Surviving Stereotypes:
Indigenous Ecology, Environmental Crisis, and Science Education in California

By Michael Capurso

I. Origins

Not in his most dire prognostications could John Muir have foreseen the extent of the damage that would be done to the natural world of California within a century of his death. In an 1876 essay entitled *God's First Temples: How Shall We Preserve Our Forests?* he predicts that the Golden State's gold and silver, "stored in the rocks, locked up in the safest of all banks" would continue to "pay out steadily… centuries hence, like rivers pouring from perennial mountain fountains." He then adds:

> The riches of our magnificent soil-beds are also comparatively safe, because even the most barbarous methods of wildcat farming cannot effect complete destruction, and however great the impoverishment produced, full restoration of fertility is always possible to the enlightened farmer. (p. 629)

Muir would surely have valued Allan Schoenherr's *A Natural History of California* (1992), though it is likely that some of its contents would greatly disturb him. Gold mining, for example, may no longer be as profitable an enterprise as Muir thought it would still be today. Nonetheless, as Schoenherr reports, the "safest of all banks" are no longer so secure.

> The threat of environmental degradation from mining operations is not over. A gold-mining process known as cyanide heap leaching has been developed. In this process, low-grade ore is piled

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> up, and a cyanide solution is sprayed on top. … Obviously, there is concern that the highly toxic cyanide solution may escape into groundwater or streams, but miners assure all those concerned that the process is safe and efficient. (p. 234)

One may well imagine Muir's likely reply to these mining industry executives' assurances. It is harder to imagine his reaction to "the enlightened farmer" of 21st century agribusiness, whose practices have led Schoenherr to make a grim prediction of his own.

> Desertification in the Great Central Valley is continuing. … A comprehensive plan, involving environmentally sound principles, will have to be enacted soon, or agriculture in California will suffer the same fate as that of the Fertile Crescent in the Tigris and Euphrates valleys. (p. 543)

Most Californians today would be at least as shocked by this fact as Muir would likely be. Assumptions of the inexhaustible bounty of the land and its resources are older than the Bear Flag Republic and American statehood. In 1830, eight years before Muir was born, Juan Bandini extolled the land's vast potential in a proposal for its development.

> The climate and fertile valleys of California offer all types of vegetation a person could hope for. … It is very unusual to find a plain anywhere in the territory that is not able to produce fruitfully. In addition, all the fields and hillsides produce infinite types of wild fruit, such as strawberries and other exquisite and diverse herbs, many of which have not been botanically classified. … The country also abounds in deer, rabbits, and hare. Unfortunately, there is also an abundance of bears, wolves, coyotes, squirrels, and moles, which do a good amount of damage in the fields, especially the latter three. Geese, cranes, and ducks are plentiful in season, and a unique type of quail is abundant. In sum, Alta California lacks none of the essential elements for an inexhaustible production. The only thing it does lack is people. (Beebe & Senkewitz, 2001, p. 385)

Given that one of Bandini's foremost objectives was the secularization of the missions, and that these had from their inception relied on forced labor by the region's indigenous peoples, it may seem odd that he perceived California as unpopulated. But this notion is consistent with European and American views of California Indians, who were perceived as occupying the lowest niche on the scale of human cultural and racial development, lower even than Indians elsewhere in the Americas. As historians such as James Rawls, Albert Hurtado, and Tomás Almaguer have documented, the dehumanization of California Indians was an integral component of Euro-American justification for their displacement, enslavement, and extermination in the process of exploiting the region's economic potential.

"There is no question but that in the time before the discovery of America by Columbus," as Robert F. Heizer and Albert B. Elsasser (1980) write in *The Natural World of the California Indians*, "the California region was one of the most densely populated areas of the continent north of Mexico" (p. 26). The authors emphasize

California Indians' expertise as hunters and gatherers. As Rawls (1984) observes, "European visitors argued that the *superior* natural environment of California had somehow created an *inferior* people. They argued that the abundance of wildlife and the temperate climate of the area had made life too easy for the California Indians" (p. 32). Other writers such as Malcolm Margolin (in Almaguer, 1994), refuting this negative stereotype, sometimes unintentionally reinforce its basic assumptions. "Lack of agriculture was not the result of isolation, conservatism, laziness, or backwardness…" Margolin writes. "The truth is far simpler: Central California Indians did not adopt traditional agricultural methods because they did not have to. Acorns, along with an extremely generous environment, provided them with a more than adequate diet" (p. 110).

