Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Using Conceptual Ecological Models as a Framework to Guide Decision Making for the LCR MSCP

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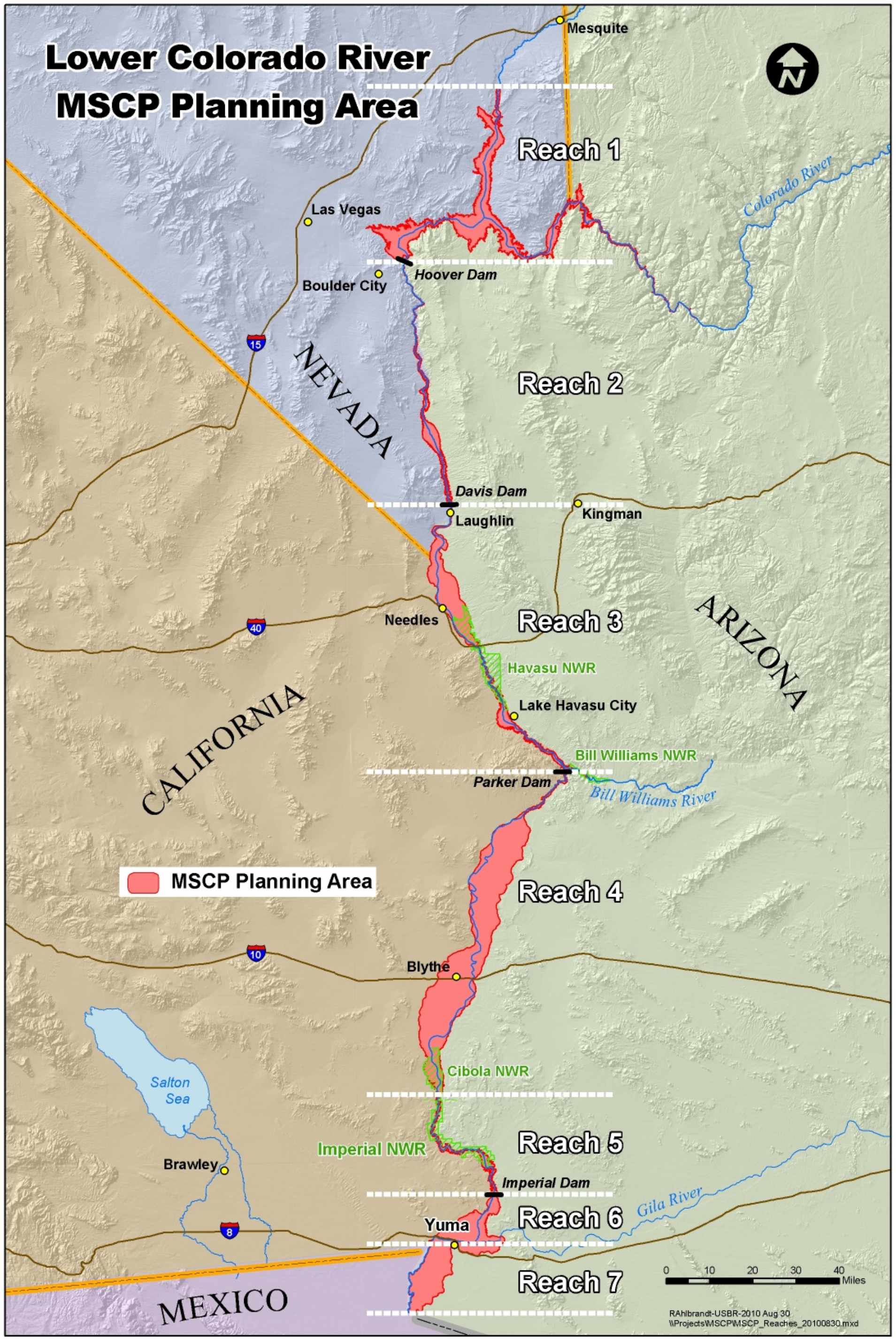


Lower Colorado River
MSCP Planning Area
Mesquite
Reach 1
Colorado River
Las Vegas
Hoover Dam
Boulder City
15
NEVADA
Reach 2
Davis Dam
Laughlin
Kingman
Needles
40
Reach 3
ARIZONA
Havasu NWR
Lake Havasu City
CALIFORNIA
Bill Williams NWR
Parker Dam
Bill Williams River
MSCP Planning Area
Reach 4
Blythe
10
Cibola NWR
Salton Sea
Imperial NWR
Reach 5
Brawley
Imperial Dam
Reach 6
Gila River
Yuma
8
Reach 7
0 10 20 30 40 Miles
MEXICO
RAhlbrandt-USBR-2010 Aug 30
\\Projects\MSCP\MSCP_Reaches_20100830.mxd

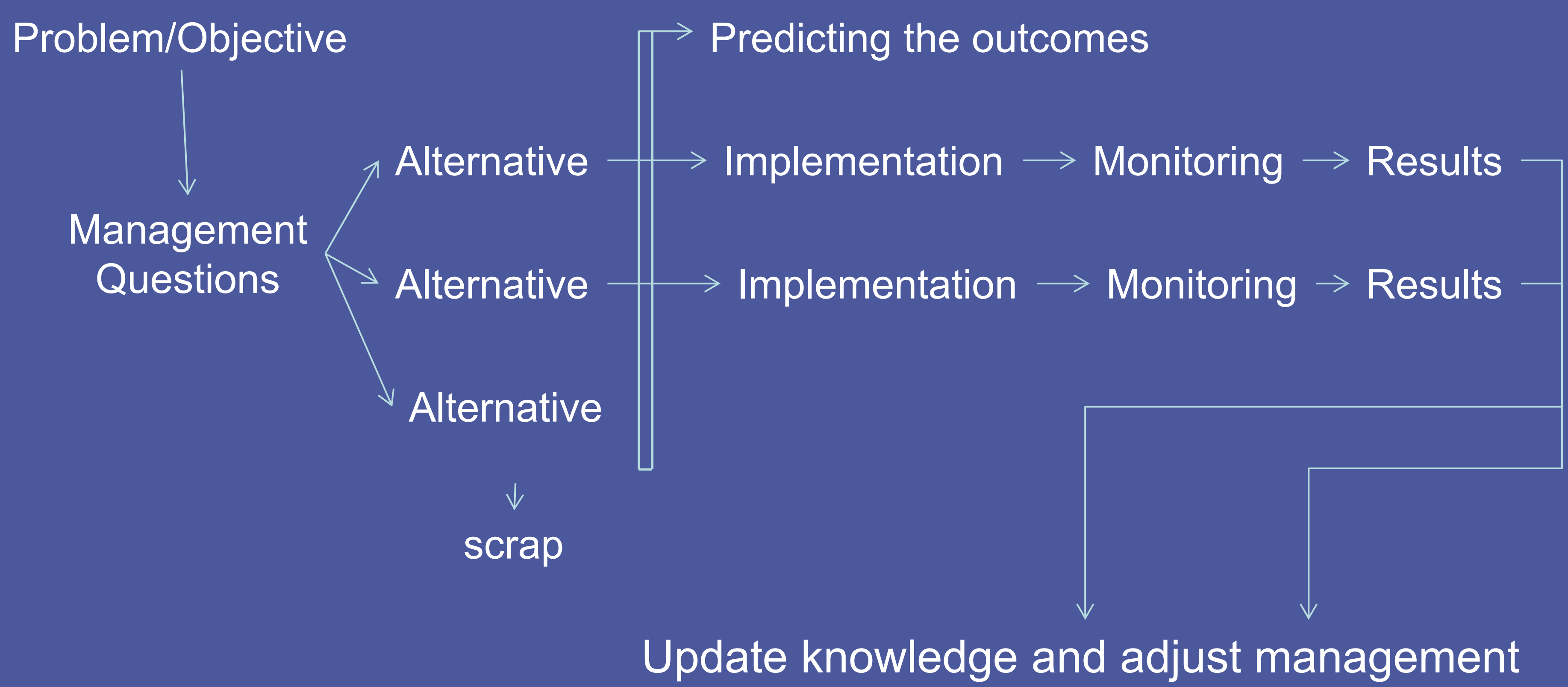
AMP Short Term Goals

- Build an AM framework
- Ensure research and monitoring projects can answer management's questions and needs

LCR MSCP AMP’s

- Creating an explicit link between the science activities and restoration site management
- A framework for meeting HCP conservation measures
- Demonstrate a process for getting there

Adaptive Management Approach



MSCP AMP

"Adaptive Management is the process whereby management is initiated, evaluated, and refined"

FWS 5-Point Policy states "AM is a method for examining alternative strategies for meeting measurable goals and objectives, and then, if necessary adjusting future conservation mgmt actions based on what is learned"

AMP

- "Provides objective scientific data and analyses on which to base management decisions…provide for professional scientific reviews to evaluate management's effectiveness"

LCR MSCP 2005

Science Strategy

- Program-level and project-level AM

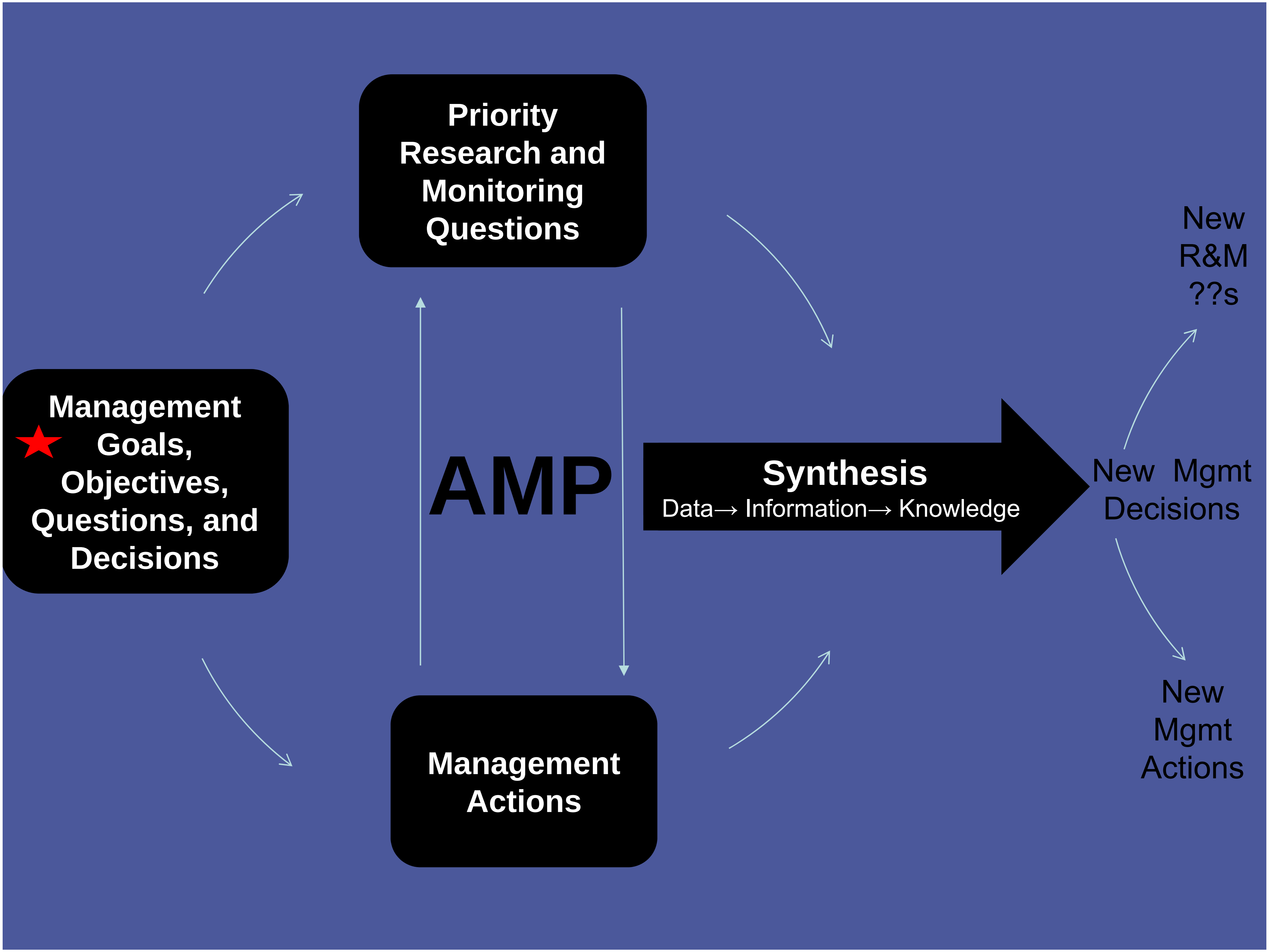
- “Both levels of adaptive management rely on the initial receipt of new information, the analysis of that information, and the incorporation of the new information into the design or direction of future work tasks”

What AM is not:

