Workplan for

DEVELOPING BIOLOGICAL OBJECTIVES FOR PERENNIAL WADEABLE STREAMS IN THE STATE OF CALIFORNIA

DRAFT 15 May 2010

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1.0 INTRODUCTION

Streams are one of California's greatest resources, providing critical economic, recreational, cultural and ecological services. There are approximately 100,000 perennial stream miles in the state, all of which support numerous beneficial uses. The health of these systems is essential to the state's environment, water supply, economy, and quality of life.

Aquatic life is just one of the many beneficial uses of streams, but support of aquatic life use is a key indicator of the overall integrity of flowing water ecosystems and the landscapes they drain. Although the State has been mandated for nearly 40 years by both federal and state laws and regulations to maintain the chemical, physical and biological health of California streams, a large fraction of these stream ecosystems are degraded. Recent statewide probability surveys found that only 50% of the total perennial stream length in the state was in good biological condition; the remaining stream length had either somewhat (~27%) or greatly altered biology (~23%). (Ode et al. 2009).

The State of California currently lists over 26,000 stream miles as impaired. These listings are based almost exclusively on chemical and toxicological objectives for water quality. While chemical and toxicological objectives serve an essential role in protecting aquatic systems, they alone are inadequate for protecting the ecological health of the state's watersheds (Davis and Simon 1995, Karr and Chu 1999, National Research Council 2001).

California currently has no numeric objectives for instream biota, but needs them to adequately protect its resources. Several regions of the state have begun to include biological condition monitoring in their assessments, but the lack of biological objectives limits their ability to define and enforce standards for the protection of ecological condition. Without these objectives, California will continue to lose critical aquatic resources.

2.0 GOALS OF THIS DOCUMENT

This is a planning document. The goal of this document is to define a path towards creating biological objectives to protect aquatic resources of the state. This Workplan outlines both the technical and nontechnical steps necessary to develop biological objectives.

2.1 Guiding Principles

Creating objectives, and especially biological objectives, requires some fundamental philosophical guiding principles. This workplan has four:

1) The state should have biological objectives for all waterbody types.

   California has a multitude of waterbody types including but not limited to: perennial streams and rivers, nonperennial streams and rivers, lakes, wetlands and estuaries, and coastal waters. Although all waterbodies should have biological objectives, we have prioritized developing biological objectives in wadeable perennial streams. For this document, perennial wadeable streams refer to surface flowing freshwater courses including creeks, streams, or rivers that do not require a boat for sampling. The state currently has a statewide bioassessment monitoring program for perennial wadeable streams (the Surface Water Ambient Monitoring Program or SWAMP) and stream bioassessment is now being integrated into a variety of regulatory permits. Therefore, perennial wadeable streams are the most logical starting point for biological objectives. Ultimately, the process used for perennial wadeable streams should serve as a framework for developing biological objectives for other waterbodies.

2) The state should use multiple indicators for biological objectives.

   There are many potential biological indicators the state could use for biological objectives including benthic macroinvertebrates, algae, riparian condition, fish, and amphibians, amongst others. Different indicators have differing levels of response to various stressors and, ultimately, the integration across different levels of biological organization will provide the most holistic assessment of condition. Integration across different levels of biological condition is currently limited by data availability and complexity. However, SWAMP has collected several thousand stream samples for benthic macroinvertebrates statewide. Therefore, benthic macroinvertebrates are a logical starting point for developing biological objectives. The process used for benthic macroinvertebrates should serve as framework for developing biological objectives for other indicators.

3) The state should develop biological objectives with numeric endpoints.

   The addition of numeric biological objectives to narrative objectives provides two important benefits: 1) a framework for consistent quantitative assessments and interpretation; and 2) the potential to trigger enforcement and remedial actions that narrative objectives do not. However, numeric biological objectives should be flexible enough to accommodate different biological expectations for different types of systems including unaltered streams, moderately, and even highly modified streams.

4) There should be statewide consistency with regional flexibility.

