Causal Assessment Conceptual Workplan

The State of California is currently developing biological objectives for perennial freshwater streams. The State's goal is to set biological expectations to ensure protection of aquatic life beneficial uses in these waterbodies. However, not every stream is going to meet these expectations. When a stream does not meet this expectation, regulated and regulatory agencies must work together to identify what stressor(s) is causing the impact so that the stressor(s) may be remediated or removed.

In situations where the stressor is not readily apparent or obvious, a causal assessment can be conducted to determine the likely cause of the observed condition. A causal assessment utilizes quantitative and logical techniques to organize and evaluate data and other information to identify the probable stressor(s). Conducting causal assessments is not necessarily easy or straightforward. Mechanisms of biological impacts can be complex and identifying the causes can be difficult. However, causal assessments have been successful and several investigations have confirmed biological impacts due to dissolved oxygen, sedimentation, habitat loss, temperature, and nutrients, amongst others. In fact, the US EPA has spent the last 15 years developing a causal assessment toolbox and has published this work for users (http://www.epa.gov/caddis).

One important concern is that very few causal assessments have been successfully completed in California. This lack of experience in California leaves both regulatory and regulated agencies in a state of uncertainty. Uncertainty regarding applicability of tools, confidence in results, insights into confounding factors, status of literature support, and consistency of results.

The goal of this workplan is to describe the State's first steps towards providing regulated community support. The objective is to provide the State Water Resources Control Board with causal assessment examples specific to California's concerns and issues. This will be accomplished by conducting three case studies that capture the diversity of California's geography, land use characteristics, and stressors. These causal assessments will identify the candidate cause or causes for the individual biological impairments and describe the evidence for that decision. Then, based on these case studies, provide recommendations to both the regulated and regulatory community for future causal assessment efforts. These recommendations will focus on optimizing causal assessment designs, identifying assessment procedures and data sources that are specific to California's needs, and providing the "next steps" needed for causal assessment to be a successful strategy for attaining compliance with the State's biological objectives. The case studies and recommendations will be summarized in a report to be submitted to the State Water Resources Control Board for distribution to the Regional Water Quality Control Boards and Regulated Stakeholder community. These are the agencies tasked

with the implementation of biological objectives and protection of our aquatic life beneficial uses.

Selection of Case Study Sites

Three case studies will be attempted in California for causal assessment. These case studies will be selected based on four criteria:

- Representativeness
- Stressor diversity and degree of biological impairment
- Data availability
- Willing partners

Representativeness will focus on two perspectives. The first perspective is geography. Case studies should span different portions of the state and not be focused all in one region. The second perspective is landscape context. Case studies should span different land cover in the state such as urban, agricultural, or timber landscapes.

Incorporating stressor diversity ensures that the case studies are not affected by the same stressor (e.g., nutrients or toxicity). Range of biological conditions refers to the status of the biological community. Identifying a site with impacted biology is a necessity, but case studies with a range of biological impact are preferred. If possible, a "local" comparator site that lacks the stressor(s) of interest should be selected as this will greatly improve the strength of the causal assessment. Both the range of impact and a comparator site allows the investigator to examine potential correlative stressors.

Data availability is the critical element of any causal assessment. The more data that coincides in space and time with the observed biological impairment, the greater the likelihood that a candidate cause(s) will be identified. Of particular use are data that describe the physical, biological, and chemical environment. At a minimum, the biological data that captured the impairment and some measure of the suspected stressors (candidate causes) should be available. Examples of data include descriptions of the physical habitat, hydrodynamics, water quality and sediment chemical measurements, toxicity, and GIS data layers (land use, industrial type and location). Synoptically collected data is preferred, but not required. No new data collection is planned as part of this case study evaluation.

Willing partners is an important aspect of this workplan. Since no new data collection is planned, we will need local partners to supply the necessary information to conduct the case study. More importantly, these local partners have the knowledge to help formulate potential causal mechanisms, score plausible scenarios, and provide local insight into conclusions. No casual assessment can be done in isolation.