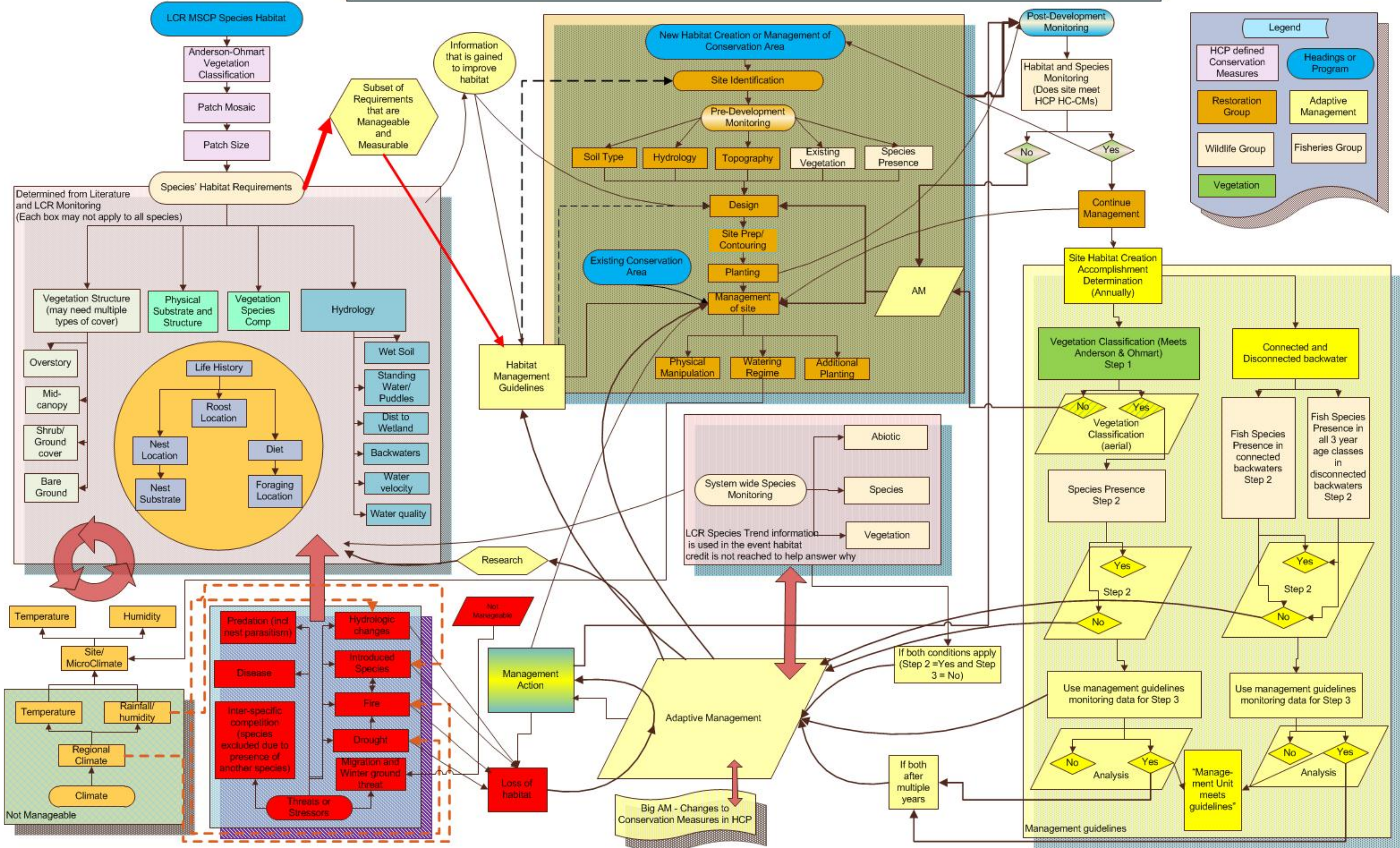
" A trial and error process, rather a process that clearly incorporates learning into the management process.

AM answers why a project succeeded so that it can be replicated, or

why a project failed and what needs to be done to succeed in subsequent actions


Priority Research and Monitoring Questions
Management Goals, Objectives, Questions, and Decisions
AMP
Synthesis
Data→ Information→ Knowledge
Management Actions
New R&M ??s
New Mgmt Decisions
New Mgmt Actions

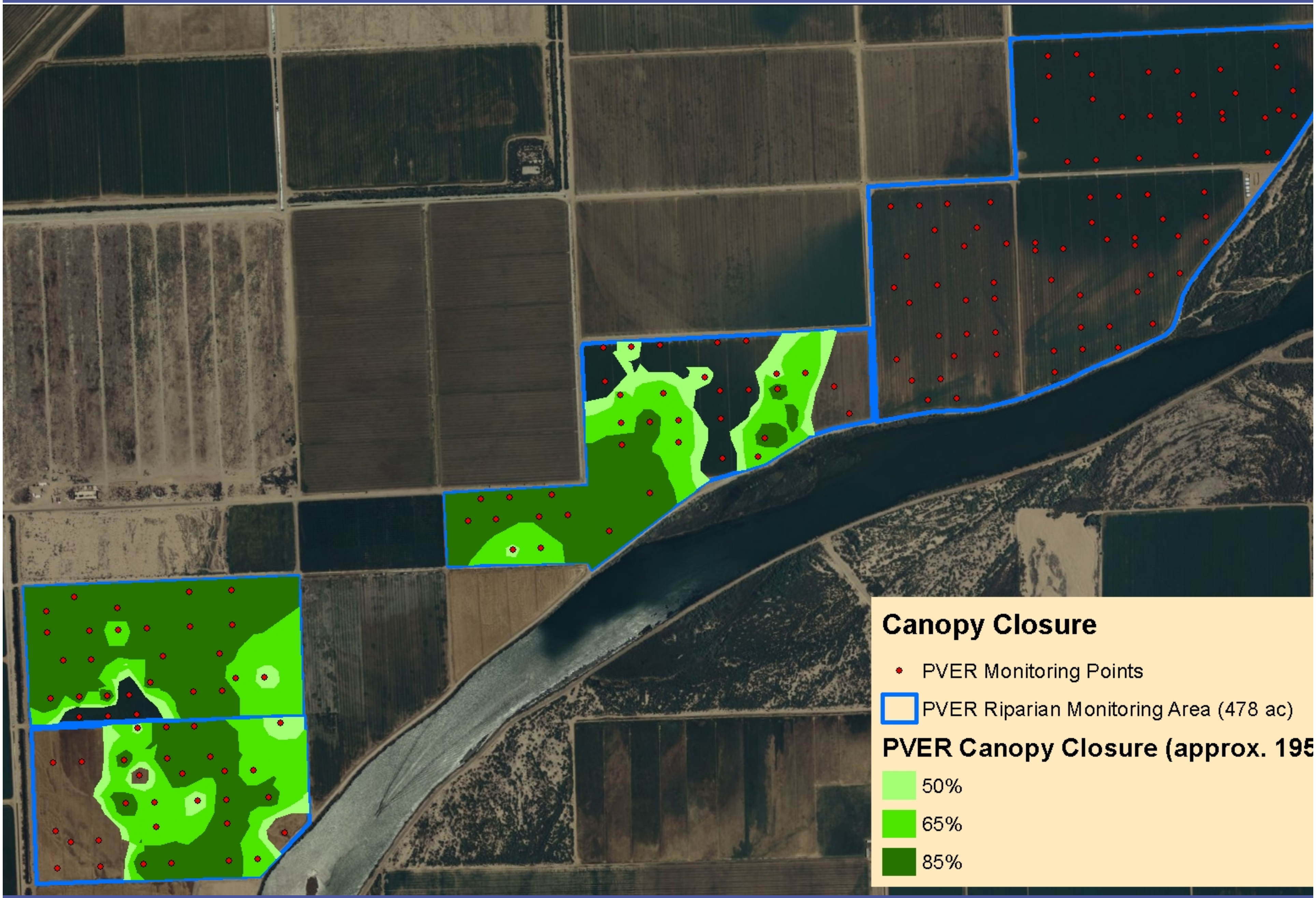
LCR MSCP Habitat Creation Accomplishment Process

