HYDROLOGIC ASPECTS OF THE SIERRA NEVADA ECOSYSTEM PROJECT

RICHARD KATTELMANN
Sierra Nevada Aquatic Research Lab, Star Route 1, Box 198,
Mammoth Lakes, CA 93546 USA

The Sierra Nevada Ecosystem Project is an evaluation of environmental conditions in the entire Sierra Nevada mountain range. It was requested by the United States Congress in 1992 and will be completed in December 1995. The basic goal of the project is to assess the status of the entire set of ecosystems in the Sierra Nevada, including their social, economic, and ecological conditions. This information should provide an improved basis for managing the natural resources of the Sierra Nevada in a sustainable manner. The project should provide an interesting example of a current approach to assessing environmental conditions throughout a large mountain range.

Water is central to the resource issues and conflicts of the Sierra Nevada. Changes in water availability, streamflow quantity and timing, flooding, quality of surface and ground water, aquatic and riparian habitat, and soil erosion and sedimentation have occurred throughout the range as results of land disturbance and resource management. However, the magnitude of such changes, their relative importance, and the ability of natural and human communities to adapt to or recover from alterations in hydrologic processes in the Sierra Nevada are largely unknown. Concern about degradation of water quality is widespread in public reaction to past and proposed resource management activities. However, Sierra Nevada streams and their drainage basins have been considered to be more resilient to forest management activities and other disturbances than other mountain areas of the western United States. The water resources evaluation of the Sierra Nevada Ecosystem Project has attempted to determine whether the primary water source of California, the Sierra Nevada, is functioning well in general and what problems need attention.

The Sierra Nevada generates about 25 cubic kilometres of runoff each year, out of a total of about 88 cubic kilometres for California. This runoff from the Sierra Nevada accounts for an even larger proportion of the developed water resources and is critical to the state's economy. The rivers of the Sierra Nevada supply most of the water used by California's cities, agriculture, industry, and hydroelectric facilities. The storage and conveyance systems developed to utilise the water resources of the Sierra Nevada are perhaps the most extensive hydrotechnical network in the world. Major water supply systems have tapped several rivers to meet the urban needs of several large cities in California. Irrigated agriculture throughout California consumes more than the annual runoff of the Sierra Nevada and accounts for more than 90 per cent of the consumptive use in the state. More than 150 power houses on the Sierra Nevada rivers produce about 24 million megawatt-hours of electricity per year. Sierra Nevada rivers support extensive aquatic and riparian communities and maintain the Sacramento-San Joaquin Delta and San Francisco Bay ecosystems.

The Sierra Nevada seems to be fundamentally intact as the preeminent water source for California society, agriculture, and industry. The hydrotechnical structures that facilitate exploitation of streams for social uses create the greatest impacts for those very uses as well as for aquatic ecosystems. The sophisticated management of the water system has created artificial patterns of streamflow in the lower reaches of most rivers and their principal tributaries. There are not many opportunities for further development of water resources in the mountain range, given the existing infrastructure and water rights. Existing groundwater development near foothill communities limits the availability of subsurface water as a dependable supply for future growth. The managed flows and physical barriers to movement of water, sediment, and biota have substantially altered aquatic and riparian ecosystems to something other than natural. Changes in reservoir management practices may offer the best hope for improving aquatic ecosystems where they are known to be impacted by artificial flow regimes. In general terms, almost any shifts back toward a natural hydrograph, such as seasonally fluctuating flows or occasional flushing flows, will be beneficial to the local biota.

Compared to the intentional alteration of streamflow through water management, hydrologic side effects of changes in land use are difficult to detect. Major changes in water and sediment regimes have not been observed in the main rivers and their larger tributaries as a result of shifts in land use. There may be a signal, but it is not obvious. Rapid expansion of

foothill communities has theoretically altered runoff and erosion processes enough to cause noticeable impacts in downstream channels, but quantitative and documentary evidence outside the Lake Tahoe Basin is lacking. Conversion of forest lands to roads associated with timber harvesting may have increased annual water yields and peak flows somewhat at the small watershed scale. However, decades of successful fire suppression may have increased evapotranspiration comparble to a pre-1850 fire regime and compensated for the flow increases attributed to roads and harvests. The offsetting magnitudes of either impact cannot be quantified at this time. The legacy of fire suppression creates substantial risks of serious hydrologic impacts from potential conflagrations.

Overall, chemical water quality remains very high, but cannot be considered pristine. A few local problems are very serious in Lake Tahoe, some abandoned mines, and some communities. The quality of receiving waters from the larger cities in the foothills has been degraded. Excessive sediment production is the most widespread nonpoint-source problem, but its extent and severity are unknown. Studies in other areas suggest that roads are the overwhelming source of sediments that end up in wildland streams. Disturbance in and near stream channels generate the vast majority of sediment transported by the streams. Information about sediment yields in the Sierra Nevada rivers is largely obsolete, and new reservoir sediment surveys are necessary to determine whether changing land use has accelerated sedimentation in the past few decades. Because of the importance of flowing water in diluting and dispersing pollution, alteration of streamflow by storage and diversion may be the fundamental water quality problem in the Sierra Nevada.