With such deeply rooted assumptions established as authoritative in both negative and positive views of California's first nations, it is unsurprising that what students are taught about them today focuses on how the peoples of different regions made use of the naturally-occurring resources available to them. The *History-Social Science Content Standards for California Public Schools, K-12* (1998), which addresses California Indians very narrowly and only in grades one, three, and four (see Capurso 2009), omits nearly everything except hunter-gatherer practices from consideration prior to European contact. The *English-Language Arts Content Standards* (1997) (see Capurso 2005) includes no mention of California Indians. One would thus hardly expect the *Science Content Standards* (1998) to depart from this pattern, as indeed it does not; no reference to indigenous knowledge of the natural world appears in the pages of that document. Native cosmology is present only in its complete absence. I do not maintain that science class should become a place to learn about cosmology. I merely observe that it already is one. Vine Deloria, Jr. (2001) has written extensively about how the cosmology inherent in Western scientific thought, preserving rigid and supposedly objective boundaries that determine what can be regarded as scientific knowledge, has sundered human beings' connectedness to nature.

> Western civilization seems clear, orderly, obvious, and without possibility of reform primarily because it defines the world in certain rigid categories. The product of this clarity, however, is a certain kind of insanity that can survive only by renewed efforts to refine the definitions and that, ultimately, becomes totally self-destructive. (p. 4)

By omitting other paradigms for understanding how human beings gain and use knowledge of the natural world of which we are a part, science education contributes to the process currently underway in which a part is destroying the whole. California offers a good example.

2. Old Ways

Omission, too, is curriculum. "Rather than base their existence on a particular animal or crop, the California natives evolved into highly omnivorous inhabitants"

(p. 1) writes William Seacrest (2003) in *When the Great Spirit Died: The Destruction of the California Indians.*

> Derided and scorned as "root diggers" by the early Anglo visitors to their lands, [they] nonetheless had a rich and varied culture. Living close to the earth as did most primitive peoples, they developed a proximity and awareness to nature which pervaded every aspect of their lives. They had a mystical reverence for their surroundings—for the game they killed or worshipped, for the seeds they ate, and for the rich land in which they lived. (p. 2)

In this notion of richness and reverence is embodied an unspoken assumption of separateness between human beings and the rest of the natural world that is more revealing of European than Native American cosmology. Heizer and Elsasser (1980) transmit a similar point of view.

> In the native peoples of California, who lived here for so very long before the whites appeared, we can see the true ecological man—people who were truly a part of the land and the water and the mountains and valleys in which they lived. The environmentalists and conservationists of today feel a kinship with the Indians in their respect for nature, a feeling which at times rises to that of the sanctity of the natural world. (p. 220)

In recent years, scholars in a variety of disciplines have begun to challenge both the notion that pre-contact Indians were proto-environmentalists and the perception of California Indians as simply hunter-gatherers. The alternative perspectives emerging from this research undermine lingering stereotypes of indigenous peoples as "primitive" worshippers of nature. Ted Steinberg writes in *Down to Earth: Nature's Role in American History* (2002):

> Obviously the Indians transformed the ecology of North America in their efforts to survive. But two points about their particular relationship with the land are worth underscoring. First, ample evidence suggests that in many instances, Native Americans exploited the landscape in a way that maintained species population and diversity. In California, for instance, Indians pruned shrubs for the purpose of basket making, but took care to do so during the dormant fall or winter period when the plant's future health would not be jeopardized. Similarly, shifting agriculture tended to mimic natural patterns in a way that modern agriculture, with its emphasis on single-crop production, does not. (p. 17)

The best study yet to examine these issues and their implications in California is M. Kat Anderson's *Tending the Wild: Native American Knowledge and the Management of California's Natural Resources* (2005). "As I rediscovered the Old Ways in California, I began to look more broadly at indigenous practices around the world" she explains.