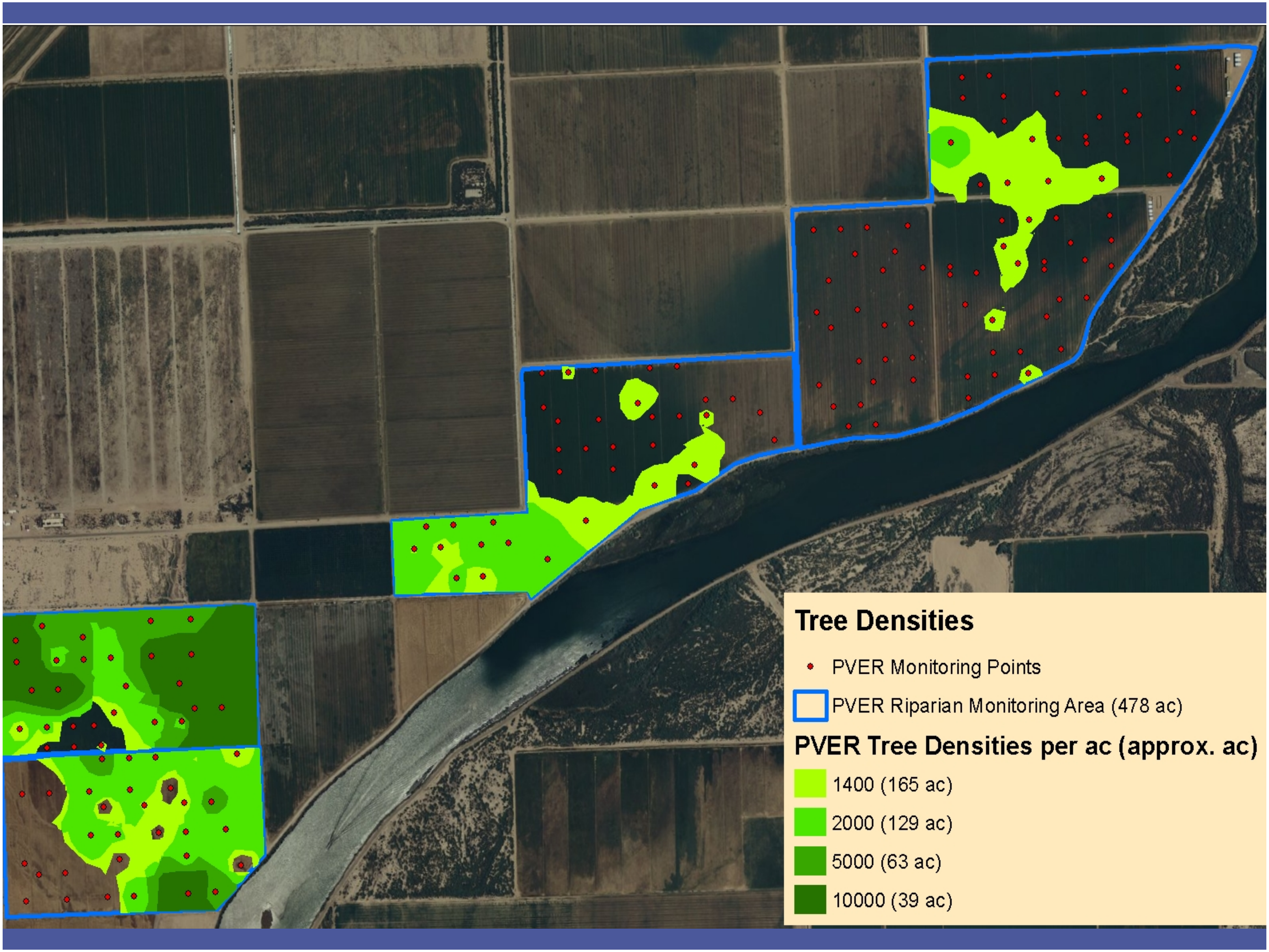


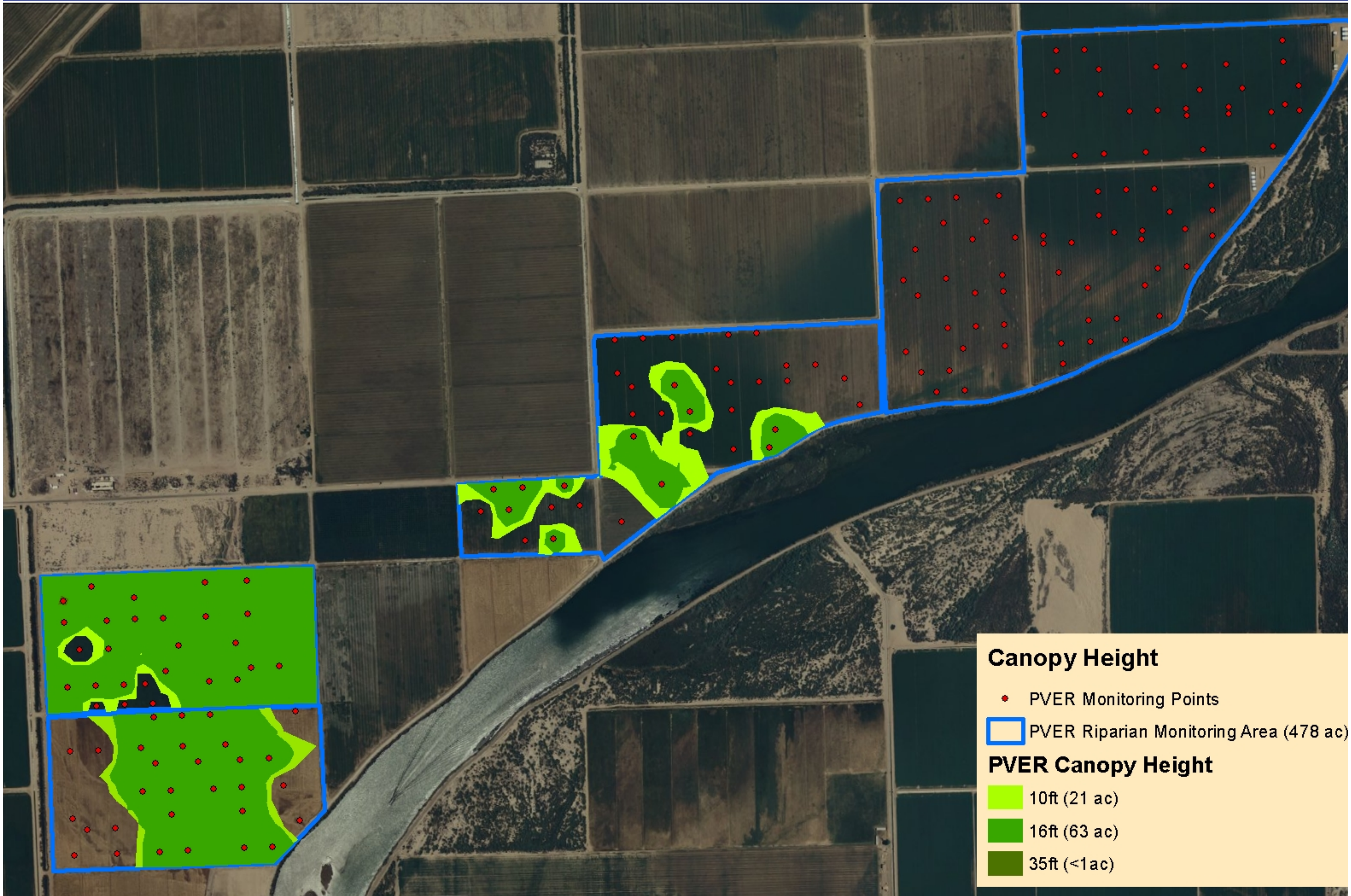
Management Guidelines

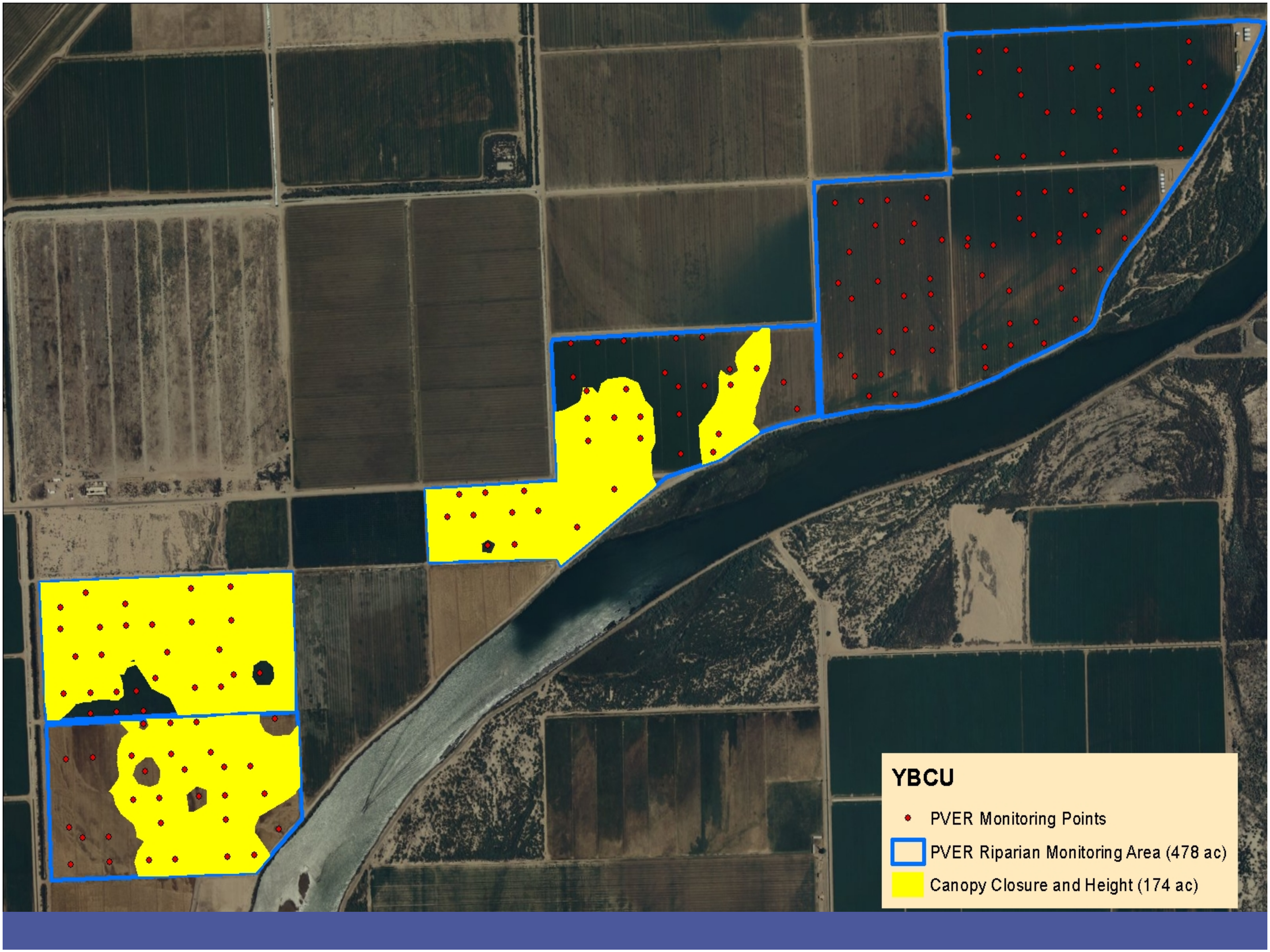
- Management Guidelines = Minimum habitat parameters

- Site Management Guidelines


Canopy Closure
PVER Monitoring Points
PVER Riparian Monitoring Area (478 ac)
PVER Canopy Closure (approx. 195
50%
65%
85%

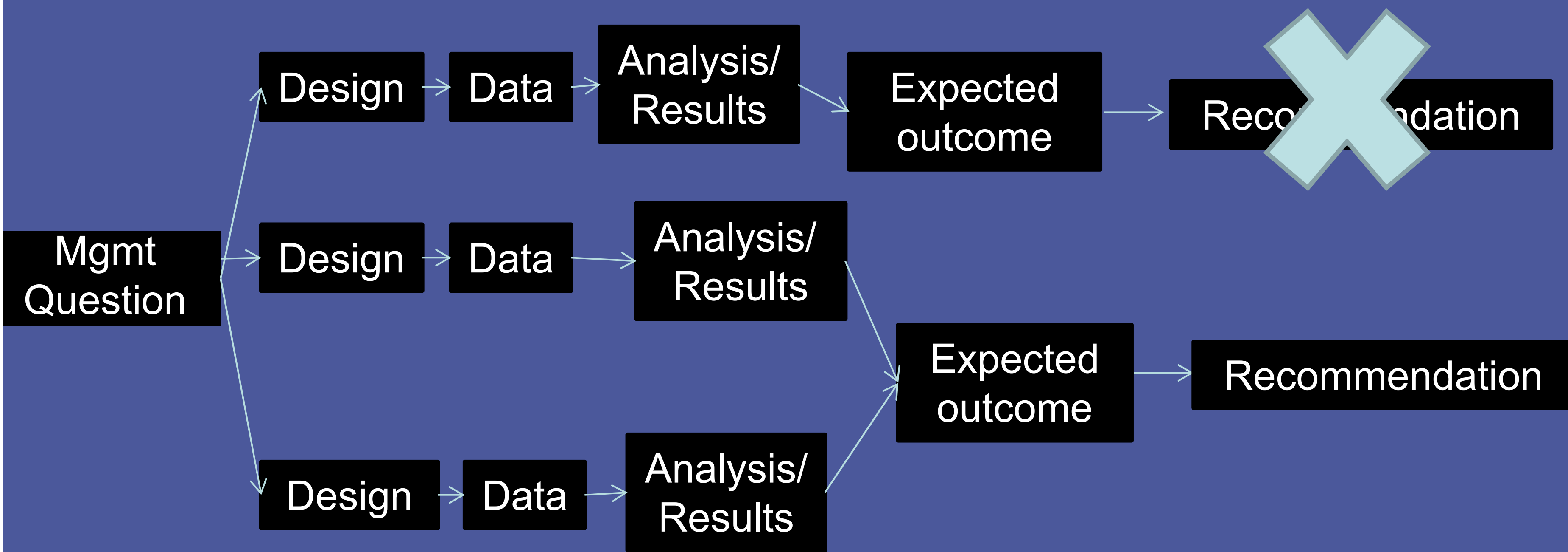

Tree Densities
PVER Monitoring Points
PVER Riparian Monitoring Area (478 ac)
PVER Tree Densities per ac (approx. ac)
1400 (165 ac)
2000 (129 ac)
5000 (63 ac)
10000 (39 ac)


Canopy Height
PVER Monitoring Points
PVER Riparian Monitoring Area (478 ac)
PVER Canopy Height
10ft (21 ac)
16ft (63 ac)
35ft (<1ac)


YBCU
PVER Monitoring Points
PVER Riparian Monitoring Area (478 ac)
Canopy Closure and Height (174 ac)

Lessons Learned

- Building an AM Framework is key.
  - Regulators, Implementers, Managers, Researchers, Resources
- Use of Structured Decision Making prior to implementation of projects
- Ensuring Research and Monitoring Projects can answer Management's questions and needs



What does this mean to Management?

How will the results be used or implemented by Management?

What effects could Recommendations have on Management?

Conceptual Ecological Models

- Using LCR MSCP species conceptual models in adaptive management
- Review of LCR MSCP species conceptual model methodology

Why do we need CEMs

- Create an explicit link between the science activities and restoration site management

- A framework for meeting LCR MSCP's conservation measures

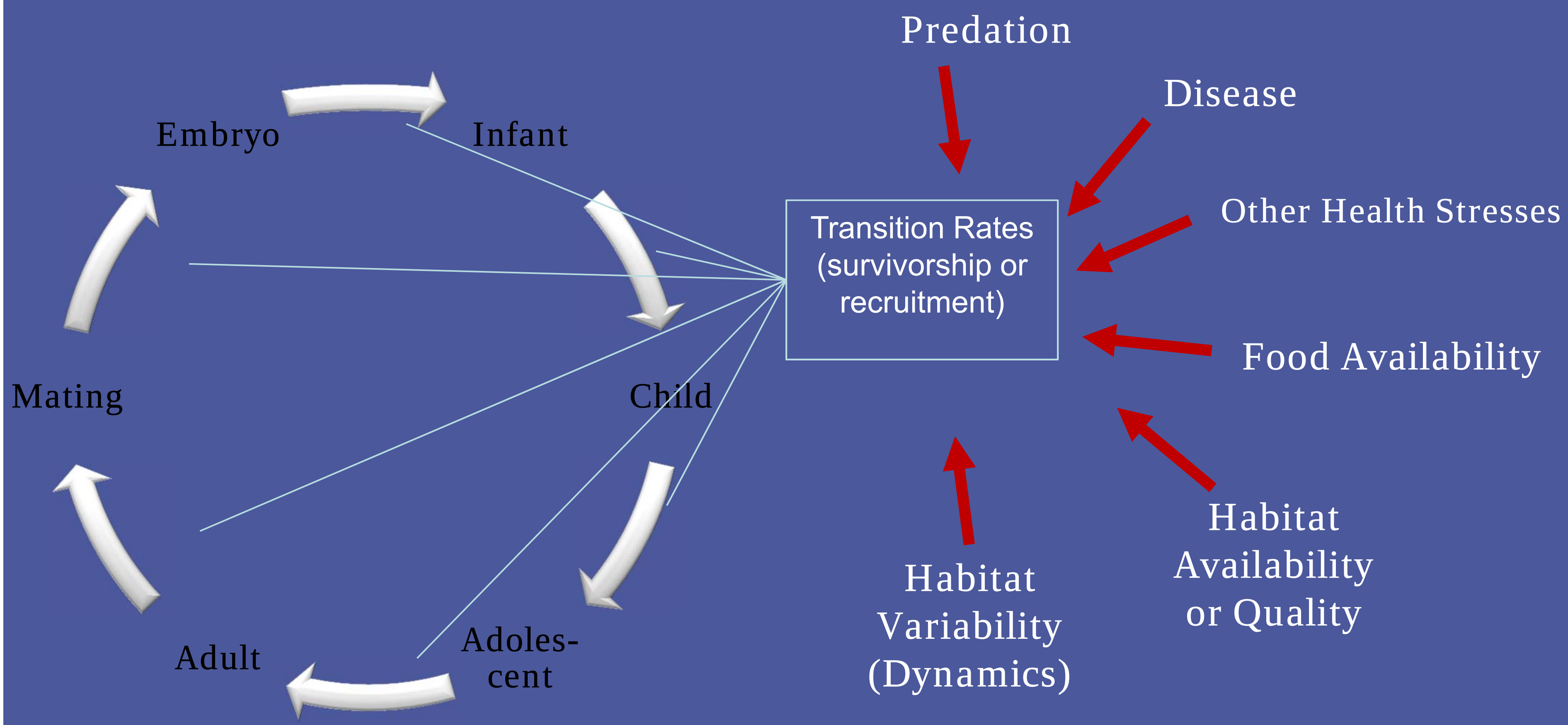
LCR MSCP Species Conceptual Model Methodology

- Follows current best practices:
  - USFWS “Structured Decision Making”
  - USACE (e.g., Missouri River Recovery Program)
  - Sacramento-San Joaquin Delta Ecosystem Restoration Program (formerly “CALFED Bay-Delta Program)
    - Partners include Reclamation
- Incorporates information from databases, literature, and experts

How Conceptual Ecological Models Support Adaptive Management

- Identify monitoring needs
- Identify crucial knowledge gaps
- Provide a framework for identifying potential management experiments to …
  - Improve resource condition
  - Increase knowledge of how resource "works"
- Provide a framework for working in "novel ecosystems"

Species Life History: Natural Stresses



LCR MSCP Species Conceptual Model Framework

- Life stages
  - Cover entire life cycle
- Life-stage outcomes
  - Survivorship and reproduction
- Critical biological activities & processes
- Critical habitat elements
- Controlling factors
- Causal relationships

Life Stages

- Biologically distinct portions of the life cycle of a species, identified from literature
- Individuals …
  - undergo developments in body form & function…
  - engage in behaviors…
  - use sets of habitats, and/or…
  - interact with their larger ecosystems…
  - in ways that differ from those of other life stages
- Need not span similar amounts of time in the overall life cycle.

