Chapter 4, part I. WATERSHED MANAGEMENT COORDINATION

PERTINENT CALFED GOALS AND OBJECTIVES

The goal of the CALFED Watershed Management Coordination Program is to help coordinate and integrate existing and future local watershed programs and to provide technical assistance for watershed activities relevant to achieving the goals and objectives of the CALFED Bay-Delta Program.

The watershed monitoring plan addresses these program objectives:

- Describe the basic biophysical functions and processes of a watershed, including linkages from upper watersheds – to lower watersheds – to the Bay-Delta.
- Identify watershed functions and processes relevant to the CALFED goals and objectives
- Describe how land use and other human activities affect and are affected by watershed functions and processes
- Illustrate benefits that accrue from watershed plans and projects designed to favorably affect the CALFED goals and objectives
- Provide monitoring assistance to aid watershed organizations.

The geographic scope of the Watershed Management Coordination Program includes watersheds at all scales within the CALFED solution area. The Watershed Management Coordination Program supports whole-watershed approaches. Consequently, at larger scales, there is overlap between the geographic purview of the Watershed Management Coordination Program and other CALFED programs that focus on the Bay-Delta and the alluvial Central Valley.

Given this overlapping geographic scope, the watershed monitoring plan shares objectives of the Ecosystem Restoration Program, addressing rehabilitation of the capacity of the Bay-Delta estuary and its watershed to support natural aquatic and associated terrestrial biotic communities in ways that favor native members of those communities, with minimal ongoing human intervention.

Likewise, watershed monitoring addresses objectives shared with the Water Quality Program, addressing aspects of water quality improvement for environmental, agricultural, drinking water, industrial, and recreational beneficial uses of water.

GOALS AND OBJECTIVES OF THE WATERSHED MONITORING PLAN

Monitoring Goals

The purpose of this plan is to promote monitoring and information exchange locally and regionally to facilitate trend evaluation and adaptive management related to watershed health and to assist development of community-based institutions for watershed stewardship. The principal goal of this plan, consequently, is not to prescribe particulars, but rather to develop a framework that will assist local watershed programs and managers participating in the Watershed Management Coordination Program in developing their own monitoring programs. For the most part, monitoring will be designed and implemented by local organizations, drawing on local expertise and local resources. CALFED can best assist in this by:

- identifying a set of common elements that should be addressed in a coordinated way in monitoring programs at various scales,
- coordinating access to needed baseline data and background landscape information in integrated, readily usable formats (including GIS), and
- providing a framework for summarizing monitoring data and coordinating information exchange across watersheds.

Refining this framework will be an iterative process involving program participants.

Program participants have repeatedly emphasized the importance of watershed monitoring as a tool for building community cooperation, knowledge, and stewardship ethics. Mutual effort in formulating monitoring needs, designing and implementing a monitoring program, and interpreting results provides an important mechanism for opening communication and gaining consensus on needed actions. Monitoring designed and carried out entirely by agencies unconnected with local communities does not provide these beneficial effects, and cannot benefit from the knowledge base and observation opportunities that rest with local residents.

This plan is also intended to serve CALFED managers in evaluating program success, and, in serving needs of program participants for baseline and background information, to provide CALFED with needed information on basic biophysical processes, linkages, functions, and landuse relationships, as outlined in the program objectives.

Problem Statement

Watershed management concerns itself with the composite of human activities, landscape characteristics, and natural processes that together affect quantity and quality of water downstream, as well as ecological health and social well-being within the watershed. The central problem for a watershed monitoring program is to provide a basis for measuring outcome of particular management actions or trends and evaluating these against a background of variation over time and space.

Watershed monitoring addresses both physical conditions of the landscape and human actions that affect those conditions. Themes identified as high priority for monitoring include:

- Watershed conditions that affect flow and sediment regimes, water quality, and flood hazard.
- Habitat conditions that affect species of the Bay-Delta, especially those species that move out of the lower reaches during part of their lives.
- Habitat conditions that affect support of populations and species that are integral to ecosystem integrity and biodiversity at local scales.
- Productivity and other characteristics of vegetation in watersheds that affect sediment and nutrient inputs to the Bay-Delta and shape regional carbon budgets.

Trends in urbanization and agriculture were identified as having major effects on watershed conditions. These and other landuse practices affect rate and quantity of water reaching streams, input of sediment and contaminants, vegetation patterns, and availability of suitable habitats. Watershed improvement actions related to landuse practices are a major focus of the Watershed Management Coordination Program. Consequently, landuse elements are included within each monitoring theme.

