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Integrating Quaternary Science Research in Land Management, Restoration, and Conservation

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Most of us have come to expect that the general public will ignore the primary message of Quaternary science that change happens. A flurry, however, of recent media attention to 20th-century global warming and its anomalies from climates of the last millennium has brought climate science at least momentarily into popular focus. Similarly, public land-managing agencies and conservation groups have begun, under the rubric of ecosystem management, to incorporate concepts of historic variability into landscape analysis, ecological monitoring, population-viability assessment, and ecological restoration. While these are important turns, and credit the influence of Quaternary science, an increasing challenge for our community is to ensure that information is understood and used accurately. With the door to thinking about the past swung open, some odd concepts and misinterpretations have blown in – many of these are being codified in difficult-to-change policy, practice, and thinking (Millar and Woolfenden, 1999a).

AMQUA president Cathy Whitlock, in her recent message to the association (Whitlock 2000), urged Quaternary scientists to view our discipline not just as basic but applied science, and to tithe outreach efforts. As scientists in the U.S. Forest Service, we have straddled the line between research and management through our careers, and underscore Cathy's plea that paleoscientists are urgently needed now. Why is this? When ecosystem management emerged in the last decade as the guiding principle for land-managing agencies, mandates shifted from emphasis on resource extraction (timber, water, minerals) to ecosystem protection, and the concept of ecological sustainability emerged as central. The mission statements of the U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and U.S. National Park Service, for example, herald ecosystem sustainability – maintaining composition, structure, and process of a system – as key policy goals. Similarly, many conservation programs and non-governmental organizations such as The Nature Conservancy and The Wilderness Society embrace sustainability as a scientific foundation to conservation planning.

Although ecosystem sustainability has caught on quickly as a policy goal, implementing it on-the-ground has proven difficult. In management and restoration circles, historical conditions have emerged as surrogates for sustainable ecosystems, and a central guiding precept in the focus on sustainability (e.g., Frelich and Puettmann, 1999). The logic behind this derives from a faith that ecosystems were functioning adaptably (i.e., sustaining themselves) prior to arrival of modern humans. Thus, if managers ensure the restoration of historic conditions, ecosystems will be sustainable. "Historical", as usually interpreted in these contexts, has meant an unprescribed slice of time prior to Eurasian settlement, usually about AD 1650-1850. Inferences of pre-settlement conditions (e.g., USDA FS, 1993) are used as references for evaluating impacts of human activities in landscape analysis, targets for ecological restoration, baselines for monitoring and population viability, and descriptions of desired future landscape conditions.

Although ecology has embraced concepts of ecological dynamism, this has often focused on short-term forces of succession and disturbance. An erroneous implicit assumption remains that there are insignificant background changes over the past centuries or millennia – i.e., that trendlines are flat, even if they have wide or changing variances. For western North American wildlands, for instance, restoring *pre-settlement* conditions translates to using the Little Ice Age as the reference historical period, likely quite inappropriate as an indicator of current or future conditions. There is little understanding how conditions during past millennia have differed from the present, and how these are inaccurate pictures of what adaptable "natural" systems would be now (Kloor 2000). Without understanding the nature and magnitudes of past climate and ecological changes, conservation managers are limited in the ability to first separate and then mitigate human impacts from inherent environmental change. Further, using specific historical conditions as a baseline for evaluating human impacts can lead to misdiagnosing cause of changes and misprescription of treatments (Millar and Woolfenden 1999b).

The newly revamped planning rules of the U.S. Forest Service (USDA FS 2000) take a step farther in interpreting and using historic information. Referred to as the "Final Rule", this document is the single-most important policy directive for the agency and will undoubtedly affect policy of sister agencies. It lays out, in considerable detail and authority, the ideological foundation and operational approaches that must be followed in future land-use projects by all Forest Service units across the country. Last revised over fifteen years ago, the Final Rule equates sustainable landscape conditions to the range of variability in analog ecosystems throughout the "current climate period". The latter is defined as "the period of time since establishment of the modern major vegetation types, which typically encompass the late Holocene Epoch including the present, including likely climatic conditions within the planning period. The climatic period is typically centuries to millennia in length, a period of time that is long enough to encompass the variability that species and ecosystems have experienced" (Sec. 219.36). Managers are instructed to determine (infer) what variability within this period of time had been/would be for their landscapes, to compare current conditions with it, and to maintain resource conditions within this "expected variability". Unlike conceptual models where snapshots of historic conditions are the targets for management, managing ecosystems within variability of the last, say, 4,000 years and anticipated future 200 years, throws the door open to an extremely wide set of choices, still reflecting misunderstanding of historic processes of change.

The ecological research community has renewed attention on diversity, stability, and resilience, and has suggested that, rather than target historic conditions, managers should promote resilient ecosystem conditions. Initially, this might seem a better approach than one that aims to restore no-longer-ambient historic conditions or historic variability because it suggests we plan for unknown but variable futures by buffering ecosystems against many kinds of change. As currently interpreted, however, resilience also carries a strong normative implication of stasis. Although promoting ecosystem conditions that are resilient to minor disturbances (wildfire, insects and disease, minor climate changes) makes good policy sense, at some point environmental conditions will change more than systems can accommodate. From a paleoenvironmental perspective, successfully resisting significant change is futile – and a questionable goal in the first place. The paleo-literature amply documents that ecosystems often respond (adapt) to environmental shifts by undergoing significant re-organizations. If these occurred today, society might view them as catastrophic, or at least undesired. What might be done instead of resisting change is to promote conditions whereby change happens as gracefully as possible, i.e., in gradual ways or in ways that are least disruptive to society. As Quaternary scientists we might prepare the public, however, not to be overly surprised if transitions occur in fits and starts and unexpected directions.