Critical Biological Activities & Processes

- May be different for each life stage
- Consist of
  - Activities in which species *must* engage to sustain an acceptable rate of transition
  - Biological processes that critically shape rate of transition (+ or –)
- Examples: mating; foraging; predation; disease; avoiding other specific hazards; nesting; egg maturation; seed germination

Critical Habitat Elements

- May be different for each life stage
- Specific habitat conditions that…
  - Are necessary or sufficient for the critical activities and processes to take place, or…
  - Can interfere with these critical activities and processes
- May have specific ranges of suitable values affecting critical biological activities or processes

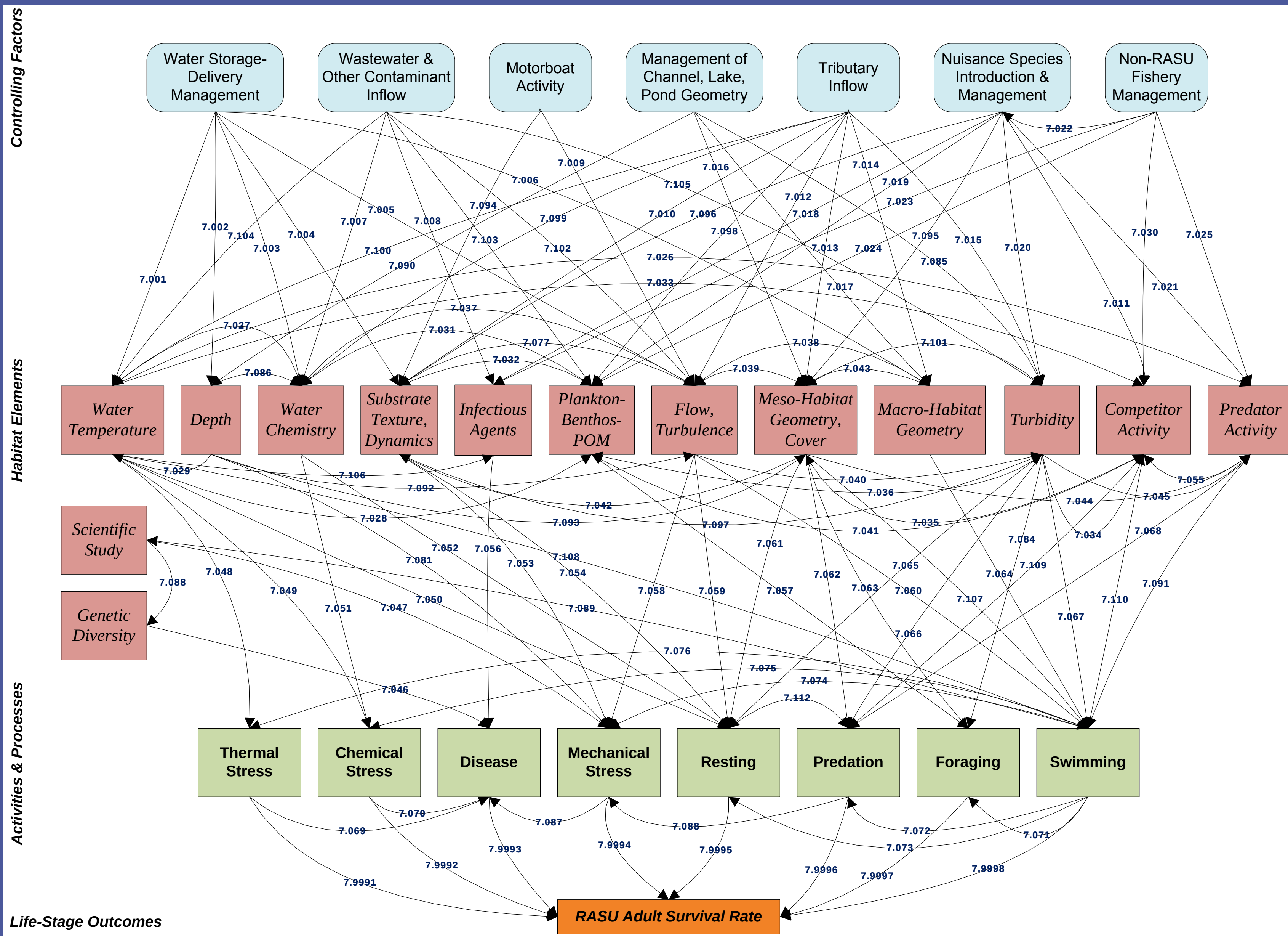
Controlling Factors (*aka* "Drivers")

- Determine the abundance, spatial and temporal distribution, and quality of critical habitat elements
- Natural and anthropogenic factors, including resource management
- May differ among life stages
- May be a hierarchy of such factors, affecting the system at different scales of time and space

Causal Relationships (links)

- Identifies how each model component (node) affects or is affected by others
- Effect: Distribution, abundance, condition, or rate of *affected* node depends on distribution, abundance, condition, or rate of *causal* node
- May differ among each life stages
- Form "causal chains" or "causal networks"
- Identify *direct* relationships
  - Indirect relationships addressed via causal "networks"

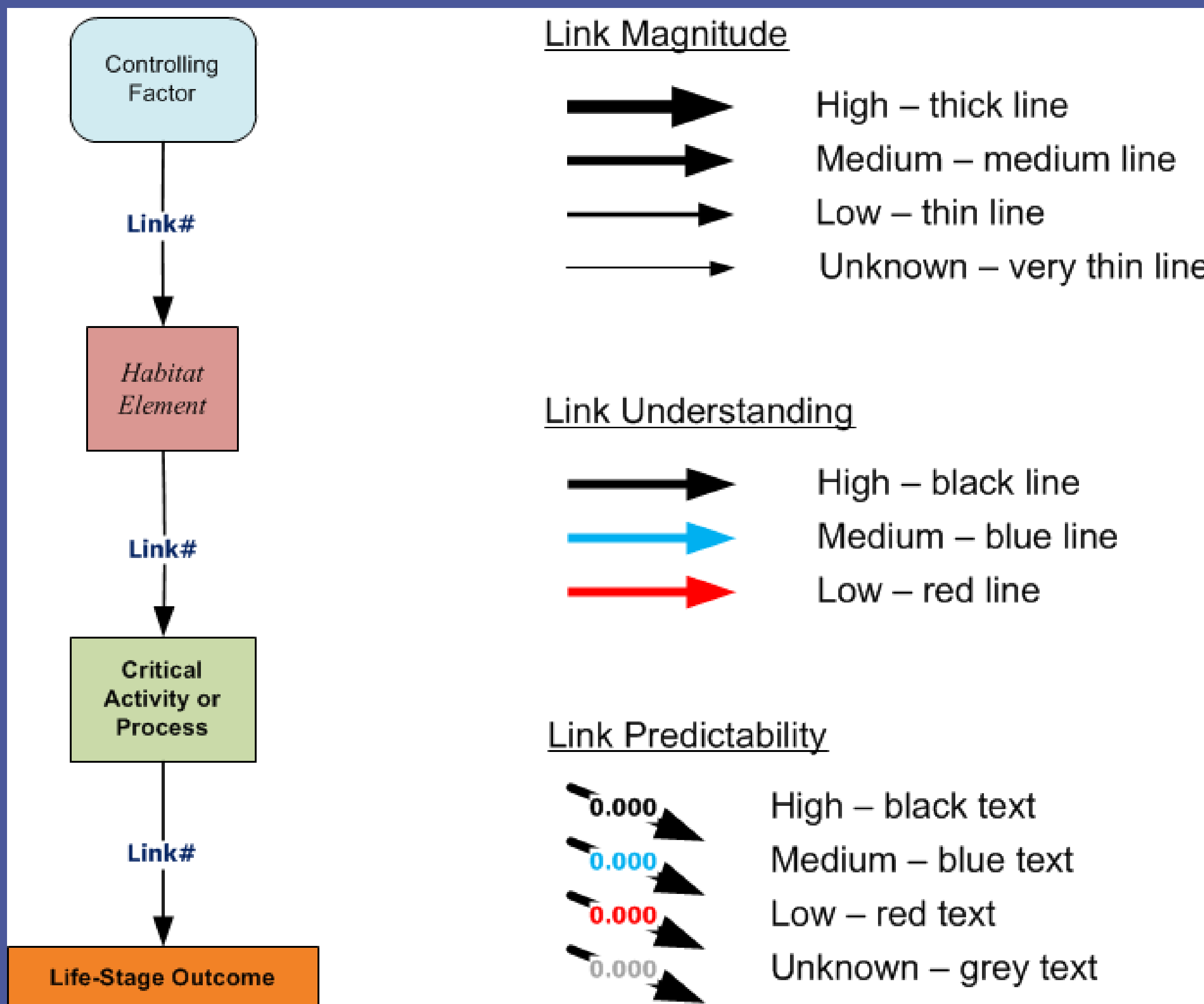
Example CEM Diagram: RASU Adult Life Stage



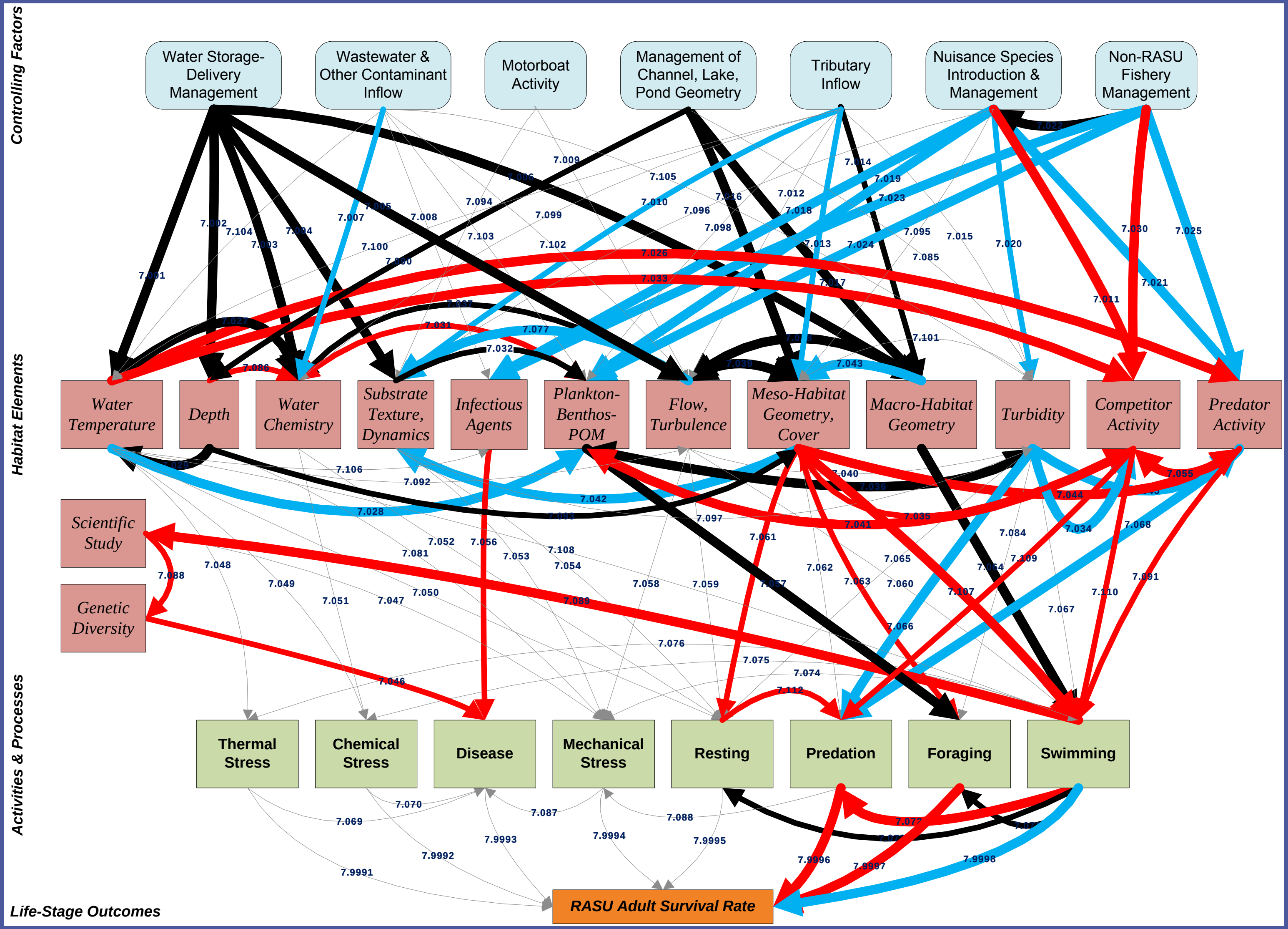
Assessing Causal Relationships (Links)

- Links identified in spreadsheet
- Each link assessed on four dimensions
  - Character (direction)
  - Magnitude
  - Predictability
  - Understanding
- Magnitude, Predictability, Understanding rated (High, Medium, Low, Unknown)
- Ratings based on standard definitions & guidance
- All reasoning documented in spreadsheet and report