Social and economic relationships related to water and watershed management are of high priority to participants in the Watershed Management Coordination Program. People living in watersheds are affected by availability and quality of water for various uses, economic exchanges related to water and water management, and maintenance of ecosystem and habitat functions that support resource-dependent livelihoods, valued species, and quality of life. Costs of watershed improvement are incurred by communities that may or may not receive the economic benefits of improved water quality or quantity. Likewise, downstream environmental and economic costs are not necessarily accounted for in upstream land-use decisions. Given the importance of these issues, themes related to social and economic aspects of watershed conditions

and management actions are included in this monitoring framework.

Scale Issues

The various users applying watershed monitoring information for their varied purposes perform tasks that fall into two distinct categories:

1. Detect, describe, and analyze trends and processes at various scales.
2. Evaluate effectiveness of particular practices in achieving desired results.

These two purposes require information on the same set of ecological and social themes, but focus at different scales. At these different scales, different process attributes come to the forefront. We highlight these contrasts in our discussion of monitoring elements (Appendix *VII.H*).

At all scales, hydrologic processes are strongly influenced by background characteristics of landscape, weather, and past history of natural and human-related change. In addition, extreme events at irregular intervals have large effects on system characteristics. Consequently, the problem of detecting trend and change due to management actions against this background of large and irregular spatial and temporal variation is a major issue at all scales. We identified central integration of background landscape and climatic information, current and historic, in forms readily usable for watershed-based analyses at all scales as a high priority component of CALFED support for watershed monitoring. Ready access to this information will facilitate local monitoring efforts while serving CALFED's internal needs as well.

The overall monitoring framework we propose employs data collection and analysis at three scales:

1. Basins and Sub-basins (CalWater Hydrologic Units and Hydrologic Sub-Areas).
   This is the scale at which information on input to the Bay-Delta system is needed to interpret ecosystem response and water-management implications of trends. Monitoring at this scale focuses on flow regime, water quality, and sediment regime characteristics, interpreted in light of
   - long-term and current weather,
   - basin geology, landforms, and vegetation, and
   - broad patterns of change in land use and vegetation related to agriculture, urbanization, road construction, and logging.

   Trend monitoring is the central focus at this scale. Direct effectiveness monitoring (interpretation of relationships between observed trends and specific management actions) is generally not feasible at this scale, although projections from observations at smaller scales (see 3. below) can be used to estimate management effects.

   Existing monitoring systems and landscape data are adequate for many parameters of interest at this scale, although substantial effort will be required to integrate data from diverse sources and convert them into forms that can be readily analyzed across ownerships and jurisdictions. Composite trends in population and habitat conditions for species of special concern are appropriately evaluated at this scale based on monitoring conducted at finer scales. Similarly, composite trends in habitat availability, species diversity, and distribution of non-indigenous species should be evaluated at this scale.

2. CalWater Planning Unit.
   This is the scale (6,000 to 30,000 acres) at which relationships between watershed health attributes and trends in land-use and management practices can be realistically differentiated from background variation. Local governments, citizen groups, and agencies often make management

decisions and conduct planning at this scale. Interpretation of trends observed at basin scale relies on consistent monitoring of a uniform core set of watershed attributes at this scale. A system for summarizing and providing access to data across watersheds and regions is needed to facilitate trend analysis of this kind. We recommend that the Watershed Management Coordination Program support establishment of such a system.

At this scale, local concerns and objectives, local institutions, and characteristics of local landscapes appropriately take major roles in shaping monitoring programs. Consequently, it is not appropriate for CMARP to recommend a uniform monitoring program beyond the limited set of core attributes needed for regional trend and cumulative effects analysis. Instead, we propose developing a set of prototype monitoring programs addressing different objectives in different landscapes to serve as templates and/or points of departure for locally developed monitoring programs.

3. Small Watershed or Stream Reach. Although cumulative effects of land-use trends may be detectable in larger watersheds, effective adaptive management feedback and estimates of program success rely on focused monitoring of contrasting practices in small watersheds or stream reaches. Attributes monitored at this scale should be selected to address specific questions regarding specific actions or practices, or to provide a basis for estimating parameters difficult to measure directly in larger watershed units. For example, sediment regime and habitat quality/species distribution parameters are appropriately monitored on a network of small sites.