   Several biological assessment tools have been built for California streams, but there is not statewide consistency in the development and application of these tools. Statewide consistency is an important component of equity among stakeholders and is therefore crucial for statewide objective development. However, it is well-recognized that the state has many different ecosystems, each of which has varying biological characteristics. Therefore, a defensible statewide program must accommodate the unique qualities of each ecoregion. Furthermore, our knowledge of the biology of streams varies throughout the state so the refinement of biological objectives will likely proceed at different rates in different regions.

3.0 GENERAL APPROACH

There are nine basic tasks that have been identified for biological objective development (Table 1). Some of the tasks are technical and some are not, but taken all together they represent the major milestones necessary for a scientifically-defensible and equitable policy.

Table 1. List of tasks for development of biological objectives for the State of California

Section	Task	Purpose
4.1	Reference condition	Provides an objective means of defining unaltered biological expectations for various environmental settings.
4.2	Stressor response models	Provides objective means of scaling biological expectations for waterbodies with varying levels of stressor influence
4.3	Waterbody classification	Assigns biological expectations based on environmental setting and stressor level to stream reaches statewide
4.4	Stressor identification	Provides the tools necessary to determine the cause of impairment (for remediation) if biological objectives are not met.
4.5	Information management	Provides the infrastructure needed to submit, store, share, and analyze biological data for assessment.
4.6	Implementation Plan Development	Defines how biological objectives are used in regulatory programs such as 303(d) listing, NPDES compliance, 401 certification, etc.
4.7	Rulemaking	The legislatively defined public process of developing, adopting, and implementing objectives
4.8	Outreach	Actively reaching out to technical, regulatory, regulated, and non-governmental stakeholders to ensure that their ideas, suggestions, and concerns are fully considered
4.9	Training and standardization	Provides sufficient documentation and education for widespread, consistent, effective implementation.

4.0 SPECIFIC APPROACH

4.1 Reference condition

The primary goal of this task is to establish objective biological expectations for all the major habitat types represented by California's diverse network of perennial wadeable streams. Biological expectations are the foundation of biological objectives; these expectations vary from stream to stream because aquatic biota differ in their preferences for specific environmental conditions (e.g., elevation, stream size, precipitation, temperature, geology, etc.). There are many physically and biologically unique ecoregions in California, including deserts, chaparral, temperate rainforests, and both coastal and interior mountains (Omernik 1995). Within each ecoregion, there are significant and predictable differences in the stream biota that result from natural gradients in these environmental conditions. For example, there are distinct differences between the biological assemblages in high and low elevation streams in both the Sierra Nevada and in southern coastal California. In order to accurately predict the biological assemblages expected to occur at a specific stream, it is essential to account for the major environmental factors responsible for natural variability in the biota.

California is in the early stages of implementing a Reference Condition Management Program (RCMP). An expert panel was convened to formulate an optimal strategy for constructing the state's reference site network. This strategy provides the theoretical basis of the RCMP (Ode and Schiff 2009). The RCMP is designed to sample sites from all ecoregions of the state, and to represent all major habitat gradients within each ecoregion. Many suitable reference sites have already been sampled in previous bioassessment programs. However, many parts of the state are under-represented and we will need to invest significant effort to identify, sample, and represent the diversity of environmental settings in each ecoregion.

This task will involve sampling under-represented portions of the state and, using biological information from reference sites, define how many distinct types of aquatic communities occur statewide. The most important physical/chemical conditions (i.e., elevation, temperature, flow status, land cover, channel modification, ionic strength, etc.) will be used to help associate these biological groups with specific habitat types. In this way, one should be able to go to any location in the state and, based upon these physical variables, be able to predict what types of organisms could/should occur there.

Product: GIS maps of the major zoogeographic regions in the state as defined by the Reference Condition Management Program. Tables or graphs that define relationships among physical and chemical parameters and biological assemblages.

4.2 Stressor Response Models

Once reference conditions have been defined for the diverse environmental settings in the state, the next challenge will be to set biological expectations for locations that cannot reasonably be expected to achieve reference conditions. We expect to use a suite of technical approaches to adjust biological expectations to account for these unalterable anthropogenic changes through the use of stressor-response models.