CEM Diagram Conventions



Example CEM Diagram: RASU Adult Life Stage



Spreadsheet-Based Assessment & Documentation of Causal Links

Microsoft Excel - RASU CEM Master 2013-09-09.xlsx

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	LCR MSCP Conceptual Ecological Model: RASU Life Stage 03, Dispersing Larvae									N of Links =	102											
2	Link Identification								Link Character		Link Magnitude					Link Predictability		Link Understanding		Discussion		
3	Specie	Link#	Life Stage	Causal Node Type	Causal Node	Effect Node Type	Effect Node	Linkage Reason	LC.Type	LC.Reason	I.Scale	S.Scale	T.Scale	Avg.Mag	LM.Reason	LP.Rank	LP.Reason	LU.Rank	LU.Reason	Management Questions	Research Questions	Other Con
67	RASU	3.61	Dispersing Larvae	Habitat_Element	Flow, Turbulence	Activity_or_Process	Swimming	Dispersing larvae swim into and out of different parts of the flow velocity field to control their drift; sensing velocities and turbulence is therefore crucial for their shaping their drift. But they have limited ability to swim out of velocity fields or zones of turbulence due to their limited size and strength.	Complex	See Linkage Reason	High:Large:Long-Term	Low:Small:Short-Term	Low:Small:Short-Term	1.67	See Link Character Reason. In addition, if flow velocities or turbulence exceed larval capabilities to avoid, there would be a strong effect; but especially in the regulated river such conditions will too rare and localized to significantly affect swimming behavior.	High	This should be a consistent relationship, affected mostly by the size and strength of the individuals as these affect their ability to avoid potentially stressful situations. Unpredictability may arise only through the effects of (rare but likely widespread) effects from extreme flow conditions due to anomalously abruptly altered, high, or low water releases; and through the effects of turbulence from	High	This relationship seems well understood, in principle, and has been studied to some extent in the UCRB, but might benefit from additional study in the LCR w/r/t how the larvae interact with drift velocity fields (see Link 3.60)	How does the distribution and abundance of resting and settling habitat along the drift path affect in-situ survivorship of dispersing larvae, in relation to drift current velocities and spatial patterns?		
68	RASU	3.62	Dispersing Larvae	Habitat_Element	Meso-Habitat Geometry, Cover	Activity_or_Process	Resting	Dispersing larvae may identify suitable or unsuitable resting locations based in part on meso-habitat form, especially the availability of cover	Complex	See Linkage Reason	High:Large:Long-Term	Medium:Intermediate:Medium-Term	Medium:Intermediate:Medium-Term	2.33	Dispersing larvae may survive better if they are able to exploit a range of meso-habitats and cover conditions which provide them with shelter from high-velocity flows and turbulence and from predators. They have some ability to control – within limits – their interaction with velocity fields, i.e., to control their pattern of drift and when/where they seek shelter. Whether the opportunities for doing so are spatially and temporally limited or not will depend on	Medium	This relationship should have high importance for the survival of dispersing larvae and their finding suitable resting and resettlement sites. Its predictability conceivable is affected by flow conditions and macro-habitat geometry, and possibly by turbidity, which may provide visual "shelter" as an alternative to the physical shelter of "cover" per se.	Low	The literature does not provide much information on resting or resettlement site preferences/preferred characteristics along the LCR, in contrast to the studies in the UCRB. And the flows and habitat patterns of the UCRB are quite different from in the LCR.	How does the distribution and abundance of resting and settling habitat along the drift path affect in-situ survivorship of dispersing larvae, in relation to drift current velocities and spatial patterns?		
69	RASU	3.63	Dispersing Larvae	Habitat_Element	Meso-Habitat Geometry, Cover	Activity_or_Process	Predation	The types and abundance of cover at resting sites and along movement pathways will affect the vulnerability of dispersing larvae to predation	Complex	See Linkage Reason	High:Large:Long-Term	Medium:Intermediate:Medium-Term	Medium:Intermediate:Medium-Term	2.33	See Link Magnitude Reason for Link 3.62.	Low	This relationship should have high importance for the survival of dispersing larvae and their finding suitable resting and resettlement sites. Its predictability conceivably is affected by flow conditions, macro-habitat geometry, possibly by turbidity (which may provide visual "shelter" as an alternative to the physical shelter of "cover" per se), and predator use of the same meso-habitat	Low	We don't know enough to predict exactly how this relationship would affect dispersing larvae because different predators use different meso-habitats and their associated cover in different ways, current knowledge of which has not been compiled for the LCR.	MSCP probably needs to inventory the predators on RASU and assess their ecology to better understand whether there are ways to enhance habitat for RASU that would not also enhance habitat for its predators.		
70	RASU	3.64	Dispersing Larvae	Habitat_Element	Meso-Habitat Geometry, Cover	Activity_or_Process	Foraging	The types and abundance of cover at resting sites and along movement pathways will affect the larval foraging, to the extent that use of cover is part of larval foraging behavior	Complex	See Linkage Reason	High:Large:Long-Term	Medium:Intermediate:Medium-Term	Medium:Intermediate:Medium-Term	2.33	Dispersing larvae presumably survive better if they are able to exploit meso-habitats along their drift and movement pathways that provide them with suitable forage opportunities and cover to use during foraging. The literature for the LCR does not indicate that dispersing larvae have high specificity for specific meso-habitat types for foraging other than the shallow-water, slow-	Low	This relationship should have high importance for the survival of dispersing larvae. Its predictability conceivably is affected by flow conditions, and possibly by turbidity, which may provide visual "shelter" as an alternative to the physical shelter of "cover" per se.	Low	We don't know enough to predict exactly how this relationship would affect dispersing larvae because current knowledge of this aspect of larval ecology has not been compiled for the LCR.	What are the foraging behaviors and meso-habitat conditions favoring (or deminishing) foraging among dispersing larvae in the LCR?		
	RASU	3.65	Dispersing Larvae	Habitat_Element	Meso-Habitat Geometry, Cover	Activity_or_Process	Drifting	The spatial distribution of meso-habitat types shapes the potential flow paths for drifting larvae	Complex	Dispersing larvae may benefit from drift pathways that bring them in contact with a specific suite of meso-habitat types, at some minimal density and with some minimal proximity along the flow path. The experiences of scientists in the UCRB and along the	High:Large:Long-Term	Medium:Intermediate:Medium-Term	Medium:Intermediate:Medium-Term	2.33	See Link Character Reason	Medium	The predictability of this relationship depends on the proximity and distribution of suitable meso-habitat along the flow path relative to the	Medium	The principles involved in this interaction are well understood, but the subject does not appear to have been studied specifically for the LCR. Studies mention that the distribution and proximity of suitable resting and settling habitat along	How does the distribution and abundance of resting and settling habitat along the drift path affect in-situ survivorship of dispersing larvae, in relation to drift		

TOC 01 02 03 04 05 06 07 08 Std.Lists Spp.Lists X-check

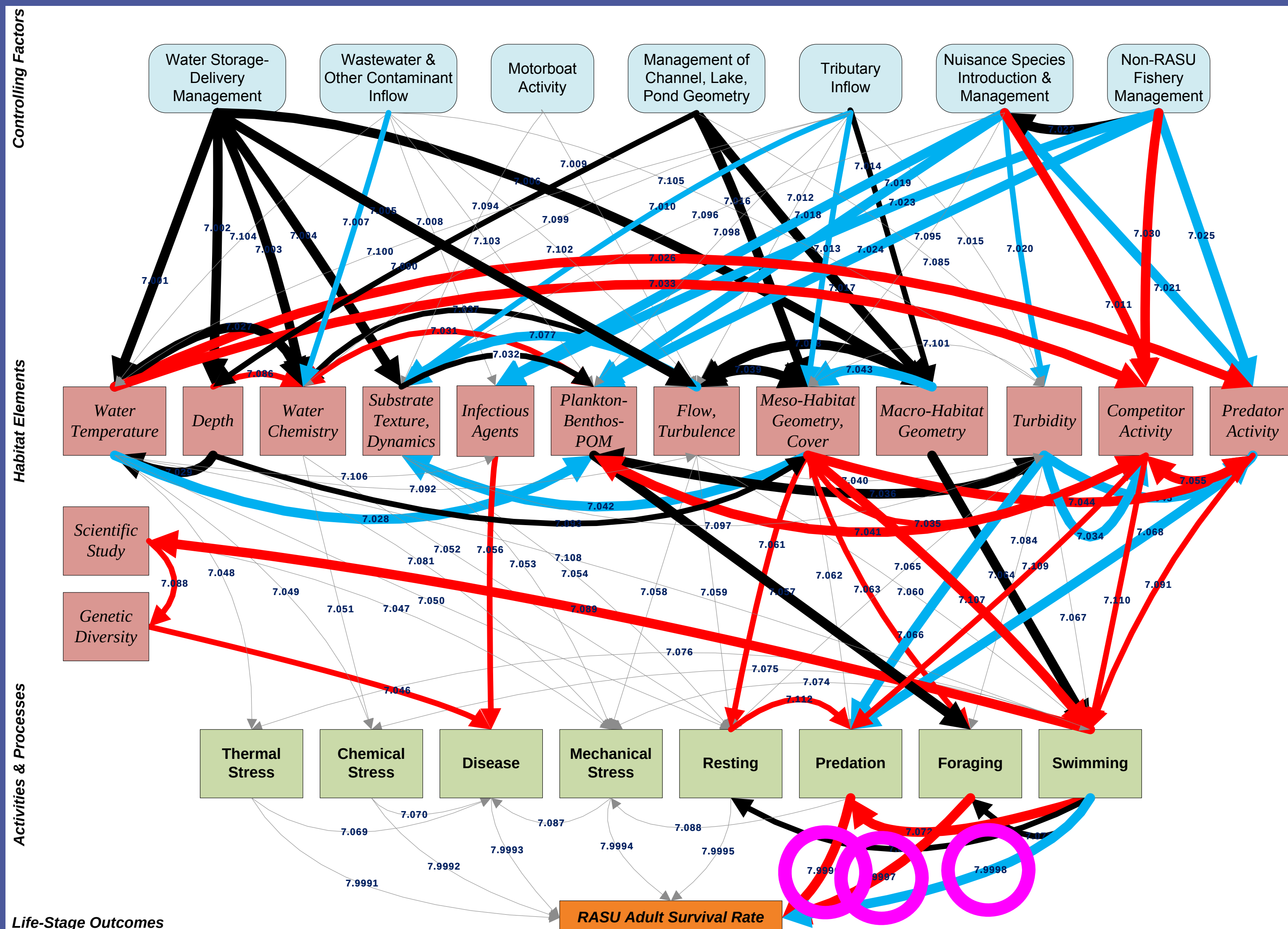
Identifying Management & Research Questions

- Focus on potential critical gaps in knowledge
  - "Critical" = potential impact on management actions
  - Gaps may be in basic knowledge or simply in field monitoring or data integration
- Focus on potential opportunities for management experiments even where knowledge is high, if intervention has not been tried

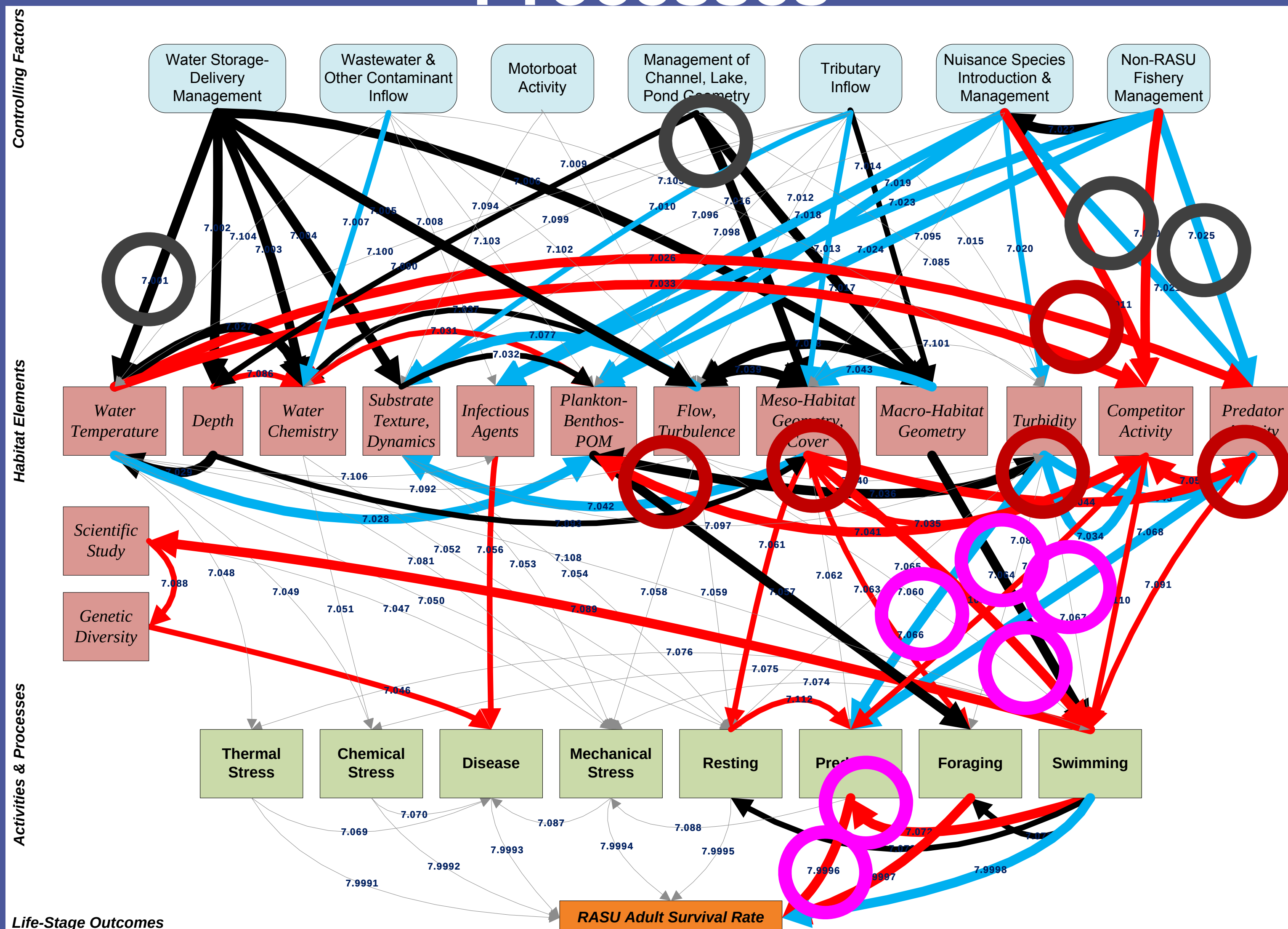
Using CEM Diagrams to Ask Adaptive Management Questions