RECOMMENDED MONITORING

In each of the major monitoring theme areas, the workteam developed a conceptual model identifying important system elements and relationships. These were then used to identify 1) baseline (e.g., streamflow records) and background landscape data (e.g., geologic mapping) needed for monitoring design and trend interpretation, and 2) central monitoring elements appropriate at the three scales identified above. Specific monitoring needs largely depend on locally defined priorities, consequently the following is not intended to be exhaustive or tightly prescriptive. Selection of a specific set of common core parameters and associated standard methods is a subsequent task to be carried out in collaboration with program participants.

Flow and Sediment Regimes – Geology, landforms, climate and weather, and regional vegetation patterns largely shape characteristics of flow and sediment regimes. Baseline and background data on all of these are high priority at all scales, along with ongoing recording of weather (especially precipitation, runoff, and evapotranspiration parameters), streamflow, groundwater, and suspended sediment and solute loads. Other aspects of sediment regime are high priority for focused monitoring (see below). Floods have major effects on many system properties and merit particular attention.

Flow and sediment regimes are affected by activities that accelerate erosion and alter runoff/infiltration relationships. Roads and agriculture are of particular concern at all scales, as are increased rate of slope failure associated with logging and wildfire. Activities that directly alter streamflow and ground water have major effects on flow and sediment regimes downstream; of major concern are dams, diversions, ground water pumping, irrigation practices, and urban runoff. Activities that affect stability and roughness of channels, banks and

floodplains, directly or through vegetation modification, also affect sediment regimes. Again, roadbuilding and agriculture are major concerns for direct effects, and logging and grazing affect riparian vegetation in some areas. In large watersheds, broad patterns of land-use change produce detectable effects on sediment and flow regimes. More subtle differences in land-use patterns and management practices have effects that, although indistinguishable from background variation several miles downstream, have major consequences for local habitat values and significant cumulative effects at broader scales. Effects of irrigation practices and mine drainage on solute loads are of major concern in some watersheds (see Water Quality, below).

At large-watershed scale, baseline and periodically updated background data are needed on broad patterns of landuse, urbanization, road network density, water use and flow manipulation (both surface and groundwater). At intermediate scale, detailed background data are needed on agricultural land and water use practices, wildfire, logging, and roads with associated monitoring of near-stream vegetation cover, rates of channel change, and rates of slope failure. Focused monitoring is needed at small scales to address rates of sediment production and channel change associated with particular agricultural, logging, and road building practices. Existing monitoring programs provide much of the direct monitoring of flow needed at broader scales. Sediment regimes are less adequately addressed by existing monitoring at these scales. Still, the primary needs are for central integration, better access to existing data sources, and evaluation of patterns and trends in light of baseline and background data mentioned above.

Water Quality – Water quality includes elements of water temperature, suspended sediments, and undesirable chemical constituents from natural sources and human activities. We refer to the Water Quality and Ecosystem Restoration Program monitoring plans for monitoring elements related to drinking water quality, aquatic productivity, and sources and ecosystem effects of contaminants and pollutants. Water quality elements addressed in this framework focus on sediment and water temperature as habitat characteristics, vegetation attributes that affect sediment movement and channel shading, and activities that affect these vegetation attributes.

Near-stream vegetation structure, water temperature, and suspended sediment are appropriately monitored at fine scales in conjunction with species and habitat monitoring. Focused monitoring is needed to address relationships among logging, grazing, road construction, and other practices and these water-quality attributes.

Habitats – Human activities have substantial effects on the extent of habitats and maintenance of processes and conditions that support survival and reproduction of native species as well as establishment and spread of non-indigenous species.

Alteration of flooding regime and disruption of sediment supply due to dams, levees, and gravel mining have drastically altered channel geomorphic processes, severely affecting habitat values and successional process. Groundwater pumping, diversions, and other water management activities have affected flow regimes, water tables, and water quality in ways that have major effects on habitat availability.

Habitat destruction and fragmentation from agriculture and urbanization, loss of pollinators and dispersal agents through pesticide use and other effects, and spread of non-indigenous species further limit ability of landscapes to support the full complement of native species that have been present historically.

Modification of riparian vegetation and alteration of channel-floodplain relationships affects primary production and transfer of organic matter from the terrestrial to the aquatic system. These changes have ramifications for community composition and species diversity across many species groups, locally and downstream. Wetlands like those that once occupied much of the Central Valley have high rates of primary production and accumulation of organic detritus (e.g., peat formation). Loss of wetlands, coupled with agricultural practices that cause net loss of organic matter from soils, especially peat soils of former wetlands, have altered the regional carbon budget.

