California Healthy Watersheds Assessment

Technical Approach

Overview

California contains a diversity of land and water resources that support public health, recreation, and the local economy. Degradation of these ecological resources inevitably leads to a diminished capacity to support the many services they provide. In recognition of these linkages, and presented with the challenge of repairing 20,000 miles of impaired streams and rivers, California has invested heavily in the restoration of its aquatic resources. Equally critical to California's future, however, is protection of its 20,000 miles of healthy streams and rivers. Without adequate protection, these streams may also become impaired and add to the financial and ecological burden that has proven so difficult to escape. The State Water Board's Surface Water Ambient Monitoring Program is leading the *California Healthy Streams Partnership* to address these challenges with an integrated and strategic approach for identifying and protecting the state's healthy watersheds before they become impaired.

The U.S. Environmental Protection Agency (EPA) is funding an effort to provide the State Water Board's Surface Water Ambient Monitoring Program with technical support in conducting an integrated assessment to identify healthy watersheds throughout California. An integrated and strategic approach incorporates multiple elements of ecological integrity and their interconnections. These include: 1) landscape condition, 2) habitat, 3) hydrology, 4) geomorphology, 5) water quality, and 6) biological condition. The goal of the California Healthy Watersheds Assessment is to produce an "aggregated analysis of whole system conditions" based on these six elements. The California Healthy Watersheds Assessment will build on previous work and use existing data to demonstrate the linkages between aquatic ecosystem components and the landscape of which they are a part.

Examples of Healthy Watersheds Assessments in other States

The California Healthy Watersheds Assessment is one of the first statewide, integrated assessments that seeks to not only identify healthy watersheds, but also to enhance understanding of the linkages between the ecological elements that comprise a healthy, functioning watershed. There is no standard or established methodology for conducting this type of assessment. However, a number of states have conducted related assessments that will influence the design of the assessment approach that will be carried out for California. Many of these are described in EPA's Draft *Identifying and Protecting Healthy Watersheds: Concepts, Assessments, and Management Approaches*[1]. For example, the Virginia Healthy Waters Program uses probabilistic monitoring data from fish and macroinvertebrate surveys to evaluate aquatic ecosystem health and presents the results at the watershed scale. Statewide maps that compare multimetric watershed integrity scores to modeled reference conditions are used to communicate the results (Figure 1). A complementary approach evaluates watershed integrity through the use of landscape indicators (http://www.dcr.virginia.gov/natural_heritage/vclnawater.shtml). The Chesapeake

[1] http://water.epa.gov/polwaste/nps/watershed/hw_techdocument.cfm

Bay program evaluates the health of the bay through a multimetric approach as well, but reports the results in the form of a Chesapeake Bay Health Report card (Figure 2). The State of Massachusetts has also developed a water quality report card. The State of Minnesota combines these approaches and uses its online Watershed Assessment Tool to evaluate watershed health with a multimetric index, reporting the results in the form of both maps and watershed "health reports" (Figure 3).

The California Healthy Watersheds Assessment approach is being developed based on a combination of the approaches described above and in the EPA document *Identifying and Protecting Healthy Watersheds*. The most appropriate approach for conducting such an assessment relies largely on the available data, which are briefly described in the following pages.