> [The] parallels indicated to me that our human forebears everywhere did not just passively gather food and basketry materials but actively tended the plant and animal populations on which they relied. There was no clear-cut distinction

> between hunter-gatherers—the category into which most California Indians had been tossed—and the more "advanced" agricultural peoples of the ancient world. Moreover, California Indians had likely completed the initial steps in the long process of domesticating wild species, something that ancient peoples in other lands had always been given sole credit for. (p. xvii)

Rejecting the absolute dichotomy between "exploitation" and "hands-off preservation" in humans' relationship with the planet, she characterizes California Indians as exemplifying "a middle way, a calculated, *tempered use* of nature (p. 2). Finding ways to use and live in the natural world without destroying its renewal capacity is one of the major challenges facing modern-day Californians, just as it was for the people who migrated here more than ten thousand years ago" (p. 9). Surviving stereotypes about these people and how they met this challenge are blinding us to our own challenges today, even as we continue to make these increasingly dire.

Schoenherr's *Natural History* is exemplary not least because it makes it clear that this is a history still unfolding in the present, and that the pages we now write are in the process of erasing in just a few decades entire chapters that have preceded them over millions of years.

> Much of California's nature is threatened. … Not only does California have the greatest number of unique organisms in the continental United States, but it also has the highest number of threatened species, many of which are among the unique or endemic ones. Some 608 kinds of plants are listed as threatened with extinction. (p. xi)

Throughout his work, Schoenherr explicates scores of human-induced ecological catastrophies and perils past and present. The final words of its epilogue dedicate *A Natural History* "to the thoughtful people who are willing to work together to preserve the natural order of things and restore the land from damage that thoughtless development has brought" (p. 725). However, as Anderson observes in *Tending the Wild*:

> Wilderness preservation, a concept perhaps unique to Western culture, is necessary … But setting aside wilderness is only a reaction to the plundering of natural resources, and both spring from a mind-set of alienation from nature. Moreover, the wilderness concept tends to compartmentalize nature and culture, giving humans the illusion that activities done outside of protected areas will not affect what is within. (p. 120)

Or to put it another way, where there's fire there's smoke.

3. Burning Truths

Surveying the terrain of controversy over how indigenous ecological practices are now to be understood, Sheperd Krech III in *The Ecological Indian: Myth and History* (1999) asserts:

> The tension is between those who think that Indians were somehow nontech-

> nological or pretechnological, had no impact on the environment, and were therefore "natural," and those who disagree. … But wilderness, as others have emphasized, is an artifact of a time and place—the twentieth-century United States—and untrammeled wilderness "is a state of mind." By the time Europeans arrived, North America was a manipulated continent. Indians had long since altered the landscape by burning or clearing woodland for farming and fuel. Despite European images of an untouched Eden, this nature was cultural not virgin, anthropogenic not primeval, and nowhere is this more evident than in the Indian uses of Fire. (p. 122)

Anderson portrays this manipulation as reciprocity. "Traditionally, Indians did not consider their actions management per se; 'management' is a Western term implying control. Rather, caring for plants and animals in the California Indian sense meant establishing a deeply experiential and reciprocal relationship with them" (p. 153). She provides abundant and detailed examples to demonstrate the degree to which Indian lifeways yielded California "far greater degrees of managerial care and ecologically sophisticated manipulation than are found today" (p. 156).

> When the first Europeans visited California, therefore, they did not find in many places a pristine, virtually uninhabited wilderness but rather a carefully tended "garden" that was the result of thousands of years of selective harvesting, tilling, burning, pruning, sowing, weeding and transplanting. (p. 126)

> Deliberate burning increased the abundance and density of edible tubers, greens, fruits, seeds and mushrooms …; enhanced feed for wildlife; controlled … insects and diseases …. It also removed dead material and promoted growth through the recycling of nutrients, decreased plant competition, and maintained specific plant community types such as coastal prairies and montane meadows. (p. 136)

"It is highly likely" she later maintains "that over centuries or perhaps millennia of indigenous management, certain plant communities came to *require* human tending and use for their continued fertility and renewal" (p. 156). The sheepherders and cattlemen who displaced Indians continued to employ this technique, until the imposition of fire suppression policies in the first half of the twentieth century. Schoenherr explicates this dynamic well.