Background/baseline data with periodic update are needed on extent and configuration of habitats and distribution of native and non-indigenous species, especially species of special concern. Focused monitoring will be developed to address population trends and habitat quality for special status species in conjunction with the Conservation Strategy. Trends in species diversity at large-watershed scale should be monitored based on analysis of composite trends in multispecies inventories at small-watershed scale.

Background data needs include mapping of habitat distribution and comprehensive distribution data for special status species and focal species groups (e.g., birds, fish, vascular plants). Monitoring of sediment and channel dynamics, vegetation structure, productivity and detritus regimes, and management practices that directly affect habitat quality should be planned in coordination with habitat mapping and species inventories so that results can be effectively used in evaluation of trends at broader scales. Monitoring of vegetation and detritus should ideally be planned so that it also provides a basis for assessing implications of wetland restoration and landuse practices on regional carbon budgets and community trophic structure.

Economic/Demographic – Human population, demographics, and patterns of economic activity have major effects on watershed conditions. Improvement of watershed function requires modification of landuse and management practices, with associated costs, benefits, and other consequences for local and distant communities. Likewise, water transfers and other aspects of management and sale of water and hydroelectric power have direct and indirect economic impacts. Associated environmental impacts have their own economic and social ramifications, affecting quality of life, viability of resource-dependent livelihoods, and human health.

Specific monitoring needs in this area largely depend on locally defined priorities. Elements will generally include human population and demographics, patterns of employment and economic activity, economic costs and benefits related to water quality, flow regime, and selected quality-of-life indicators.

Watershed Action/Education – Education and community values influence and are influenced by watershed improvement actions and, as discussed previously, the act of watershed monitoring itself. Consequently, this is an important element in analysis of Watershed Management Coordination Program's effectiveness. Current directories of community-based watershed actions and monitoring programs should be maintained by the Watershed Management Coordination Program. Further detail and priorities in this area will be developed by program participants.

RESEARCH QUESTIONS

Applied research to evaluate and improve effectiveness of watershed restoration practices is a high priority. Research at small scales on implications of alternative agricultural, forestry, and road construction practices on flow and sediment dynamics is needed for interpretation of system trends and program effectiveness at larger scales.

Development of baseline data resources and GIS tools for analysis of physical, biotic, and cultural characteristics of landscapes is essential for analysis of trends and management effects. Development and integration of this information into useful, multipurpose, web-accessible databases constitutes a technological challenge. Although not research in a strict sense, this task requires the type of expertise, resources, and approach ordinarily employed in research.

LINKAGES

Ecosystem Restoration – Watershed monitoring provides information on flow, sediment, water quality, and nutrient dynamics relevant to analysis of ecosystem characteristics and habitat quality in the Bay-Delta, as well as feasibility of restoration of channel geomorphic processes. It also provides data on habitat availability and quality for species that use habitats outside the Bay-Delta. Watershed monitoring provides the basis for analyzing trends in land-use practices that have major effects on the Bay-Delta ecosystem.

Water Quality – The Watershed monitoring program refers to the Water Quality program for description of elements related to natural and anthropogenic dissolved constituents and contaminants and to design a program that will provide data for assessing effectiveness and cumulative effects of watershed improvement actions. Watershed monitoring provides information on land-use patterns, sediment delivery and transport data, and biotic response related to water quality.

Water Transfers – Watershed and Water Transfers monitoring programs share a need for detailed baseline information on geology, geomorphology, weathering (e.g., background rates of solute production), and climate. Both programs address effects of land-use patterns on groundwater dynamics and use. We refer to the Water Transfers monitoring program for description of elements related to groundwater measurement, agricultural practices, demographics, and patterns of economic activity. Watershed monitoring is expected to provide data needed to evaluate environmental consequences of water transfers.

Delta Levees – Watershed conditions have implications for flood risk, and sediment regimes have implications for channel maintenance. Watershed and Delta Levees programs share a need for information on extreme precipitation and flow events, although the scale of focus differs because of the need here for analysis of alternative management actions and land-use trends in small watersheds.

Storage and Conveyance – Watershed monitoring contributes information on flow and sediment regimes relevant to water availability and maintenance of storage capacity in reservoirs. It also provides information on land-use practices relevant to interpreting trends in flow and sediment regimes. Storage and conveyance monitoring provides information relevant to estimating consequences for downstream users, including economic costs and benefits, associated with watershed improvement and land-use trends.