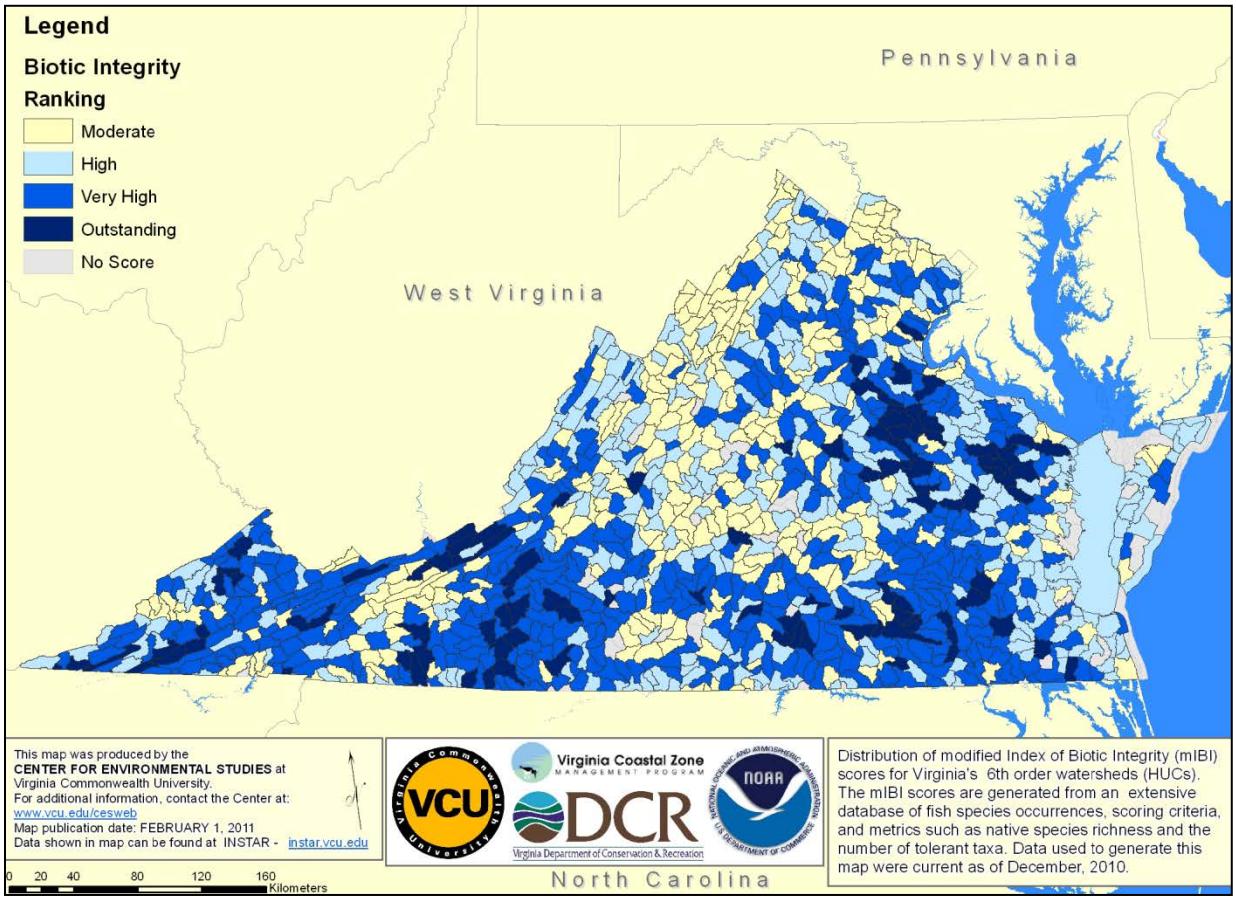

Figure 1. Statewide map of biotic integrity scores for Virginia watersheds (http://gis.vcu.edu/instar/watershed.html).