> In the past, fires were started by lightning or by natives who knew the value of such fires to the economy of the forest ecosystem. These frequent fires would burn off litter and duff, open the canopy to allow light to enter, and open [redwood] cones. Fires would loosen and soften the soil and release nutrients to it. In contrast, fire suppression allowed a long accumulation of flammable materials that could produce a very hot conflagration if a fire did start. There is also evidence that long periods of fire suppression enabled a deadly fungus to invade the root systems of the conifers …. This disease… is killing an inordinate number of trees in Yosemite Valley. (p. 119)

"By suppressing fire," Schoenherr writes "the National Park Service and the U.S. Forest Service were 'loving their trees to death'" (p. 12).

But scientists have only recently begun to acknowledge Indian uses of fire, and still cannot see (as it were) the wood for the trees. Harold Biswell, among the first, in *Prescribed Burning in California Wildlands Vegetation Management* (1989) demonstrates the continued prevalence of the hunter-gatherer stereotype in entitling his second chapter "Fires Set by Lightning and by Indians"—as if both kinds were comparably random natural events. "The Indians of California found little or no need for agriculture," he writes.

> Food was plentiful, consisting of acorns and other seeds, wildlife, and seafoods along the coast and fish in the rivers. Acorns were their principal plant food. Oak trees were abundant over nearly all of California, just as they are now except where removed for agricultural reasons. (p. 49)

The operant assumption here is that hunter-gatherers living amid such abundance might use fire to increase the convenience of hunting and gathering, but surely not consciously to shape their environments in such a way as to actually *cultivate* all those "removed for agricultural reasons" oak trees. He emphasizes:

> In no way does this book advocate the lessening of efforts in wildlands fire prevention and suppression; these activities are essential. Instead, it advocates prescribed burning in wildlands vegetation management, since these fires can be highly beneficial in preserving and enhancing vegetation and other wildland resources, as well as in reducing the wildfire hazards. (p. 9)

Obliviousness to indigenous modes of being in the world even while advocating the decontextualized adoption of an ancient practice is still commonly enshrined in scientific terms as being for the purpose of resource management. Thomas Berry in *The Great Work: Our Way Into the Future* (1999) characterizes this orientation toward the natural world as a storehouse of resources for human use as a fundamental tenet of Western cosmology.

> The deepest cause of the present devastation is found in a mode of consciousness that has established a radical discontinuity between the human and other modes of being and the bestowal of all rights on the humans. The other-than-human modes of being are seen as having no rights. They have reality and value only through their use by the human. (p. 4)

When science is conceived of narrowly as a means of serving the interests of human life, it paradoxically becomes a force that undermines the viability not only of human but also of all other life. "The Indian perspective of the natural world" Deloria (2001) asserts "is not subject to this limitation because it already has a fundamental principle of interpretation/observation that pervades everything that Indians think or experience" (p. 33). Like Berry, Deloria sees great potential in a mutually respectful dialogue between Western and Indian ways of knowing. "The

next generation of American Indians" he maintains "could radically transform scientific knowledge by grounding themselves in traditional knowledge about the world and demonstrating how everything is connected" (p. 39).

Daniel Wildcat, in his essay "Indigenizing Politics and Ethics" (in Deloria & Wildcat, 2001), specifies the difference between the Western understanding of human beings' relationship with the earth and its other inhabitants and that of Indian peoples, which as he defines it holds "the concept of person, or personhood, to include plants, animals, and other natural features of [the] environment." This does not make it less scientific.

> Morality and politics require that we acquaint ourselves with the many personalities we interact with daily. Natural resource "managers," public policy makers, scientists, and the general public can gain much by developing policies and practices informed by this key feature of indigenous North American worldviews. … It is frustrating to constantly hear non-Native peoples speaking romantically of the Indians' "closeness to nature" or "love of nature." The relationship is more profound than most people can imagine, and the implications of this relationship will imply uncomfortable consequences for many. … As Onondaga elder Oren Lyons remarked during the twenty-fifth-annual Earth Day celebration in Washington, D.C.: "We don't call a tree a resource, we don't call the fish a resource. We don't call the bison a resource. We call them our relatives. But the general population uses the term resources, so you want to be careful of that term—resources for just you?" (pp. 93-94)

The instinct to dismiss this point of view as mystical or sentimental does not emerge from an absence of a cosmological prejudice. It is itself an expression of one.

