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

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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

Management Questions

Problem/Objective

Alternative

Alternative

Alternative

scrap

Predicting the outcomes

Implementation → Monitoring → Results

Implementation → Monitoring → Results

Update knowledge and adjust management
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”
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.
Management Goals, Objectives, Questions, and Decisions

Priority Research and Monitoring Questions

AMP

Synthesis
Data → Information → Knowledge

Management Actions

New R&M ??s

New Mgmt Decisions

New Mgmt Actions
Management Guidelines

• Management Guidelines = Minimum habitat parameters

• Site Management Guidelines

AMP

Site Mgmt Plans
Research & Monitoring
Canopy Closure

- PVER Monitoring Points
- PVER Riparian Monitoring Area (478 ac)

PVER Canopy Closure (approx. 195 ac)

- 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)
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”
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

Link Magnitude
- High – thick line
- Medium – medium line
- Low – thin line
- Unknown – very thin line

Link Understanding
- High – black line
- Medium – blue line
- Low – red line

Link Predictability
- High – black text
- Medium – blue text
- Low – red text
- Unknown – grey text
### Spreadsheet-Based Assessment & Documentation of Causal Links

#### Link Identification:
- **Entity Mode:** Causal Mode
- **Effect Mode:** Causal Mode

#### Link Characteristics:
<table>
<thead>
<tr>
<th>Link Character</th>
<th>Link Magnitude</th>
<th>Link Reliability</th>
<th>Link Understanding</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (L)</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>High (H)</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

#### Link Reason:
- **High:** See Linkage Reason
- **Low:** See Linkage Reason
- **Medium:** See Linkage Reason

#### Example Links:
1. **RASU 09:** Ocellus Larvae - Habitat/Element: Flow, Tallness, Acetabulum, Procaudal Variety of Flow, Tallness, and Acetabulum as high in linkage strength.
   - **Flow:** High in linkage strength due to its role in determining larval distribution.
   - **Tallness:** Medium in linkage strength due to its impact on habitat suitability.
   - **Acetabulum:** Low in linkage strength due to minimal direct influence.

2. **RASU 07:** Ocellus Larvae - Habitat/Element: Water Quality, Cover, Acetabulum, Procaudal Variety of Water Quality, Cover, and Acetabulum as high in linkage strength.
   - **Water Quality:** High in linkage strength due to its critical role in larval survival.
   - **Cover:** Medium in linkage strength due to its protection against predation.
   - **Acetabulum:** Low in linkage strength due to its minor impact on larval behavior.

#### Research Questions:
- How does the distribution and abundance of larval habitats change in response to environmental factors, such as varying water quality?
- What are the key biological interactions that drive larval distribution and survival?
- How do larval movements and behaviors influence habitat preference and distribution?
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?
What Causal Nodes Most Strongly Affect the Most Influential Activities or Processes

Controlling Factors
- Water Storage-Delivery Management
- Wastewater & Other Contaminant Inflow
- Motorboat Activity
- Management of Channel, Lake, Pond Geometry
- Tributary Inflow
- Nuisance Species Introduction & Management
- Non-RASU Fishery Management

Habitat Elements
- Water Temperature
- Depth
- Water Chemistry
- Substrate Texture, Dynamics
- Infectious Agents
- Plankton-Benthos-POM
- Flow, Turbulence
- Meso-Habitat Geometry
- Macro-Habitat Geometry
- Turbidity
- Competitor Activity
- Predator Activity

Activities & Processes
- Thermal Stress
- Chemical Stress
- Disease
- Mechanical Stress
- Resting
- Pressure
- Foraging
- Swimming

Life-Stage Outcomes
- RASU Adult Survival Rate
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

Development of Species 1 (CEM)

Development of Species 2 (CEM)

Development of Species 3 (CEM)

Step 2

Species 1 (CEM) Research and Monitoring needs

Species 2 (CEM) Research and Monitoring needs

Species 3 (CEM) Research and Monitoring needs

Step 3

Species 1 (CEM) Measurable Objs, measures and indicators

Species 2 (CEM) Measurable Objs, measures and indicators

Species 3 (CEM) Measurable Objs, measures and indicators

Management determines these outcomes
Species 1-3 (CEM) Measurable Objs, measures and indicators

Site Management Objectives

Water Regime, Planting Asbuilts, Land owner

Site Analysis and Recommendations

Management Decision

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?