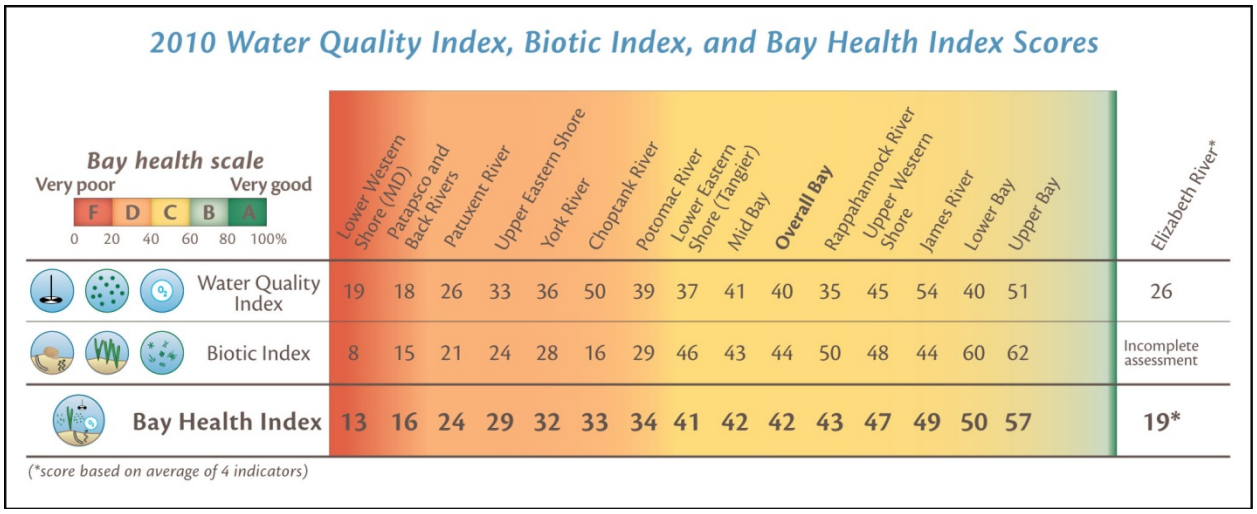

Figure 2. Chesapeake Bay Health Report Card (http://www.eco-check.org/reportcard/chesapeake/2010/).

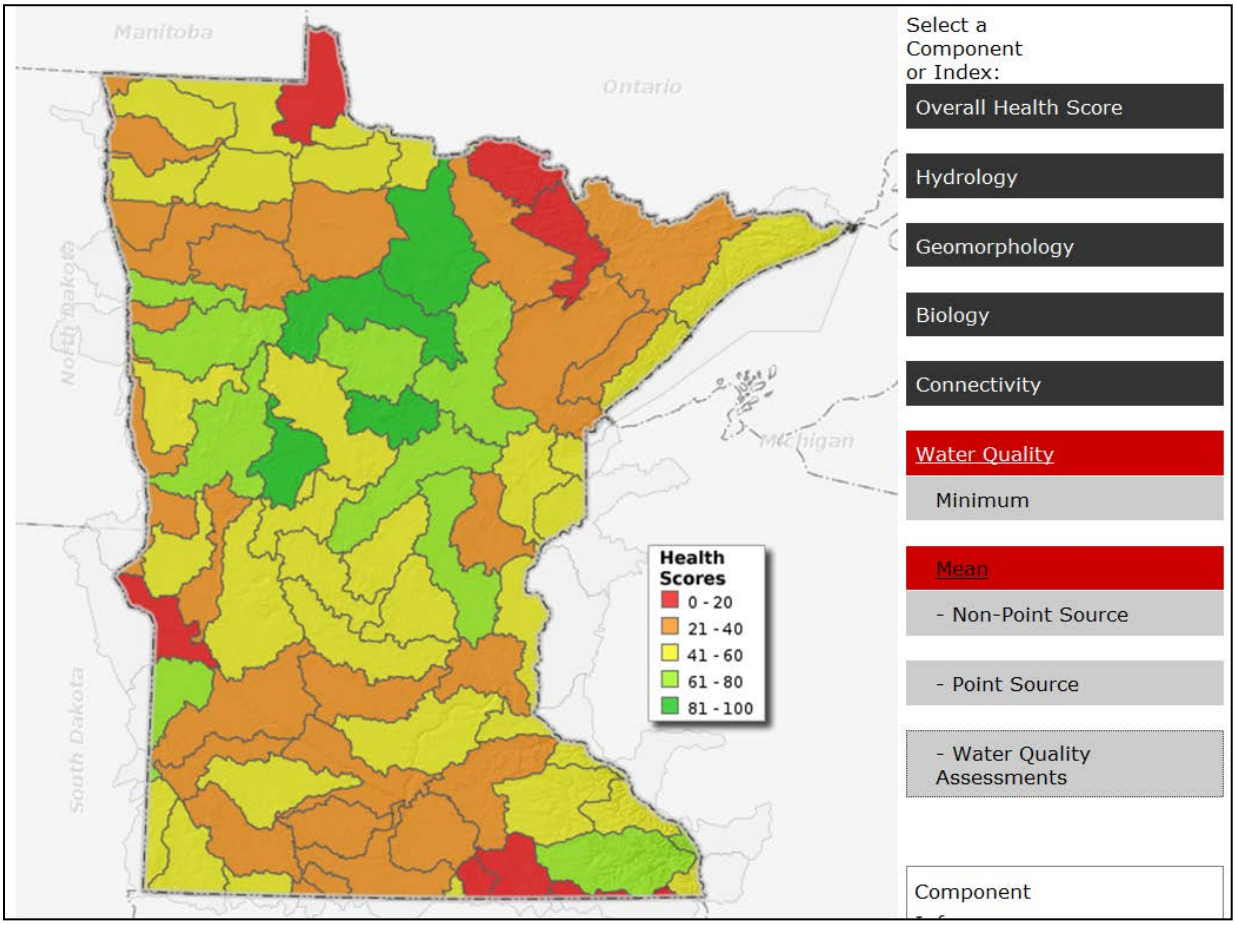

Figure 3. Screenshot from Minnesota's online Watershed Assessment Tool showing a statewide map of watershed health scores. Individual indicators can be chosen from the menu on the right to explore patterns across the state (http://www.dnr.state.mn.us/watershed_tool/index.html).