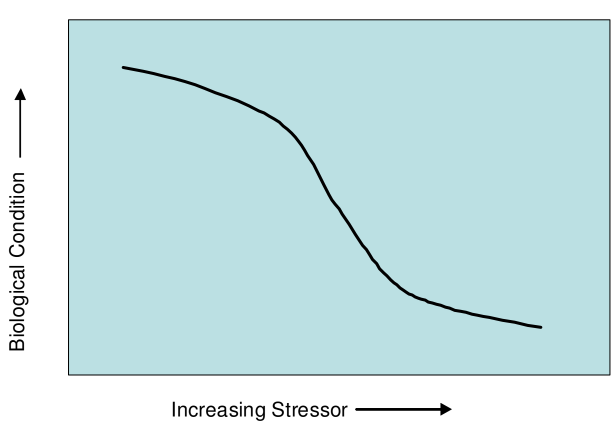
Stressor response models describe empirical relationships between anthropogenic alterations to the environment and concomitant changes in the biological condition (Figure 1). Unalterable anthropogenic alterations may include land use, hydromodification, or habitat, amongst others. Unalterable anthropogenic stressors will not include those items under the direct regulatory authority of the SWRCB and RWQCBs such as water quality or toxicity. Biological response may include changes in abundance, richness, indicator species, combinations of these metrics, or integrative assessment tools such as the index of biological integrity (IBI), amongst others. Characterization of the relationships between these factors will help us to define standards that are both realistic and protective of the resource.

The primary goal of this task is to quantitatively define appropriate stressor response models for all regions of the state. This will be accomplished in a two-step process: 1) creating and assembling biological and stressor datasets; and 2) modeling stressor-biota relationships for different regions of the state. For the first step, much spatial information already exists in the form of validated GIS layers for many candidate stressors (e.g., land use). However, spatial data for many important candidate stressors is of insufficient quality or resolution to use in this exercise. (e.g., hydromodification variables, grazing intensity). Therefore, additional GIS layers may need to be compiled, validated, or created. We anticipate that existing biological data will be sufficient to meet the needs of this step, so no new biological sampling will be necessary.

For the second step, several potential stressor response models exist including categorical, univariate, or multivariate stochastic models. More than one model may be necessary in order to capture the range of biological impact statewide. Stressors may be aggregated at reach, catchment, or watershed scales. Most importantly, the biological responses with the greatest discriminative power will begin to form the basis of the proposed biological objectives. One important challenge will be to calibrate the biological responses, particularly regionally developed IBIs, so that biological scoring systems are responsive to regional conditions and have statewide consistency in interpretation.

Product: List of candidate stressors; quantitative stressor response model(s).

Figure 1. Conceptual stressor response model.



4.3 Waterbody classification

The primary goal of this task is to assign biological expectations to each perennial wadeable stream segment in the state. Four steps are required to complete this task. First, a statewide GIS base layer will be defined representing all perennial wadeable stream segments. A GIS layers will also be assembled that summarizes the physical and chemical attributes used to delineate the boundaries of the major zoogeographic regions of the state identified in Task 4.1. Second, GIS layers of key stressors will be assembled as determined in Task 4.2 to be the best variables for predicting responses in biological expectation. Third, GIS spatial analysis tools will be used to assign each stream segment to a specific biological expectation class based on overlays of natural and stressor variables of the stream network. Streams with low amounts of disturbance will be assigned to a reference condition class, while streams subject to higher levels of unalterable anthropogenic stressors from Task 4.2 will be assigned to non-reference classes. Fourth, validation of the assignments will be conducted to ensure segments were correctly classified. This validation will include examination of independent data sets and/or field verification of representative segments. In particular, sites that occur near habitat boundaries will be validated to ensure model accuracy.

Product: Statewide spatial database for physical and chemical factors that drive perennial wadeable stream biological assemblages; spatial database that defines biological expectations for each perennial wadeable stream segment.