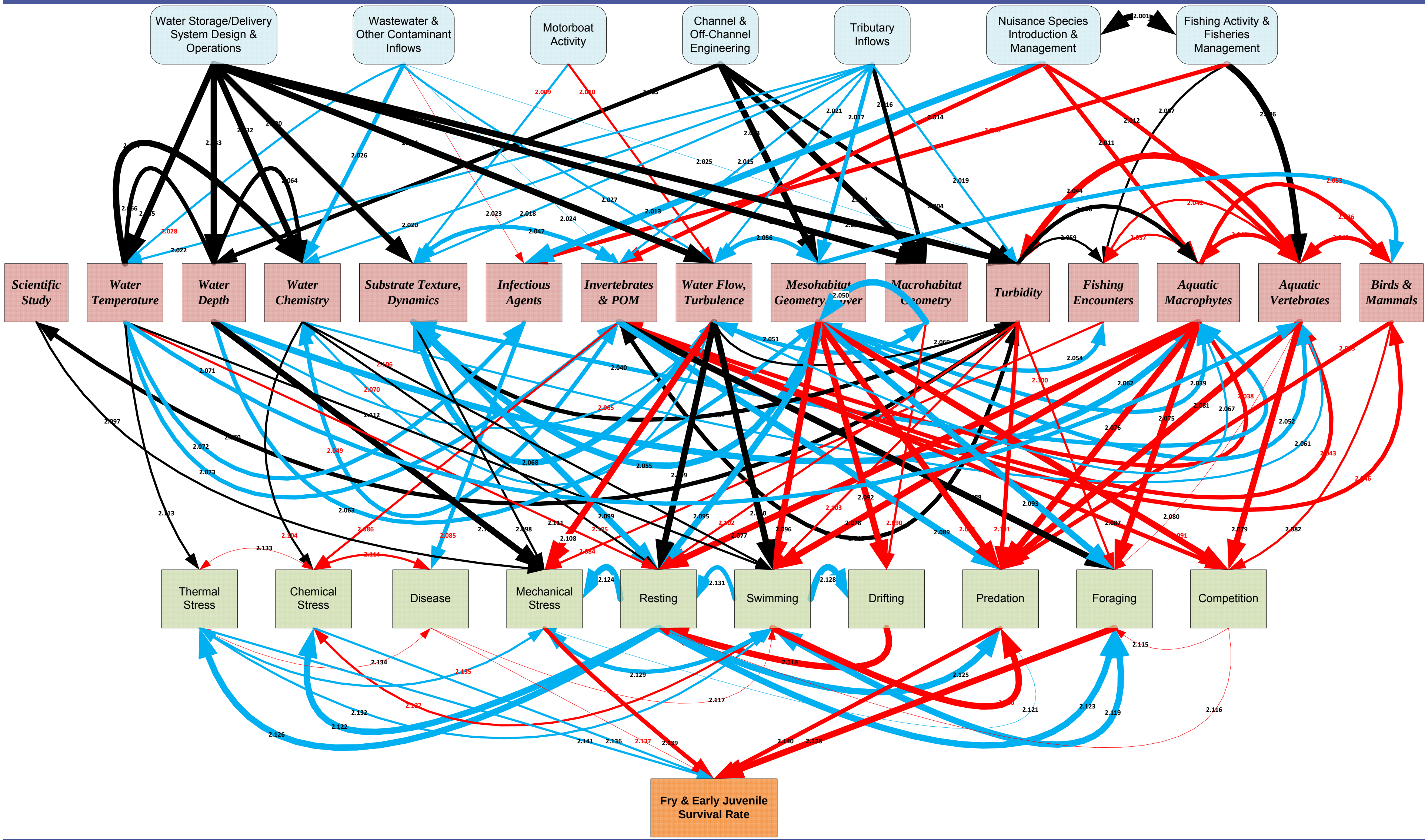
- Four examples:
  1. What critical activities or processes most strongly affect life-stage outcome for Life Stage X?
  2. Which of these most influential relationships are the least understood for this life stage?
  3. What habitat elements most strongly affect the most influential activities or processes?
     a. Directly affect
     b. Indirectly affect
  4. Which controlling factors most strongly affect the most influential habitat elements?

Most Influential Activities or Processes

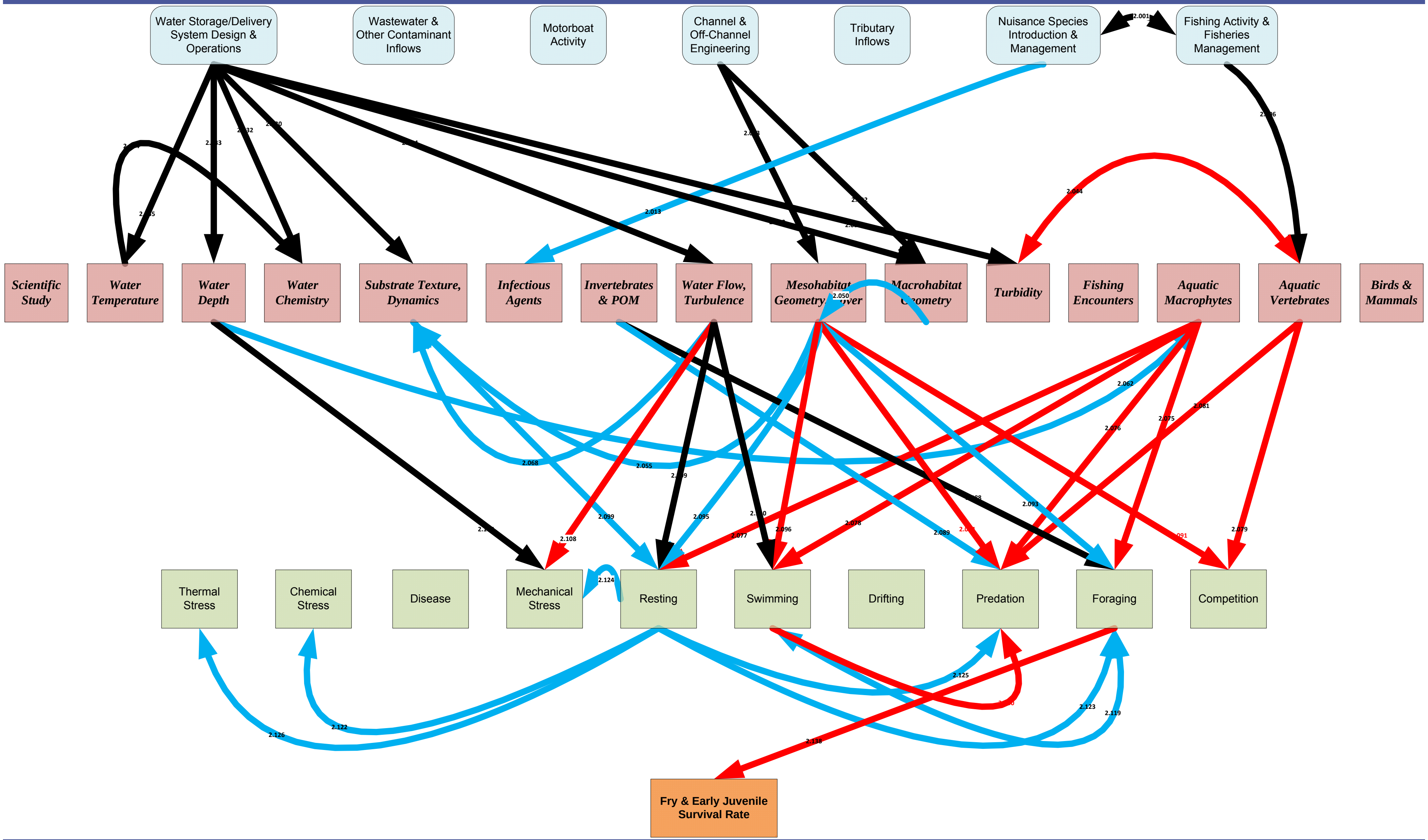


What Causal Nodes Most Strongly Affect the Most Influential Activities or Processes