Available Data for California

The biological, chemical, and physical integrity of aquatic ecosystems is largely a product of landscape factors and hydrologic processes occurring at the watershed scale. Watersheds with natural, vegetated land cover and free-flowing rivers are likely to contain aquatic ecosystems with water chemistry values within natural ranges of variation and physical habitat characteristics that support balanced and adaptive biological communities. Watersheds with large amounts of urban and agricultural land cover and/or large numbers of dams and water withdrawals are less likely to contain healthy aquatic ecosystems. There are many indicators that can be used to evaluate the condition of a watershed's landscape, habitat, hydrology, geomorphology, water quality, and biological condition. For example, macroinvertebrate species richness is one indicator of biological condition while percent natural land cover in the watershed is an indicator of landscape condition. Monitoring and assessment programs in California have collected vast amounts of data for these indicators. Some of the programs and datasets that will be used in the development of the California Healthy Watersheds Assessment are listed below (this list was compiled by the Healthy Streams Workgroup):

- Perennial Streams Assessment (PSA): Statistically valid estimates of biological, chemical, and physical habitat/geomorphic condition for perennial streams statewide.
- California Rapid Assessment Method (CRAM): Wetland condition assessments for hundreds of sites statewide.
- Reference Condition Management Program (RCMP): An effort to better define reference condition (minimally disturbed) and characteristics of reference sites statewide.
- California Essential Habitat Connectivity Project: A green infrastructure assessment for California.
- Fire and Resource Assessment Program (FRAP): A statewide program that assesses conditions and threats to California's landscapes and aquatic resources based on geospatial data.
- Fire Regime Condition Class: Evaluates degree of departure from the natural fire regime.
- Ecosystem Management/Watershed Assessment Framework: An assessment of watershed health on US Forest Service lands.
- California Environmental Resources Evaluation System (CERES): An electronic database of data and information on California's natural resources.
- Flow / hydrology / hydrologic alteration: These data will be obtained from the US Geological Survey and the California Department of Water Resources.
- Land use / land disturbance index: Developed as part of California's bioassessment program.
- Water Rights Diversions (eWRIMS): Information on water withdrawals in California.
- California Environmental Data Exchange Network (CEDEN): A database of environmental information in California.
- Integrated assessment (303d/305b): Statewide water quality assessment.
- Stream Pollution Trends (SPoT) program and statewide toxicity assessment: Evaluates relationships between toxic pollutants and landscape factors in California.
- Biology (BIOS, CalFish): Information on aquatic biological condition.

- Fish Tissue Contaminants: Data from the bioaccumulation oversight group (BOG) on contaminants in fish tissue.
- Groundwater Dependent Ecosystems: An assessment by The Nature Conservancy that identifies the locations of ecosystems dependent on groundwater resources.
- GeoTracker/Groundwater Ambient Monitoring & Assessment Program (GAMA): A groundwater information system for California.
- Safe to Eat Fish & Shellfish: A California program that evaluates fish and shellfish consumption safety.

Methods

The California Healthy Watersheds Assessment will integrate data and assessment results from the sources listed above to provide a holistic and integrative understanding of watershed health in California. Separate, but interrelated approaches will be used to conduct the analysis at two spatial scales.