4.4 Stressor identification

The goal of this task is to develop the tools necessary to determine the cause(s) of impairment if biological objectives are not met. This information is crucial for stakeholders to begin remediation or compliance measures. There are four general approaches to identifying potential stressors:

1) Correlative approach: correlations among potential stressors and biological responses developed on a site-by-site basis.
2) Relative risk: the increased risk of biological impairment associated with relative changes in stressor levels.
3) Tolerance values: species-specific limits for stressor levels based on either lab-based dose-response studies or field-based empirical data.
4) Mechanistic approach: identifying species-specific responses based on exposure such as molecular techniques (i.e., gene microarrays) or chemical dose-response investigations (i.e., toxicity identification evaluations).

None of these approaches have been rigorously evaluated and/or widely applied in California, The most frequently used approach has been the correlative approach, largely based on study designs that focus on biological assessments upstream and downstream of a discharge. Initial relative risk assessments have begun using the large-scale probability survey designs. Tolerance values have been explored for temperature, conductivity and sediment based on EMAP data (Rehn 2005).

Since any one of these approaches may require a substantial amount of effort with no guarantee of success at statewide spatial scales, initial steps for this task should focus on a pilot study to determine the feasibility of each approach. The US Environmental

Protection Agency (EPA) currently utilizes a Causal Analysis Diagnosis/Decision Information System (CADDIS) for assisting with biological community stressor identification (http://cfpub.epa.gov/caddis/). CADDIS integrates all four approaches to help build weight of evidence for determining potential stressor(s). However, CADDIS has not been strongly pursued in California. This task should use the CADDIS framework for at least three pilot studies that span different habitats and stressor categories. Recommendations for the future of stressor identification tools should be based on the success/failures of these pilot studies.

Product: Three pilot studies in California, summary document emphasizing the most effective stressor identification tool(s), recommendations for future stressor identification tool development.

4.5 Information management

The goal of this task is to create the infrastructure needed to analyze, share, and submit bioassessment and associated data to regulatory agencies. There is a large volume of data collected at each location for biological assessments including site information, sampling information, physical habitat data, basic field chemistry, as well as taxa-by-taxa identification and abundance data. Supplementary quality assurance data should also accompany the results. This mass of information needs to not only be efficiently stored and effectively extracted, but also analyzed, synthesized and presented into useful information for managers and the public.

The State's Surface Water Ambient Monitoring Program in conjunction with California's Environmental Data Exchange Network (CEDEN) has made significant progress in the area of information management. A database architecture for storing biological data has been completed. A distributed database network has been initiated so that data can be efficiently uploaded and extracted for analysis. This distributed database network consists of regional data nodes in southern California, the San Francisco Bay area, and north-central California. All three nodes have developed systems based on stakeholder input. Remaining steps for the distributed database network include the development of a public-friendly user interface. This is important for making the transition from data to information. This step can be effectively accomplished after the geospatial data foundations (Tasks 4.1 and 4.2) are completed. Training on this information management system must include stakeholders (Task 4.9) as well as documentation.

Product: Database architecture for storing biological objectives data, development of user interface, documentation for the information management system.

4.6 Implementation Plan Development

The goal of this task is to define how biological objectives can be used in regulatory programs such as 303(d) listing, NPDES compliance, 401 certification, etc. Chemical water quality objectives, as will the biological objectives, typically apply at single site - single event scales. However, regulatory programs often rely upon multiple sites and/or multiple samples per site over time. This task will focus on how single site-event information should be translated into policy that influences these regulatory programs.

The linkage between biological objectives and compliance should be abundantly clear, convincing, and defensible.

The State currently has specific guidance for how multiple site/event data should be compiled to make regulatory assessments. For example, there is an implementation policy for the 303(d) listing/delisting program. However, this guidance is based largely on chemical objectives. This task necessitates working with stakeholders, regulators, and external science advisors to define the implementation guidance for biologically-based objectives. Topics such as how many sites are needed per waterbody, how many sample events over what period of time, the precision or error inherent in the stressor response model, and how large the magnitude of impairment, should all be factors used to decide if a site is defined as biologically impaired.

Product: Implementation Plan to accompany the draft bio-objectives policy that includes draft language for 303(d) listing, NPDES permit comliance, and 401 certification.