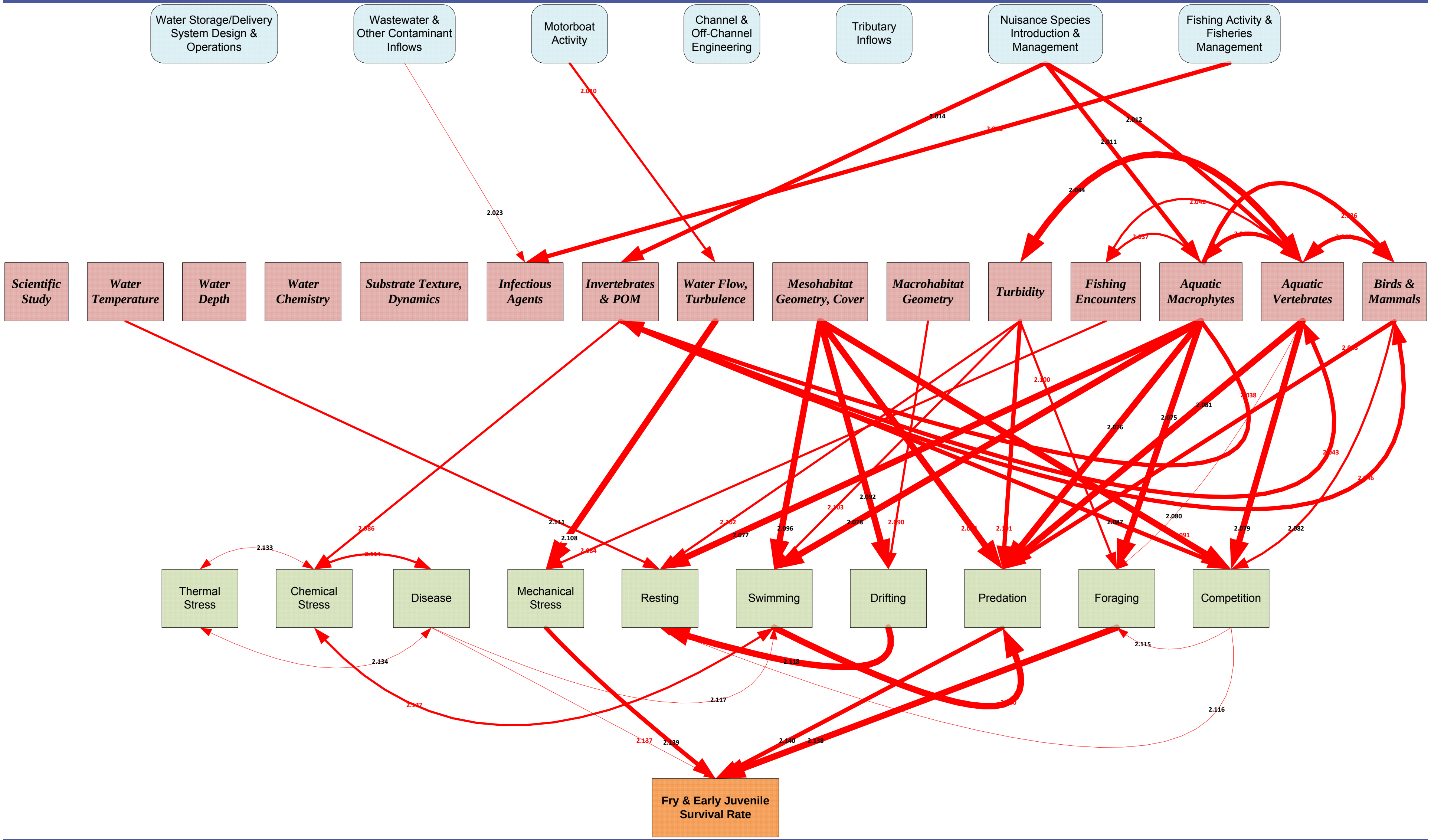




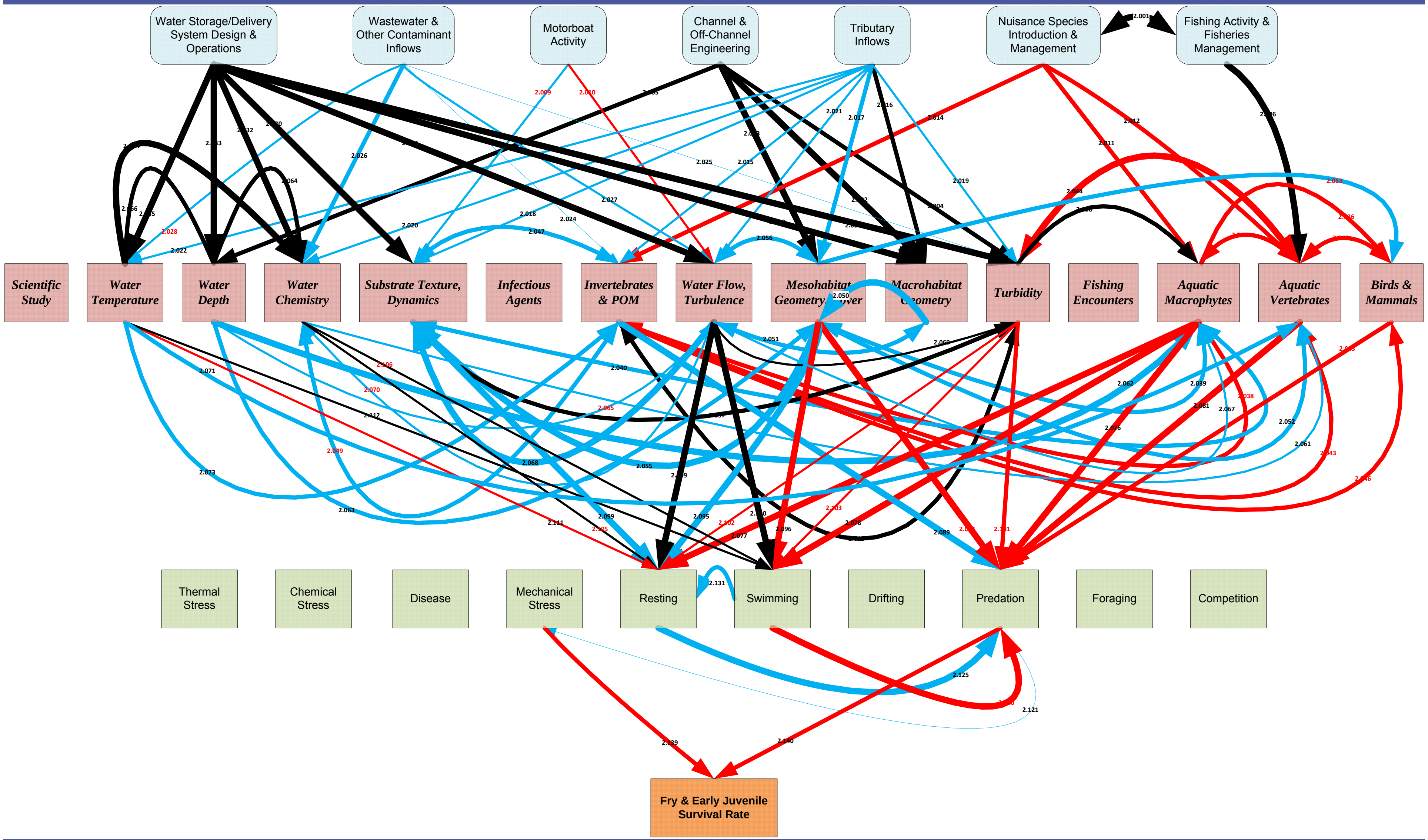
FLSU Fry & Early Juvenile Life Stage, “Master” Model



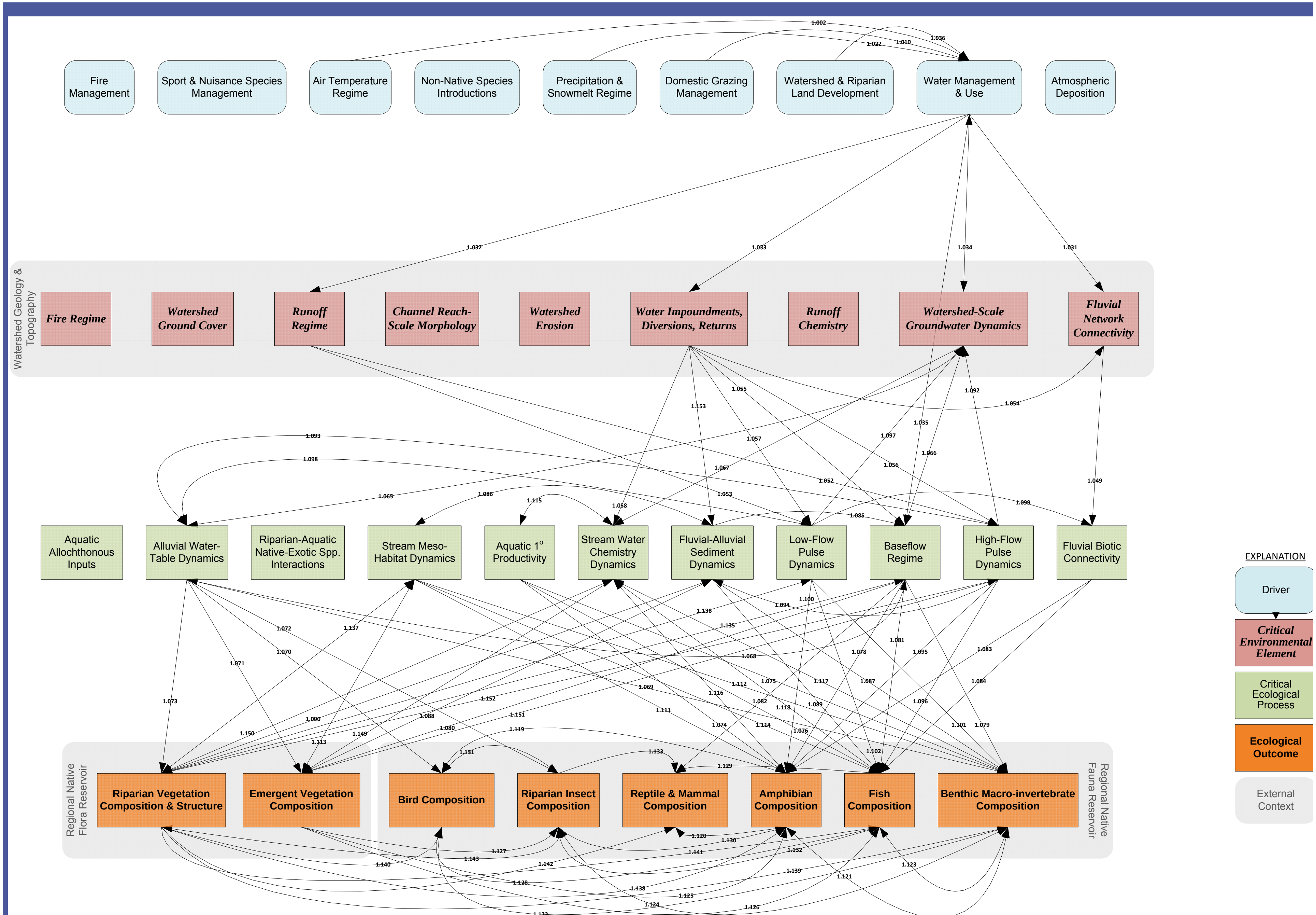
FLSU Fry & Early Juvenile Life Stage, “High-Magnitude” Causal Relationships



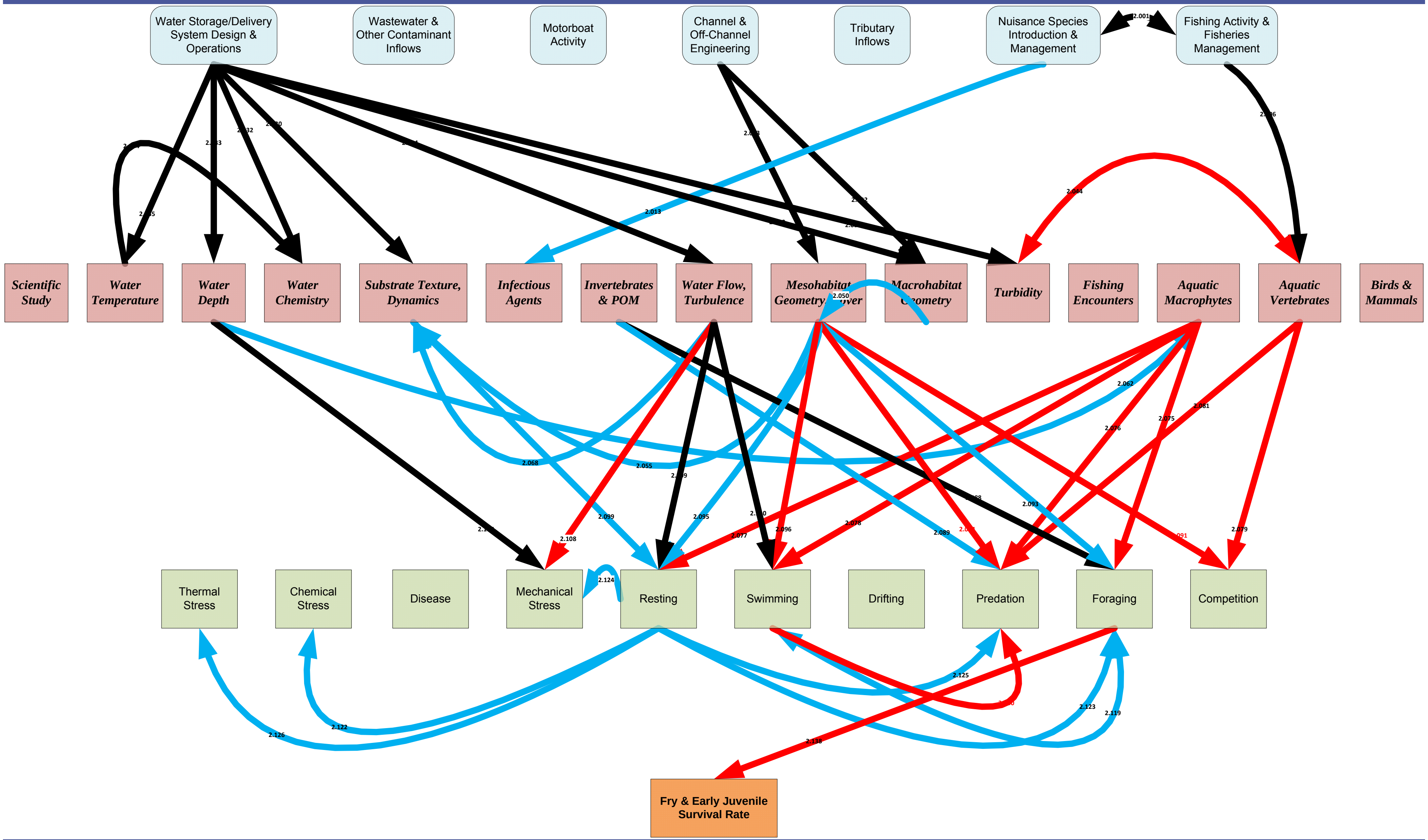
FLSU Fry & Early Juvenile Life Stage, “Low Understanding” Causal Relationships



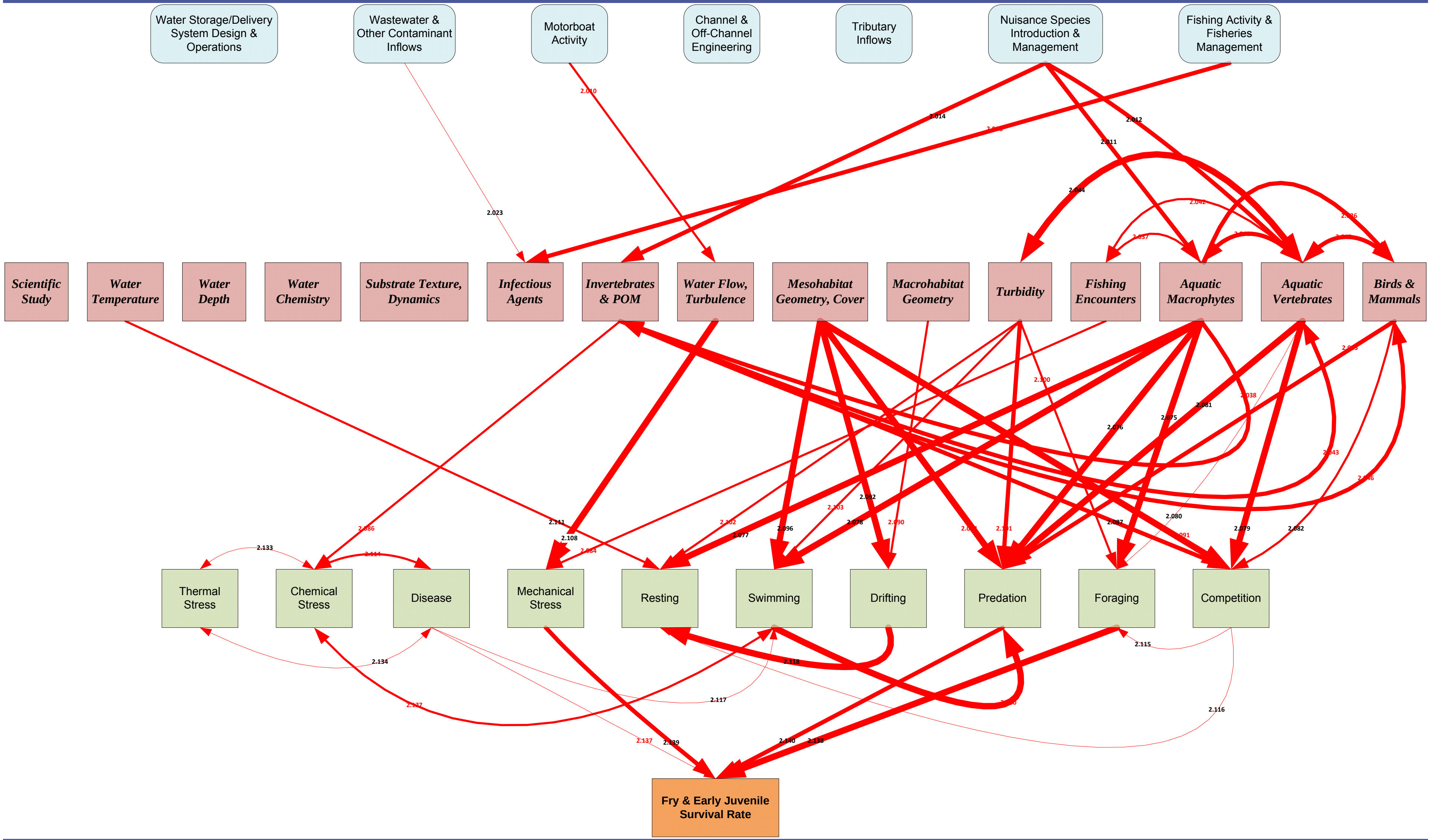
FLSU Fry & Early Juvenile Life Stage, “Predation” Causal Relationships