Multimetric Index at the Sub-basin Scale

A multimetric index combines individual metric values into one overall index value. Before being aggregated into a multimetric index, each individual metric must first be tested, calibrated to a consistent scale, and transformed into a unitless score. Each metric describes a different process or function and the multimetric index describes overall condition. A multimetric index will be developed for identifying healthy watersheds at the spatial scale of 8 digit hydrologic unit codes (HUC8) as defined by the U.S. Geological Survey (USGS). There are 140 HUC8 sub-basins in California, with a median size of 850 square miles (Figure 4). This flexible approach will allow for a broad scale view of watershed health across the state, as well as statewide comparisons of individual metric values. Metrics that represent landscape, habitat, hydrology, geomorphology, water quality, and biological condition will be derived from the available datasets using geospatial measurement techniques. These metrics will then be combined into a draft multimetric index using standard index development procedures. This will include selection of a “goal” or “reference” value for each indicator, which is important for normalizing the metric values to a relative scale. Different normalization options will be discussed with the Healthy Streams Workgroup. Options for combining the individual metrics into an overall index of watershed health will also be discussed with the Workgroup. For example, one common method for calculating a multimetric index is to calculate the average of all indicator scores in a watershed. This approach is often augmented by applying weights to those indicators that stakeholders feel should be given more importance. In addition, cutoff values of the index must be chosen to represent different classes of watershed health (e.g., healthy, moderately healthy, degraded, severely degraded, etc.). It may be appropriate, in some cases, to apply a cutoff value to the overall index score whereas, in other cases, a low score in any one indicator may result in a watershed being excluded from the “healthy” class. These and other critical decision points will be discussed with the Workgroup.