4. Closing the Gaps

In order to achieve a hybrid wisdom derived from both cosmologies, the scientific establishment will need to overcome what Deloria (1999) describes as its habitual reaction of "paternalism" and "chilling ridicule" (p. 5) to assertions of the importance of traditional Indian knowledge and practices. As Anderson points out, for example, "The inability of plant and animal geographers and authors of floras and faunas to distinguish natural and human-extended distribution has probably resulted in many mistaken assumptions about the 'natural ranges' of plants and animals" (p. 160). Schoenherr's *Natural History* offers several revealing instances of this pattern. Even when dutifully explaining how the "Digger Pine" got its name for providing one staple in the diet of Indians of the Sierra, and adding that Blue Oaks have the same distinction, he remarks: "An unexplained gap occurs in Digger Pine distribution. It should be an associate of Blue Oak all around the Great Central Valley. However, it is missing from the Kaweah drainage near Three Rivers, at the southern entrance to Sequoia National Park" (p. 95). (See also p. 111.) No consideration is given to the possibility that these trees grow together in such consistent fashion because Indians planted and tended them to do so; instead, in

the case of Black Oaks, it is supposed that "clumping may result from unclaimed acorns left behind by Gray Squirrels, who bury them in sizable caches for winter sustenance" (p. 109). Schoenherr also notes, again without mention of any possible connection to the cessation of Indian ecological practices, that:

> The predator extermination program imposed by humans has caused an unnatural abundance of acorn-eating animals such as gophers, mice, ground squirrels, rabbits, and deer. … The consequence of this imbalance is that throughout much of the Foothill Woodland, in the Sierra Nevada and the Coast Ranges, Blue Oaks are not regenerating. Acorns and seedlings are being eaten out of existence, which ultimately could cause Blue Oaks to disappear. (pp. 96-97)

Effects of the disruption of the complex native patterns of interdependence among human beings and other life are evident in other increasingly acute ways. Schoenherr's treatment of the impending crisis in California agriculture is thorough and authoritative. He notes "In a single year the income from California's agriculture in greater than the total value of all the gold mined since 1848. Of the total agricultural income in California, about 42% is generated by four farm products (p. 540). In California, 85% of the water is used by agriculture (p. 32). So much water is pumped by this system that the State Water Project is the largest user of electricity in the state (p. 16). Irrigation of big tracts of land, using water subsidized by public finds, has encouraged large-scale agribusiness oriented toward immediate profit, rather than long-term land use (p. 541). A day of reckoning is near, when California will be faced with the reality that its agricultural practices could lead to its own destruction" (p. 17). The ongoing destruction of countless other species in this process (as usual) goes unmentioned. Anderson sees the crisis from an indigenously-informed perspective, and also perceives elements of a solution.

> Today's industrial agriculture relies on fewer and fewer crops, monoculture, chemical fertilizer, and pesticides, creating homogenized landscapes in which everything is dead but the crop. Subsidized by massive inputs of fossil fuels and tending to degrade the soil over time, our agricultural practices are clearly unsustainable. Critics of industrial agriculture contend that sustainable agriculture can only come from considering agricultural systems as ecosystems, dependent on diversity, natural processes, and species interactions for healthy functioning. … Thus awareness of how California Indians blurred the line between gathering and agriculture can be helpful in the design of sustainable agroecosystems, which resemble the managed "natural" ecosystems of the Indians. (p. 253)

It is difficult to imagine how such a "natural" approach could emerge or be implemented as long as the science that informs agronomy and policy excludes modes of scientific thought that are responsive to the presence of nonhuman life as more than resources. Whatever forms a solution may take, its development will depend to a significant extent on how California's present and future generations of citizens, and in particular its science teachers and scientists, learn to understand the problem. Since science class

is the only place where such learning can take place in a manner capable of guiding the combined work of all other disciplines, it would be unwise in the extreme to be content with this content area remaining insular to native lifeways.

