Recovery Potential Metrics Summary Form

Indicator Name: CERTAINTY OF CAUSAL LINKAGES

Type: Social Context

Rationale/Relevance to Recovery Potential: Certainty in restoration is usually relative and rarely absolute. Nevertheless, a truly unknown cause is a major obstacle to restoration. Restoration prospects depend heavily on understanding the impairment, the stressors to which the system is exposed, and the sources and pathways along which such exposure occurs. Together these elements make up a causal pathway that, if uncertain, jeopardizes the progress of restoration. Action taken despite causal uncertainty can lead to targeting the wrong stressor or source, funding or requiring inappropriate control actions, under- or over-estimating controls needed, and related development of significant stakeholder conflicts or legal actions.

How Measured: With 303(d)-listed waters, some impairment causes (usually bioimpairments) are reported in the National TMDL Tracking System (NTTS) as 'Cause Unknown' when a pollutant cause for a verified impairment effect is not yet evident at the monitoring stage. Due to variable reporting among states, several other actual cause (i.e., pollutant) unknown listings also occur under categories such as low DO, degraded habitat, toxicity, and other terms not specific to one pollutant cause. One measurement approach is to sort waters using this metric by simple presence/absence of 'cause unknown' or similar listings. Another option is to measure the percent of waters with unknown causes of impairment out of the total length of impaired waters within each reporting unit.

Data Source:
Cause information occurs in attribute tables that are linked to 303(d) shape files of each state's impaired waters. Data is available through the Assessment TMDL Tracking and Implementation System (ATTAINS) (See: http://www.epa.gov/waters/ir/).

Indicator Status (check one or more)
_______ Developmental concept.
___x__ Plausible relationship to recovery.
_______ Single documentation in literature or practice.
___x__ Multiple documentation in literature or practice.
_______ Quantification.

Examples from Supporting Literature (abbrev. citations and points made):

- (Leach and Pelkey 2001) themes relating to watershed partnership success include [note that **bolded ones** are spatially representable for recovery screening with existing data while others are usually not available as spatially explicit data]: **funding, broad and inclusive membership,** committed participants, **effective leadership,** bottom-up leadership vs balanced among levels, trust, low or moderate conflict (vs none), geographic scope, limited scope of activities, adequate time, well-defined process rules, consensus rules, **formal enforcement mechanisms, effective communication, adequate sci-tech info,** monitoring data on outcomes, training in collaboration, **agency support and participation**, **legislative encouragement, community resources**.

- (Norton et al 2003) We do causal evaluations routinely, from diagnosing a child's illness, to figuring out why the video recorder won't play. Our causal conclusions are often guided by the joint operation of rational analyses, based on rules of logic and evidence, and our experiences, based on intuitive processing and heuristic rules of thumb (Denes-Raj and Epstein 1994). When the consequences of errors are small and the situation is repeated frequently (such as in diagnosing common illnesses such as colds), we can fine-tune our intuition and heuristic aids at small cost. However, when potential consequences are severe or the situation occurs infrequently, we tend to turn to an expert who has observed many cases (e.g., we bring our child to the doctor) or rely on rational analyses (e.g., we follow the VCR troubleshooting guide). Interest in causal investigations in aquatic systems has been a natural outgrowth of the increased use of biological monitoring to characterize the condition of resources. Although biological monitoring approaches are critical tools for detecting whether effects are occurring, they do not identify the cause of the observed effects. When we investigate the causes of biological impairments in a stream in order to guide restoration, the cost of a proposed action may be high, and the likelihood of being able to try different restoration strategies is small. For these reasons, there may be insufficient repetition of experiences to accurately hone heuristic aids and patterns. Formal approaches to causal evaluation can provide a mechanism to build on expert knowledge, increasing the likelihood that remedial efforts will achieve the desired environmental improvement.

- (Norton et al 2002) We all routinely make conclusions about cause, so the need for improved methods for determining them may not be readily apparent. When the situation is complex and the cause is not immediately apparent, a formal process can help organize available data and optimize further collection efforts. Showing clearly how information is used to make causal conclusions can help others replicate the process and can convince skeptics that the true cause has been identified. A consistent process can help meet legal and regulatory standards for reasonableness and ensure that scientific information contributes to these decisions. Perhaps most important, improved methods can help eliminate errors that often arise because we tend to formulate and accept causal hypotheses too readily. As aptly articulated by Richard Feynman [1], ‘‘The first rule of science is not to fool yourself—and you are the easiest person to fool.’’

- (Fabricius and De’ath 2004) The resulting lack of consensus can lead successively to conflict, confusion over policy development, government inaction and environmental degradation (1448).
- (Fabricius and De’ath 2004) Application of the framework is simple and transparent in order to effectively communicate scientific evidence to decision makers and the public. This enables the detection of change and judgments about causality to be made in a rigorous, structured, and open manner, and thus the agreement among stakeholders, necessary for successful implementation of management strategies, can be obtained (1448).
- (Fabricius and De’ath 2004) Causal arguments are needed in ecosystem management in order to convince interested parties that management actions should be implemented and will be effective. These arguments need to balance scientific rigor with ease of communication to nonscientists (1450).
- (Fabricius and De’ath 2004) However causal attribution profoundly enhances the ability of scientists to contribute to environmental management, and increases the effectiveness of management action. For example, in coral reef ecology the cause(s) of outbreaks of the crown-of-thorns seastar *Acanthaster planci* are still being debated by scientists 40 years after the first observations of outbreaks. Costly local eradication programs are now in place to protect some tourism sites; funding that might have been spent on preventative measures if causes had been identified with a reasonable level of certainty. A contrasting example is that high sea surface temperatures are now accepted by most scientists as the major cause of coral bleaching (Strong et al. 1997), and agreement on the cause of predicted massive ecosystem changes by coral bleaching is adding momentum to the call for political action to combat greenhouse gas emission (1460-1461).