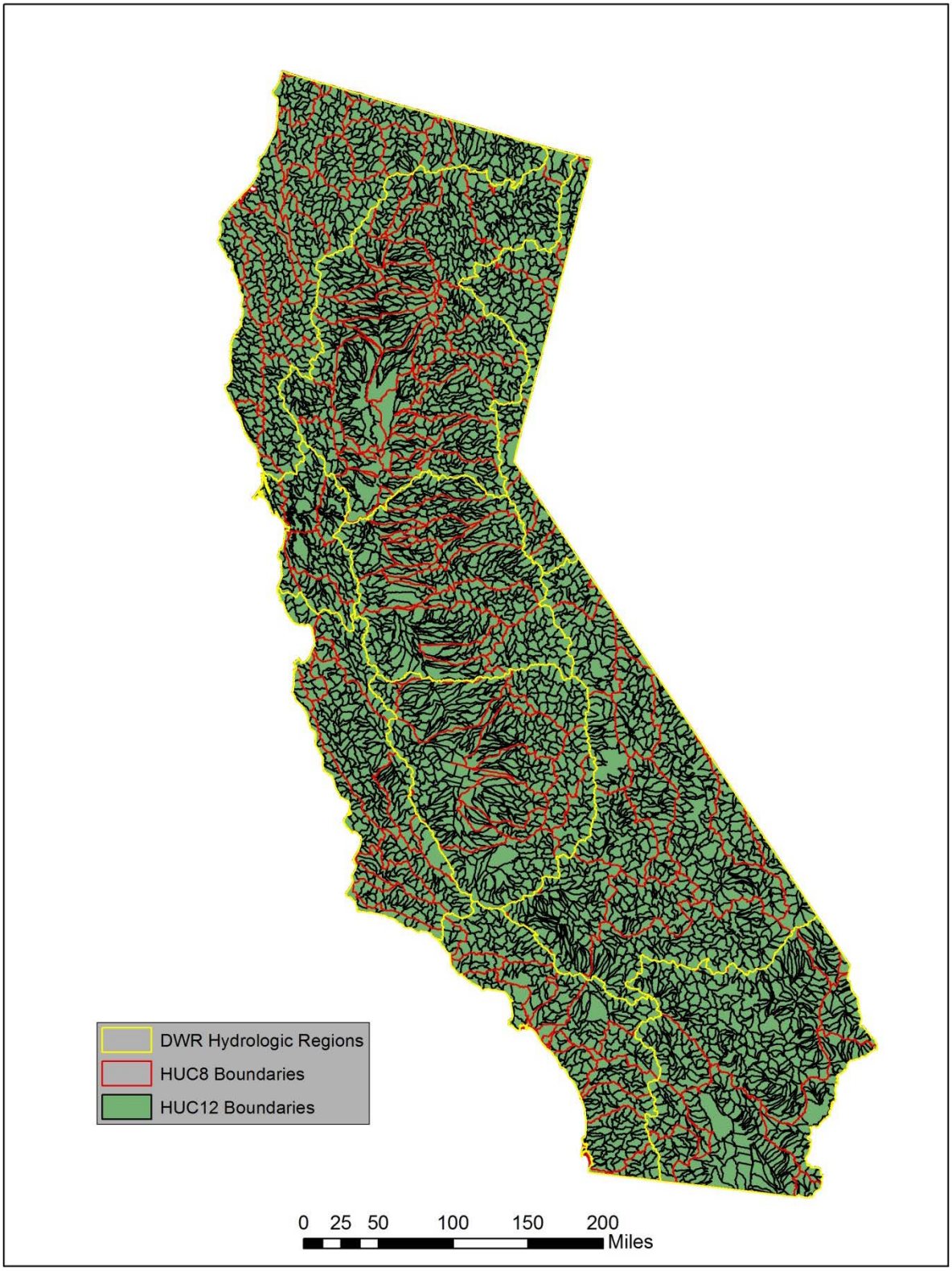

Figure 4. The three scales at which the California Healthy Watersheds Assessment results will be reported: 1) Division of Water resources (DWR) Hydrologic Regions; 2) Hydrologic Unit Code (HUC) 8 sub-basins; and 3) HUC12 sub-watersheds.

The HUC8 scale is an appropriate level of analysis for developing a multimetric index to evaluate healthy streams in California because it is a common scale at which water resource management decisions are made, the boundaries are physically (rather than administratively) determined, and because high quality datasets representing each healthy watersheds element are available at this scale. A number of these datasets, such as the PSA data, were developed using probabilistic monitoring designs. Indicators from these datasets can be reported at the HUC8 scale with a known level of statistical confidence. Other datasets, such as streamflow gage data, were not developed using probabilistic monitoring designs and will thus not allow for statistically valid estimates. These datasets are still valuable however and will be used in the development of the multimetric index. Caveats regarding the level of confidence for each metric will be explained fully in the final report.

Statistical Estimates at the HUC12 Subwatershed Scale

The data used to develop the HUC8 multimetric index will also be used to explore relationships between the different healthy watersheds elements (e.g., landscape condition and biological condition). Based on this analysis, statistical models for estimating watershed health at the HUC12 scale will be developed using available geospatial datasets. There are 4,628 HUC12 watersheds in California, with a median size of 32 square miles (Figure 4). This will allow for a more detailed picture of watershed health in California and will illustrate the critical relationships between landscape, hydrologic, biological, chemical, and physical attributes of watershed health. Demonstrating these relationships is important for an integrated understanding of watershed health and will assist the Healthy Streams Partnership with their goal of supporting hypothesis-driven data collection, analysis, and reporting to provide more useful and more integrated information to decision makers.

This approach relies on identifying relationships between landscape-level data (e.g., land cover, dam density and storage capacity, etc.) and instream data (e.g., macroinvertebrates, water chemistry, flow, habitat) in order to estimate watershed health in the absence of more detailed data. Statistical methods, such as multiple linear regression, will be used to examine these relationships and build predictive models for estimating watershed health at the HUC12 subwatershed scale. Since data are not available for each healthy watersheds attribute in every HUC12 watershed, the results of the detailed assessment will be statistical estimates with a known level of confidence that can potentially be confirmed with future data collection efforts.

Final Products

The deliverables for this analysis will include a series of maps displaying indicator and index scores for each HUC8 and HUC12 in California, as well as a final report detailing the background, methods, results, and a discussion of the assessment and its implications for protection of healthy watersheds in California. Recommendations for future data collection efforts that may help to refine the assessment and provide additional detail needed to properly identify healthy watersheds in California will also be provided. The report will present the results of the assessment in the form of maps, tables, and/or "report cards" that allow the reader to examine the individual indicator scores and their relationships with one another, as well as the overall watershed health score. The most appropriate method for

communicating the results will be determined through discussions with the Healthy Streams Workgroup and/or the Water Quality Monitoring Council.

Major Decision Points

The project milestones listed below also represent decision points that require discussion with the Healthy Streams Workgroup and/or the Water Quality Monitoring Council. More decision points may be identified during the project.

- Technical approach
- Selected indicators for representing each healthy watersheds element
- Selected reference values for indicator normalization
- Selection of indicator weights (if any)
- Index calculation method (e.g., simple average or "independent applicability" approach)
- HUC12 statistical models
- Selection of most appropriate approach for presenting assessment results (e.g., maps, report cards, etc.)