5. Eureka

In the Golden State (which features John Muir on the back of its commemorative quarter, and a Grizzly Bear—the last within its borders was killed in 1922—on its state flag and seal) what are public school students (who are supposed to become its informed voting citizens, public officials, and scientists) expected to learn in science class? To answer this question, first consider what science teachers are expected to learn to teach them, and what schools of education in the state are held accountable for in equipping science teachers to accomplish in their careers. The first paragraph of the introduction to Part 1 of a California Commission on Teacher Credentialing document entitled *Science Teacher Preparation in California: Standards of Quality and Effectiveness for Subject Matter Programs* (2003) reads:

> One of the purposes of education is to enable students to learn the important subjects of the school curriculum to further their professional goals and to function effectively in work, society, and family life. (p. 6)

The order in which those three spheres of "function" are identified is revealing. So are the implications of how far the notion of the third, "family," extends. A section under the subheading "Needs of California Elementary and Secondary School Students" contains this sentence: "Contributions from diverse cultures to the construction of scientific understanding and to technological development should be recognized by students" (p. 15). Native California is entirely excluded in this emphasis on "technological development." In Part 2 of the document, under "Category II: Program Standards for Science," the third of three "Required Elements" under "Standard 11: The Vision for Science" requires that:

> Candidates know there are many different natural energy and material resources, including air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests, and know how to classify them as renewable or nonrenewable. They realize that sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. Candidates understand that the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process. They know the natural origin of the materials used to make common objects. (p. 25)

This is objectification on a cosmic scale. The teacher preparation standards are closely aligned to the *Science Content Standards for California Public Schools, Kindergarten through Grade Twelve* (1998). In fact, the language of the instructional objectives in both documents is almost identical. The *Content Standards* introduction states "By adopting these standards, the State Board of Education affirms its

commitment to provide a world-class science education for all California students" (p. 1). But this "world-class" class (even when it actually is a class) turns out not to be a place to learn very much about what is happening to the world.

In kindergarten, students are to learn "how to identify resources" and "that many resources can be conserved." In second grade, that "Earth is made of materials that have distinct properties and provide resources for human activities"; for example "rock, water, plants, and soil provide many resources, including food, fuel, and building materials, that humans use." Sixth grade is devoted exclusively to a "Focus on Earth Science." This is when students are to learn how "sources of energy and materials differ," about "the factors that are involved in their utility … and the consequences of the conversion process," and that "air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests" are "renewable or nonrenewable" resources "used to make common objects." This being primary, what is secondary?

The section "Earth Sciences- Grades Nine Through Twelve" does not specify in which grades students are to learn about "Energy in the Earth System," "Structure and Composition of the Atmosphere," or "California Geology." However, an item addressing the "origins" and "climatic consequences" of "differing greenhouse conditions on Earth, Mars, and Venus." and another item (which does not appear in the *Science Teacher Preparation* document) regarding "how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions" are marked with asterisks. The *Science Content Standards* specifies that "Standards that all students are expected to achieve in the course of their studies are unmarked. Standards that all students should have the opportunity to learn are marked with an asterisk (*)." Since only what is "expected" is expected to be tested, the "opportunity" to consider the fate of the planet is typically missed.

The second paragraph of the introduction to the standards proclaims "Glenn T. Seaborg, one of the great scientific minds of this time and of all times, chaired the Academic Standards Commission's Science Committee." Seaborg, an American chemist who died in 1999, played a central role in discovering and isolating ten transuranic elements (including plutonium, americam, and californium), worked on the Manhattan Project, proposed the addition of the actinide series to the Periodic Table, shared the Nobel Prize in Chemistry in 1951, and served as chancellor of University of California, Berkeley and chairman of the United States Atomic Energy Commission (http://en.wikipedia.org/Glenn_t._Seaborg). Among a collection of quotations on one page of a website devoted to his life and work (http://www.lbl.gov/Science-Articles/Archive/seaborg-quotes-own.html) is his view that "The education of young people in science is at least as important, maybe more so, than the research itself." There is also this statement on the future:

> The modern technological world appears overwhelming to many people. It drives some to pessimism and despair. It makes others doubt the future of mankind unless we retreat to simpler lives and even to the ways of our ancestors. What these people

> fail to realize is that we cannot go back to those ways and those days. Furthermore, for all our difficulties, life today is far better for more people and the possibilities for the future can be brighter than ever if we develop not only new knowledge, but a greater faith and confidence in the human mind and spirit.

