monitoring state variables (e.g., indicators) and why they were selected.
3. State the spatial and temporal domain (sampling frame) of the population of interest (that is, the sample frame).
4. State the type of change to detect.
5. Specify the magnitude of effect to detect effect size (essential for sample design decisions).
6. Following (5) specify desired precision for the trend estimate (this requires pilot data and a components of variance analysis).
7. Generate estimates of uncertainty.
8. Specify 'trigger point' (thresholds) that will lead to a management response.
9. Specify the management action that will occur.
10. Determine (monitor) the effects of the management actions.
11. Update design as needed—making sure objectives, actions, and metrics align (adaptive monitoring).