Causal Assessment Tasks

The causal assessment process undertaken here is based on the Stressor identification (SI) process which is comprised of five tasks: 1) Define the case; 2) List candidate causes; 3) Evaluate data from case; 4) Evaluate data from elsewhere; and 5) Identify probable causes

Define the case

When it has been determined that a perennial stream does not meet biological expectations, the first step is to define the subject of the analysis (i.e., the case) which is comprised of three parts. The case definition sets the foundation for the rest of the causal analysis: it influences the information that will be assembled, the causes that will be considered, and the way in which conclusions will be presented. For this reason, it is important to get input from managers and stakeholders at this early stage of the process. The first part is to define in detail the biological impairment and the specific biological effects that led to the impairment. The second part is to determine the geographic scope of the investigation, which includes establishing the region of impairment and, for comparative purposes, a local region that lacks the same impairment. The causal assessment is strengthened if the regions are physically, biologically, and chemically similar. The third part is to clearly establish the objectives of the assessment.

List candidate causes

The second step is to generate a list of candidate causes, or stressors, which may be responsible for the observed biological effects. Listing these candidate causes further refines the scope of the causal analysis, and provides a framework for assembling available data and determining what data are lacking for the causal analysis. The list should include all stressors that could be causing the biological impairment. These stressors may be chemical, physical, and/or biological in nature. A candidate cause may be as simple as listing the proximate stressor or a more detailed account that includes the precursors of the proximate stressor. The list will be based on many things, including existing data from the site, existing knowledge of biological processes or mechanisms, or stakeholder input.

From list of candidate causes, conceptual model diagrams will be developed for each candidate cause. These models are simple graphics showing the linkages between potential sources, stressors or candidate causes, and biological effects in the case. The models will be used to identify potential mechanisms, refine the list of candidate causes, and highlight interactions among candidate causes. The models also provide a framework for keeping track of what data are available and relevant to each candidate cause, as well as an effective way to communicate to stakeholders the working hypotheses and assumptions about how and why effects are occurring.

Specific Tasks:

a) The Project Team will develop a preliminary list of candidate causes.

b) Conceptual models for each candidate cause will be developed.
c) The list and conceptual models will be distributed among stakeholders for comment and input.
d) The final lists of candidate causes for each case study will be summarized in a table.

Evaluate data from case

The third step is to assemble and analyze data from the case at hand in order to develop consistent and credible evidence that allows you to confidently eliminate very improbable causes, or to use symptoms to refute or diagnose a cause, and to begin building the body of evidence for those candidate causes that cannot be eliminated or diagnosed. Analyses combine measures of the biological response with direct measures of proximate stressors, or other measures linking sources, candidate causes, and biological effects. Evidence used to support or refute a candidate cause include spatial/temporal co-occurrence, exposure, biological mechanism, casual pathway, field based stress-response relationship, manipulation of exposure, laboratory tests of site media, temporal sequence, verified predictions, and symptoms. The degree to which each type of evidence supports or weakens a case is scored using a standard system. Scores for the candidate cause or causes that remain are carried forward.

Specific Tasks:

a) The Project Team will identify, collect, organize, and screen data specific to the case (i.e, from the target sites).
b) The data will be organized along the conceptual pathways.
c) Worksheets will be developed that show how the data relates to each candidate cause and to synthesis information.
d) Data will be analyzed in terms of statistical associations and assigned to an evidence type.
e) The Project Team will develop the means by which the evidence is scored.
f) A summary table of scores will be developed for each candidate cause and improbable cause eliminated.

