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Preface: Conservation and Management of Aquatic Resources in Arid Lands

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Water is clearly one of the most important natural resources in the western United States and drought is a major issue in states like New Mexico. Regulation of river flows and land uses in riparian zones and areas linked to them impair aquatic ecosystems and endanger the native biota in regions everywhere. The pervasive effects of humans on aquatic ecosystems reach their greatest magnitude in highly variable ecosystems situated in arid landscapes. The precious value of water, to humans and, in fact, to all life forms on Earth, demands that we look carefully at the changes we inflict on the landscape and seek an understanding of how we might inadvertently be affecting our own future existence.

This issue contains articles contributed to a conference on "Aquatic Resources in Arid Lands" that was held in Las Cruces, New Mexico on April 30–May 2, 2003. We organized this conference to bring together prominent aquatic scientists, natural resource agency personnel, and water users to consider issues associated with management of aquatic resources. Invited experts spoke on paleoclimatology, terrestrial-aquatic linkages, ecology, invasive species, decision-support modeling, river restoration, and conservation genetics. The 2-day conference concluded with a half-day facilitated workshop on "Sound Science and Effective Policy for Managing Aquatic Resources." This issue presents conference research papers on aquatic resources in five categories: climate, hydrology, endangered species, river restoration, and water policy.

Climatic uncertainty is the major challenge in managing aquatic ecosystems in arid lands. The first article by Lioubimtseva and Cole addresses the global concern of climate change. Compelling evidence for global warming continues to accrue, although the potential consequence for arid lands is uncertain. Lioubimtseva and Cole argue that the extreme variability of deserts contributes to this uncertainty and they raise the possibility that local and regional human impacts, such as large-scale irrigation projects, may have a greater effect on regional climate than global climate change. In a second article on climate, Hall et al. examine a 40-year climatic record for the upper Rio Grande Basin of New Mexico and Colorado. They report that there is little consistency in time or space in climatic variations across the region. Local regions have climatic shifts in specific periods of the year that appear unrelated to trends in other periods and places. Hydrologic variations in the basin generally indicate trends for elevated river discharge and earlier onset of freshet in recent decades.

Understanding hydrologic interactions between surface and groundwaters would enhance water resource management in many ways, especially in regions with most or all of the surface water appropriated for human uses. For the Alcalde Ditch in northern New Mexico, Fernald and Guldan have found that at least 5% of the total ditch flow seeps out of the ditch during irrigation season. Their research demonstrated that ditch seepage raises groundwater levels and orients subsurface flow paths toward the Rio Grande. This seepage also contributes delayed irrigation return flow to the Rio Grande and helps maintain river flow after peak runoff periods. In a second article considering hydrology, Rinne and Miller discuss the influences of stream hydrology and geomorphology on the composition of the fish communities in two desert rivers, the Verde and Gila. The authors believe many factors appear to influence the fish community structure including peak flow, mean volume and variation in flow, canyon-bound and alluvial reaches, and the presence of non-native species. They hypothesize that hydrology, geomorphology, and the introduction of non-native species are important factors structuring fish assemblages in southwestern rivers.

The endangered Rio Grande silvery minnow is the focal point for controversy over water use in the middle Rio Grande of New Mexico. In the first silvery minnow article, Cowley et al. describe aspects of the ecology of the species they inferred from examination of old museum specimens collected in 1874. Their analyses show that the silvery minnow forages on benthic periphyton and detrital organic matter. The kinds of diatoms found in the gut indicate the silvery minnow can tolerate nutrient-enriched habitats with low levels of dissolved oxygen. Scale annuli reveal a species with a longer life span than has been assumed. The genetic consequences to the silvery minnow that derive from captive breeding are the focus of a second article. Osborne et al. find that three captive stocks have depleted levels of genetic diversity, but similar levels of heterozygosity to the wild population. The authors caution that large-scale reintroductions of captively propagated silvery minnows into the Middle Rio Grande could cause significant changes in the genetic composition of the wild population.

In the first article on river restoration, Smith and Fernald explore the effectiveness of the National Environmental Policy Act (NEPA) as a driver for restoration. In an evaluation of the draft environmental impact statement for river management alternatives for the Rio Grande Canalization Project, the authors show that the environmental enhancement goals of NEPA are ineffective in achieving habitat improvement. A conceptual framework grounded in aquatic ecology facilitates understanding river ecosystems from a landscape scale and helps identify the problems in attempting to restore an isolated section of a river.

As human populations grow increasingly larger in arid lands, more of the native biota will become imperiled and listing of species under the Endangered Species Act will grow. The recovery plans for these endangered species are likely to provide a key driver for future habitat restoration. In a second article on restoration, Cowley discusses how recovery of the Rio Grande silvery minnow provides a basis for restoration of the middle Rio Grande. In comparing needed elements of recovery of the species with those for river restoration, Cowley finds that the two activities do not fully overlap. River restoration includes some elements that might not contribute directly, in measurable ways, to saving the species from extinction.

The final two articles deal with water management policy. Ward and Booker estimate the economic consequences of instream flows dedicated to support endangered species. In the middle Rio Grande, reallocating water from agricultural and urban uses to silvery minnow conservation results in economic damages to agricultural water users but not to New Mexico water users as a whole. Downstream users in New Mexico and Texas actually realize benefits from policy that redirects water to the silvery minnow. Economic impacts of instream flows dedicated to conservation purposes are greatest in drought years.

In the closing article, Sallenave and Cowley summarize the discussions that occurred in a facilitated workshop at the close of the conference. Natural resource managers confront significant problems in making sound, science-based management decisions. History, changing social values, legal constraints, economics, and politics affect policies for management of natural resources. Scientists have an important role in policy development by helping managers identify the correct problem and by applying scientific methods of inquiry to generate sound knowledge and insight; implementation of effective public policy for conservation and management of natural resources depends on it. On occasions when decisions must be made using information with less integrity and soundness than science, managers and scientists alike need to be honest and vigilant as they proceed.

We hope that this Special Issue will raise awareness of the need for an integrated and global perspective in water management. Significant problems associated with water use in arid lands will be more manageable, if future research is aimed at improving our ability to predict how aquatic ecosystems respond to change. Critical gaps exist in predicting biotic community responses to global climate change, practices to control spread of exotic species, endangered species recovery, and development of new water management paradigms.

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