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Aquatic Invertebrates: Sentinels of Watershed Condition

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An aquatic ecosystem is an interactive mosaic of environments, extending from headwater streams and wet meadows through mainstem rivers to the sea. Invertebrates and other living components of aquatic ecosystems tell us about the health of these landscapes.

Unfortunately, the laws governing water deny that our basic biological heritage has any relevance to societal needs. This denial, and resource degradation resulting from it, continue even though the Clean Water Act specifically mandates efforts to "restore and maintain the . . . biological integrity of the nation's waters." In the arid West, water is allocated on a first-come, first-served basis. Nationwide, the Clean Water Act is implemented as though crystal-clear distilled water running down concrete conduits were the ultimate goal.

Two hundred years of treating water like a commodity rather than a community have led to serious ecological decline. Human activity affects five attributes of watersheds and streams--water quality, habitat structure, stream flow patterns, sources of energy and nutrients, and biotic interactions. To protect the biota of streams, we must plan for these five factors in a comprehensive way. In the Pacific Northwest, we have contributed to the decline of Northwest salmon populations by degrading water quality with chemical pollutants; altering habitat structure by removing woody debris or destroying pools; disrupting flow patterns with dams; removing organic material from the riparian corridor; and changing relationships among species by overharvesting for sport or commerce, or by introducing exotic species.

Living systems provide the most direct and effective measure of the condition of watersheds and water bodies, as well as information critical to charting a course for federal and state programs to protect both the economic and ecological interests of society. Yet despite the efficacy of biological monitoring, chemical monitoring dominates water resource programs.

Biological monitoring detects changes in species composition, including the identity and number of species present; changes in ecological processes, such as nutrient dynamics and energy flow through food webs; and health of individuals, which is likely to influence species survival and reproductive rates. Water use and watershed alteration inevitably has unanticipated effects; in contrast to chemical monitoring, biological monitoring enables managers to detect change sooner, rather than later.

Biological evaluations can be used to diagnose and identify chemical, physical, and biological impacts as well as their cumulative effects; they can serve many kinds of environmental and regulatory programs when integrated with chemical and toxicity testing; and they are cost effective. Furthermore, because living systems respond to all impacts of human activity, they are

less likely than chemical measures to underprotect water resources. When combined with strictly chemical assessments of water resources, assessments using biological criteria typically find double the proportion of stream miles that violate water quality standards.

Fish and benthic (bottom-dwelling) invertebrates are particularly effective indicators of the condition of waterways and watersheds. Invertebrates are abundant and easily sampled, and the species living in virtually any water body represent a diversity of morphological, ecological, and behavioral adaptations to their natural habitat. As humans alter watersheds, changes in the benthic invertebrate fauna signal the consequences of our actions.

The ecological integrity of water bodies rests on the well being of all their biological components, not just the size of commercially important populations. Failing to protect phytoplankton, zooplankton, insects, plants, bacteria, or fungi ignores the key contributions of these groups to healthy biotic communities. The ability of a water body to support healthy living systems directly determines its ability to support human goals. No species, including those important to humans, can persist outside the biological context that sustains it.

Past water policy has ignored these biological realities to the detriment of water resources and human society. Policy that is refocused on protecting the biological integrity of waterways would offer a means for real protection of these resources. Let us adopt a broader concept of water; forge partnerships among scientists, policymakers, resource managers, and other citizens; revise the fragmented legal framework guiding water resource policy; redouble our efforts to protect existing waters, and restore those that are degraded. Programs to protect aquatic resources should be broadly conceived and explicitly biological. Chemically clean waterways are good; living waterways are better.

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