4.7 Rulemaking

The goal of this task is to follow the legislatively defined public process of developing, adopting, and implementing objectives. We contemplate documents such as a detailed Staff Report and proposed amendments to the State Water Board's Inland Surface Waters Plan. This task will also include public dissemination, review, and response process such as public workshops, response to comments, informational meeting presentations, State Water Board briefings, and a California Environmental Quality Assessment (CEQA) document, or equivalent, including a discussion of the factors that must be considered when establishing water quality objectives, which include economic considerations.

Product: Full and complete administrative record for state and federal approval.

4.8 Outreach

The goal of this task is to actively reach out to technical, regulatory, regulated, and non-governmental stakeholders to ensure that their ideas, suggestions, and concerns are fully considered. This task covers three important areas. First, stakeholders need to know about the development of any new objective. Transparency is imperative for a successful process because even the perception of secrecy dooms the process based on mistrust. Second, biological objectives will never be perfectly acceptable to all parties, but it is important that the Water Boards give all parties a reasonable and fair opportunity to voice their opinions about the respective merits/demerits of the recommended approach(es). Third, the technical aspects of the objectives should receive a thorough and rigorous peer review to ensure scientific integrity.

This task will require the creation of three different committees. These include:

1) Scientific Advisory Group: reviews all technical aspects of the objectives development. Members should not be vested in the state process, so out-of-state experts selected by the stakeholders are recommended.
2) Stakeholder Advisory Group: the primary committee that responds to early ideas and concepts, provides recommendations on policy development, and serves as

one of the vehicles for public outreach. Members should represent different sectors of the community such as regulated dischargers (i.e., wastewater, storm water, industrial, etc.), non-governmental organizations or environmental advocacy groups, other vested parties as needed and interested.

3) Regulatory Advisory Group: the primary committee that responds to regulatory specific issues such as Implementation Plan development including compliance/enforcement. Members may include staff from each of the nine Regional Water Boards, staff from each of the major programs at the State Water Board, other state resource agencies such as Fish and Game, and federal agencies such as the USEPA and/or Fish and Wildlife Service.

This three-committee system, if started early in the process, will provide tremendous value in terms of communication and policy-building, creating fair and equitable objectives, and minimizing potential road blocks at the end of the objective development process.

Product: Creation and facilitation of three Advisory Groups; Scientific, Stakeholder, and Regulatory.

4.9 Training and Standardization

Once biological objectives are promulgated by the state, there must be clear and concise guidance to stakeholders on how to collect data with prescribed levels of quality assurance, how to interpret data, how the data will be used in regulation, and what to do if one fails to meet the objectives.

To ensure biological objectives are applied appropriately, standardization of bioassessment monitoring must be achieved. This Task will require development of Methods Manuals, Standard Operating Procedures, and Quality Assurance Plans as needed to ensure that this standardization occurs. To the State's benefit, significant progress in the area of methods standardization has already been achieved. Methods Manuals for field sampling currently exists for benthic macroinvertebrates and physical habitat measurements (http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads). A statewide Manual for Standardized Taxonomic Effort also exists (http://safit.org/ste.html). Standard Operating Procedures for a variety of techniques has been prepared. A Quality Assurance Plan is currently in preparation.

This task will also require a series of training workshops. The training curriculum should be targeted for implementation and could include regulated, regulatory, and non-governmental sectors. While there is no curriculum developed as of yet, the State Water Board has a Training Academy that could serve as the platform for implementing the training.

Products: Methods Manuals/SOPs, training curriculum, training events in various regions of the state.

5.0 SCHEDULE

Mar 2010	Workplan Complete Stakeholder Committee Formation
Jun 2010	Regulatory and Scientific Steering Committee Formation Technical Work Element Review and Approval
Mar 2011	Reference Condition assessment Method Standardization Information Management
Sep 2011	Stressor response models
Mar 2012	Waterbody classification Stressor identification pilot studies
Jun 2012	Scientific Advisory Groupreview of written Technical Reports
Sep 2012	Final draft technical documents to Stakeholder Advisory Group
Dec 2012	Final Technical Documents to the SWRCB

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