Template for ISB Documentation of Stressors

A. General Information:

1. Name or Location of Example/Approach: US EPA's CADDIS (Causal Analysis/Diagnosis Decision Information System)

2. Literature/Citations Used: www.epa.gov/caddis

3. Reviewer(s): Judy Meyer

B. Specific Questions:

1. What stressors are considered?

Stressors in general, primarily in stream ecosystems. There are modules for several stressors (e.g., ammonia, DO, flow alteration, herbicides, etc.) In the stressor ID step, one possibility is "multiple stressors" with the following guidance for combining stressors: Combine stressors that are part of the same causal pathway; Re-aggregate stressors that have been unnecessarily disaggregated; Combine similar stressors into one; Identify independently acting stressors that cause the same effect; Combine stressors that induce the effect interactively. This is accompanied by the following warnings: Avoid combining causes without an underlying model; Avoid broad definitions of candidate causes; Do not lose the independent effects of individual causes.

2. Are stressors categorized? If so, how?

They are weighted by the strength of evidence supporting the causal pathway. See below for further explanation of this weighting.

3. Are the relations between stressors and management objectives modeled, and if so, how?

Conceptual models of causal relationship between stressor and response are used. I didn't find any models linking stressors with management objectives other than reducing the observed effect, e.g., decline in fish populations.

4. If stressors are prioritized, describe the general approach.

This approach is basically a logical stepping through a process of scientific analysis. To the extent that this can be done in a cookbook format, this site does that well.

The approach has 5 steps:

- Define case
- List of candidate causes with conceptual models showing linkage to observed effect
- Use available evidence to refute causes and identify most likely causes by weight of evidence
- Use data from elsewhere to help ID probable causes
- ID probable causes

Then ID and apportion sources, which seems to be primarily links with various BMPs

The weighting of evidence is done using scores on evidence that can be ++, +, 0, -, - - depending on how strongly the causal link is supported. The following are considered: cause and effect co-occur spatially or temporally, temporal sequence of cause and effect, stressor-response relationship (e.g., effect gradient) observed in the field, are the steps in a causal pathway present?, is exposure and biological mechanism consistently present?, effect responds when exposure is altered, laboratory tests support cause, are other effects of the candidate cause confirmed?, species occurrences are diagnostic of the candidate cause.

They identify 6 criteria of a causal relationship: co-occurrence (The cause co-occurs with the unaffected entity in space and time.), sufficiency (The intensity, frequency, and duration of the cause are adequate and the entity is susceptible to produce the type and magnitude of the effect.), time order (The cause precedes its effects.), alteration (The entity is changed by the interaction with the cause.), interaction (The cause physically interacts with the entity in a way that induces the effect.), preceding causation (Each causal relationship is a result of a larger web of cause and effect relationships.)

When the evidence suggests multiple causes are operating, the following is suggested:

"It may be appropriate to consider whether the impairment was properly defined .

- The apparent multiple causes may actually be individual causes of multiple effects. Consider partitioning the impairment if, for example one cause is inducing tumors in fish and another is reducing benthic insect abundance.
- The apparent multiple causes may actually be operating in different areas of the aquatic system. Consider partitioning the impairment in space."

If the impairment does have multiple causes, the following remedial strategies are suggested:

- "Remediate a dominant and potentially sufficient cause. An apparently dominant cause may be sufficient alone to induce the impairment and its actions may be masking the more subtle effects of other causes.
- Remediate a necessary cause. If one cause is necessary for occurrence of the impairment, then remediating only it is adequate.
- Remediate a feasible cause. If it is not clear how multiple causes interact, perform the easiest remediation and monitor the results.

- Remediate all causes. In some cases, it is feasible to remediate all of the multiple causes."

5. How might this approach be relevant to Bay Delta?

The individuals who have created this site have obviously thought a lot about how one uses weight of evidence to diagnose likely causes. I'm not sure the approach is appropriate for a system as complex as the Bay-Delta. I found the questions asked about weighing evidence and criteria used for causation to be helpful for thinking about the issue of multiple stressors, and the remediation strategies (above) to be an interesting approach.

6. Follow up regarding additional questions/literature review/etc?