Shedding light on misunderstandings and helping to develop paleo-defensible resource-management philosophies are thus important tasks for Quaternary scientists. Perhaps the single most important challenge is to foster a fundamental acceptance of the nature of environmental and ecological change over time. This is not to deny that many anthropogenic disturbances on ecosystems are "unnatural" and/or undesired. But until inherent attitudes about sustainability and stasis are couched within an overall *Weltanschauung* of continuous environmental change and ecosystem realignment, we will be stuck with resource-management approaches that go against the grain of nature. Understanding how historic systems responded under different climate-change scenarios, how climate mechanisms affect bioregions differently, and mostly how change is a key strategy for species persistence over time become priority topics in the nexus between paleoscience research and resource management.

How can Quaternary scientists work effectively with land-managers and policy makers? Given the significant cultural differences between research and management communities, effective communication often has as much to do with attitude as content. Thus, understanding the goals, demands, and real political stresses of the manager's universe are paramount. Public land-use agencies today are the forums where the American people play out their environmental values; as such the agencies are caught in the cross-fire of volatile social controversy. The broad missions of many of these agencies (e.g., multiple-use policies) mean that diverse values must be balanced in decision-making, thus putting the agencies regularly in the position of pleasing noone with compromise decisions. When scientists misunderstand legal and institutional constraints, grow arrogant about how their scientific information is (or isn't) used, or confuse personal opinion with objective fact, the gap widens and managers view scientists as one more special-interest group to deal with. A working relationship is far more effective in the long run than an adversarial one. Thus, appreciating the complex demands and emotionally exhausting role of managers, and repeating the mantra that an offer to help will go farther than strident critique, may make the difference to getting in the door.

Effective integration of science also depends on which doors we knock at. Most agencies have a stream of decisions being made that require, through laws such as the National Environmental Policy Act of 1969 (NEPA) and their state equivalents, frequent public disclosure and involvement. For direct and most immediate application, work at local levels. Local projects are least influenced by politics and most likely to accept, use, and implement outside help. Adopt a local unit for a geographic area you know most about. Check websites for current environmental projects and request that you be put on mailing lists for ongoing projects. Don't restrict involvement in these to publicized "comment periods" or to letters of review, but call or e-mail the individuals named as contacts at any time during the project's course. Offer to help by investigating specific areas of uncertainty, reviewing draft documents, volunteering to set up (and run) simple monitoring projects, finding cooperative funding sources, giving educational seminars or training sessions to local managers, volunteering graduate students on projects, or offering to run simple analyses in your lab. Stay close to a project from its onset through implementation – often focused energy is required to keep agency attention from straying, and outside commitment can make enormous difference.

To influence policy that affects many units simultaneously, work at state to national levels. Increasing attention is put on scientific assessments and science-based policy at these scales (e.g., efforts such as the Northwest Forest Plan, Sierra Nevada Ecosystem Project and Environmental Impact Statement, Greater Yellowstone Ecosystem Project, Southern Florida Ecosystem, or national policy about wildland fire, air quality, road building, endangered species). Regular policy revisions, such as the USFS Final Planning Rule mentioned above, are mandated by law (in this case, the National Forest Management Act of 1976); these present situations where major changes in philosophy on resource science and management are incorporated. Scientific involvement is increasingly demanded as a primary foundation in such revisions: The Planning Rule, for instance, was based on a national committee of scientists report (COS, 1999) – commissioned by the USDA –whose members were non-agency scientists.

Although the temptation may be great to focus on national policy for its widespread applications, effectiveness of individual scientists diminishes at these levels. Not only is the input of a great many people (scientists and other) weighed so that individual contributions tend to vanish, but strong political pressures often outweigh real scientific debate. One must be willing to put up with many frustrations, such as conflicting goals and objectives, frequent changes in directions and leadership, fluctuating budgets, influence from special-interest groups, and in general much wasted time. Further, the higher the policy level, the longer the directives take to be implemented (if at all), due to such things as repeat delays in finalizing policy; changing administrative, societal, and political backgrounds; appeals and lawsuits; insufficient funds for implementation; and many other bureaucratic impediments.

Although choosing to work in the public arena has challenges, the opportunities to influence policy and land stewardship are great. By keeping our sight on final outcomes, scientists can build the intellectual bridges that enable managers and policy-makers to apply meaningful scientific information in conservation planning and resource decision-making. Although science is only one form of knowledge that contributes to resource planning in the public sector, there are many as yet under-utilized channels by which scientists can ensure that science is properly used. The initiative of scientists can effect conservation planning that is consistent with relevant available research, accommodates risks and uncertainties fairly, and incorporates unexpected outcomes, thereby promoting the best resource stewardship possible at local to global scales.

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