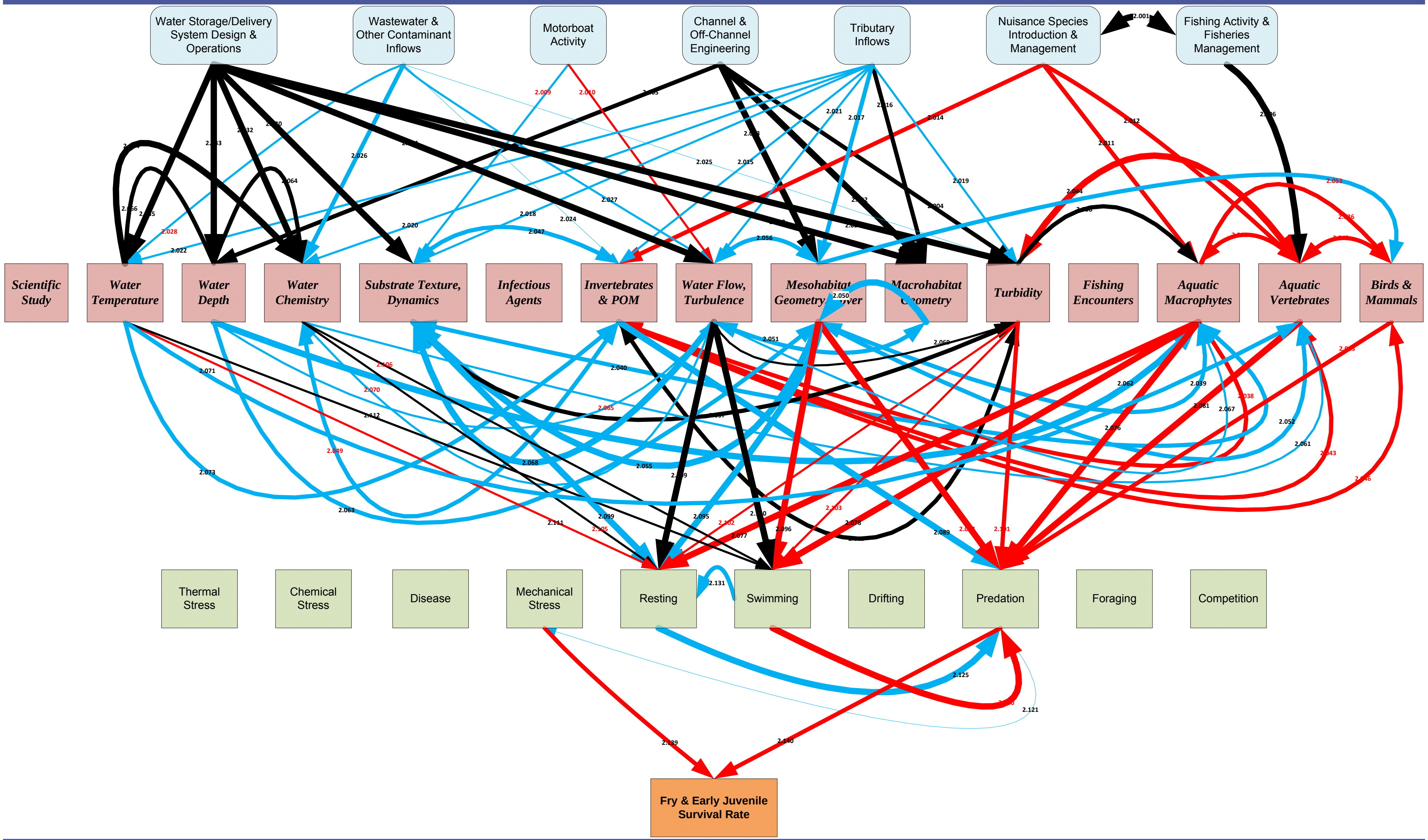
“Water Management” Stressor-Outcome Sub-Model



FLSU Fry & Early Juvenile Life Stage, “High-Magnitude” Causal Relationships



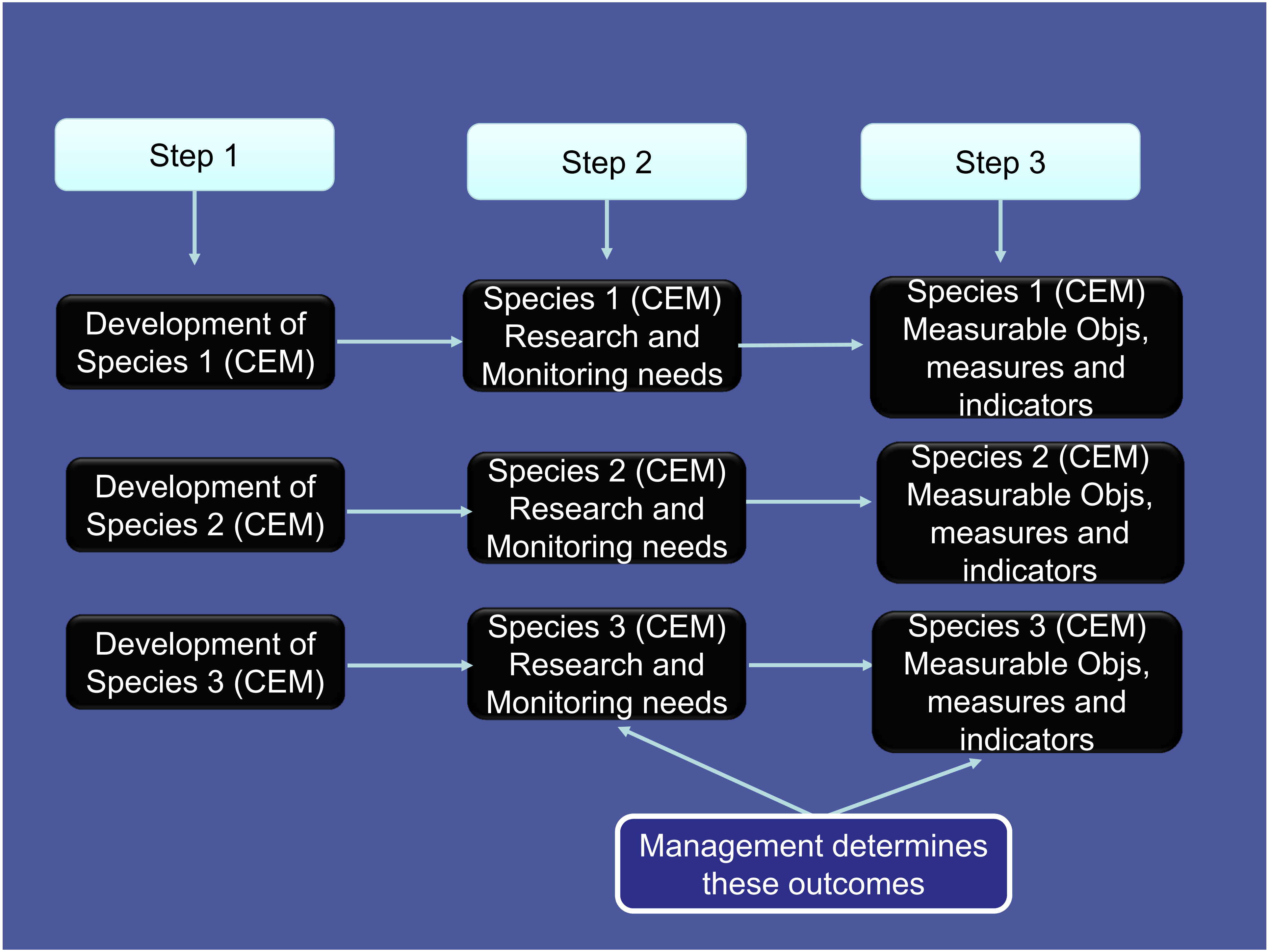
FLSU Fry & Early Juvenile Life Stage, “Low Understanding” Causal Relationships

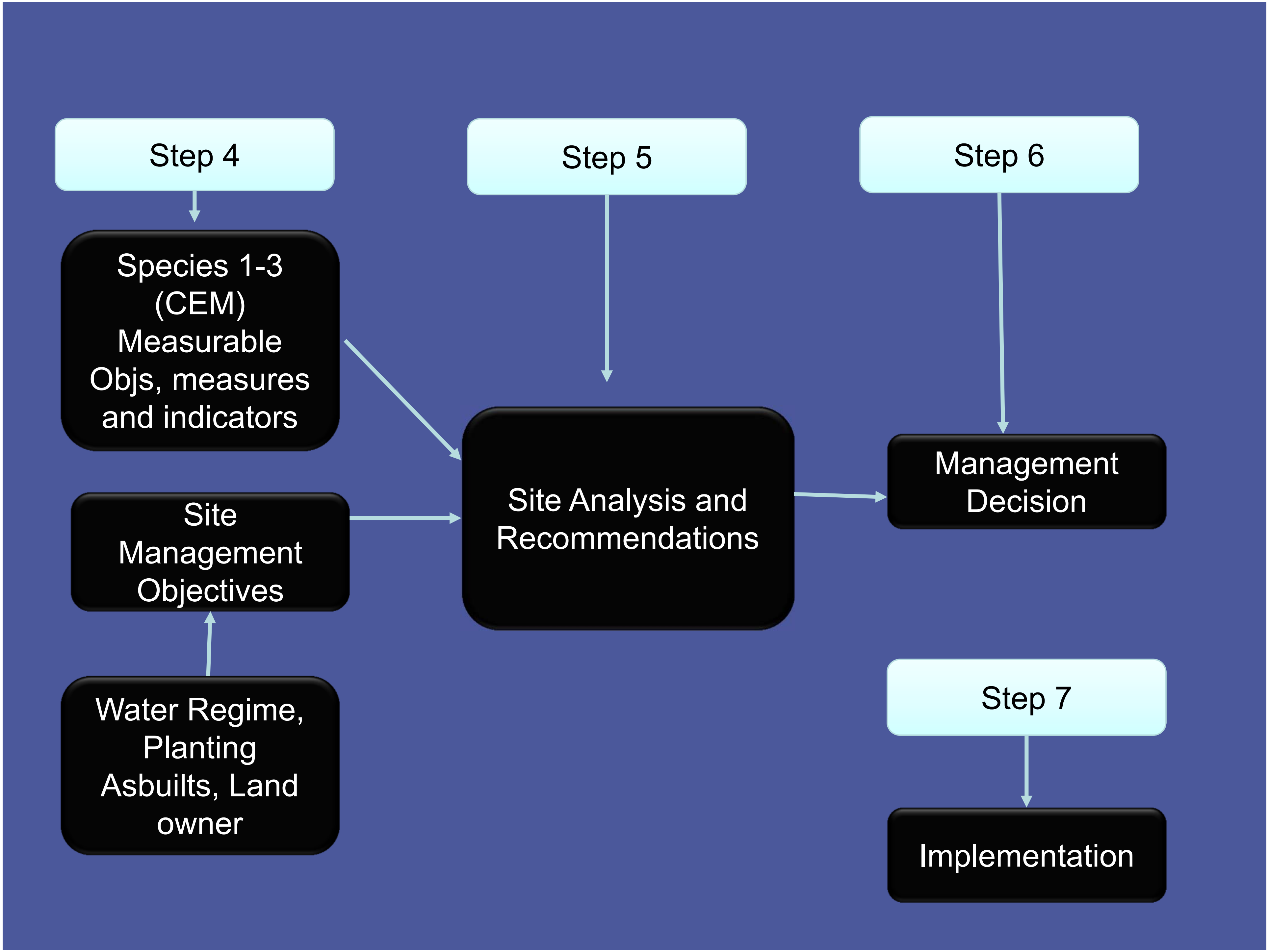


FLSU Fry & Early Juvenile Life Stage, “Predation” Causal Relationships

Using Output from Cause-Effect Assessment

- Identify causal relationships with greatest impact on overall survivorship
  - Assess full causal chains, from controlling factors to outcomes
  - Identify pivotal habitat elements
  - = Potential places for management intervention
- Identify high-magnitude links with low understanding
  - = Potentially critical knowledge gaps
- Many other applications


Step 1
Step 2
Step 3
Development of Species 1 (CEM)
Species 1 (CEM) Research and Monitoring needs
Species 1 (CEM) Measurable Objs, measures and indicators
Development of Species 2 (CEM)
Species 2 (CEM) Research and Monitoring needs
Species 2 (CEM) Measurable Objs, measures and indicators
Development of Species 3 (CEM)
Species 3 (CEM) Research and Monitoring needs
Species 3 (CEM) Measurable Objs, measures and indicators
Management determines these outcomes


Step 4
Step 5
Step 6
Species 1-3 (CEM) Measurable Objs, measures and indicators
Site Analysis and Recommendations
Management Decision
Site Management Objectives
Water Regime, Planting Asbuilts, Land owner
Step 7
Implementation

Big Picture

- Step 1
  - Identify what is known and what needs to be known about a species based on current conditions
- Step 2
  - Identify Research and Monitoring priorities of management

Big Picture

- Step 3
  - Identify measurable objectives, measures and indicators
- Step 4
  - Identify multi-species and site constraints given the goals of the site and HCP.

Questions?