Evaluate data from elsewhere

The fourth step is to gather data from elsewhere that are independent of what is observed at the case sites. Data may include information from other sites within the region; stressor-response relationships derived from field or laboratory studies; studies of similar situations in other streams, and numerous other kinds of information. Upon assembling the information, the data must then be related to observations from the case to determine plausibility. Evidence developed using data from elsewhere cannot be used to eliminate a particular candidate cause; rather this evidence is used only to compare the strength of evidence associated with each cause. The

degree to which each type of evidence supports or weakens a case is scored using a standard system.

Specific Tasks:

a) The Project Team will identify, collect, organize, and screen data not immediately associated with the case. This will include information from the literature, observations of similar cases, and data sets from the larger geographic area.
b) The data will be organized along the conceptual pathways.
c) Worksheets will be developed that show how the data relates to each candidate cause and to synthesis information.
d) Data will be analyzed in terms of statistical associations and assigned to an evidence type.
e) The Project Team will develop the means by which the evidence is scored.
f) A summary table of scores will be developed for each candidate cause.

Identify probable causes

The fifth step relies on the evidence organized in Steps 3 and 4 to distinguish the most probable cause(s) from a set of less probable causes. This step is divided into two tasks to make the process of determining a probable cause more manageable. First, evidence for each candidate cause is evaluated, candidate causes are sorted into categories, and the most compelling lines of evidence are noted. Second, evidence for candidate causes is compared across all candidate causes. The product is the identification of the candidate cause or causes for the biological impairment and a description of the evidence for that decision. Key elements of the product are the scores for each type of evidence, an evaluation of the consistency and credibility of the case based on the scores, a classification of each candidate cause as refuted, diagnosed, probable, unlikely or uncertain, a discussion of the reasons for the final conclusions including the most compelling lines of evidence, and a report describing the causal assessment.

In the best case, a probable cause or causes are identified, and the information is effectively communicated to managers and stakeholders. In some situations, no cause is identified or the confidence in conclusions will be too low to support management action. However, even when this happens, by going through this process you will likely be able to make a strong recommendation for the collection of additional information that will enable a cause to be identified.

Specific Tasks:

a) The Project Team will evaluate the evidence for each candidate cause to identify the most compelling lines of evidence. This will be accomplished by:

    a. Generating a table of scores for each type of evidence.

b. Evaluating the consistency and credibility of the case based on the scores.
c. Classifying each candidate cause as refuted, diagnosed, probable, unlikely or uncertain.
d. Discussing the reasons for the final conclusions including the most compelling lines of evidence.
e. Submitting a report describing the causal assessment.

Schedule and Products

This project should take approximately 18 months. The final product will be a report that describes the causal assessment methodology, describes the three case studies, and lists recommendations on favored approaches and tools based on case study success, pitfalls to avoid that lead to inefficiencies, and suggestions for future needs where data gaps remain.

Since one of the primary keys to success is communication, a series of three workshops will be held in association with important project milestones:

1) Define the case and list candidate causes

This one-day workshop will be held with all three case studies together. Invitees will include both the regulated and regulatory parties associated with each case. This group exercise provides not only an introduction to all parties, but helps the investigators get the "inside scoop" on each case.

2) Evaluate data from the case and elsewhere

This workshop will be held with each case separately. These workshops will be very hands-on, reviewing, analyzing, and interpreting data. Once again, working with both the regulated and regulatory parties will be the fulcrum to making decisions and narrowing the field of potential stressors. Often, data gaps emerge and only the local agencies know where additional information can be found to help confirm or refute a probable cause.

3) Identify probable causes and compile recommendations

This two-day workshop will be held with all three case studies together. Invitees will include the both the regulated and regulatory parties associated with each case, plus the Biological Objectives Scientific Advisory Committee. This culminating workshop will compare and contrast the final results from each case, and then use this information to generate the final list of recommendations.

Task	Date of Completion
Site selection	November 2011
Workshop 1: Define the case and List candidate causes	February 2012
Workshop 2: Evaluate data from case and Evaluate data from elsewhere	June 2012
Workshop 3: Identify probable causes and compile recommendations	October 2012
Final Report	March 2013