Berry (1999) might reply:

> Because of this basic attitude we consider that the more extensively we use the world around us, the more progress we are making toward some higher state of being. The vision of a transearthly status to be achieved by exploiting the natural world has driven us to ever more violent efforts toward this end. The ideal is to take the greatest possible amount of natural resources, process these resources, put them through the consumer economy as quickly as possible, then on the waste heap. This we consider progress—even though the immense accumulation of junk is overwhelming the landscape, saturating the skies, and filling the oceans. (p. 76)

Before we and all our relatives become buried in "common objects" we may reach a point where we are ready to contemplate an alternative. In an international survey of the scientific literature on indigenous ecological practices (Berkes, Colding, & Folke, 2000) the authors conclude "The two ways of knowing, scientific ecology and Traditional Ecological Knowledge, are potentially complementary" (p. 1259).

> In this sense, adaptive management can be seen as a rediscovery of traditional systems of knowledge and management. Even though there are no doubt major differences between the two, adaptive management may be viewed as the scientific analogue of Traditional Ecological Knowledge because of its integration of uncertainty into management strategies and its emphasis on practices that confer resilience. By responding to and managing feedbacks from ecosystems, instead of blocking them out, adaptive management seeks to avoid ecological thresholds at scales that threaten the existence of social and economic activities, as do some traditional knowledge systems. Drawing on management practices based on Traditional Ecological Knowledge, and understanding the social mechanisms behind them, may speed up the process of designing alternative resource management systems. (p. 1260)

Were such a shift away from ecocide toward stewardship ever to take place, it would constitute neither "pessimism and despair" nor "retreat to simpler lives and even to the ways of our ancestors" but rather an inclusive application of scientific thought to survival.

6. Natural Selection

No "thoughtful" person (to borrow Schoenherr's adjective from his epilogue) could assert that the California teacher preparation or content standards for science adequately address the severity or the urgency of ecological problems at the state, national, or global levels. Readers elsewhere will need to examine their own state's science standards to judge whether they surpass or fall short of the Golden State's

example. It is important to observe that standards are intended to define minimum competency in a given subject area. Furthermore, they are not supposed to dictate how subject matter is taught. (Alas, many public officials, education bureaucrats, administrators, professors of education, and teachers have yet to grasp these basic principles of standards-based school reform.) Teacher educators and teachers should make informed and responsible decisions about how to interpret and achieve the objectives of standards in ways that best serve their students and the world. This responsibility rests first with teacher educators.

For practitioners who are inclined to emphasize environmental issues in their approach to science education, one way to adapt within the boundaries standards impose is to make use of textbooks that offer more insight into such topics as pollution, climate change, and extinction. But publishers increasingly design and market their products specifically to align with national and state standards. Pearson, an imprint of Merrill-Prentice Hall, publishes the widely-used *Science K-8: An Integrated Approach* (2004). Under "Conservation of Mineral Resources" one reads "Today's coal mining and use relies heavily on the concept of clean coal technology, which depends heavily on sophisticated machinery, including robotics, lasers, and computers" and "Surface mining accounts for more than half of U.S. coal mining. An important component of the surface mining industries is that of restoring the land that has been mined" (p. 221). Under "Air Pollution" teachers are to inform their students that "Air pollution becomes a serious problem when weather conditions are formed in which the polluted air cannot be blown away" and "In the United States, attempts are being made to control air pollution" (p. 222). The most "serious problem" related to "control" here is not the patent farcicality of these statements, or even that they are to be read in a science textbook, but that they reinforce in science class the dangerous notion that humans command and control the life of the planet.

Gregory Cajete, in his book *Look to the Mountain: An Ecology of Indigenous Education* (1994), points out the limitations and possible consequences of a "command and control" approach to teaching and learning.

> This paradigm so guides the consciousness of American mainstream education that it forms the nature of thought, research and education. It motivates the views, methods and solutions that are a result of that education. This conditioned orientation has resulted in a colonization of perception with repercussions of a magnitude almost beyond description. (p. 78)

For these reasons, the commercially produced textbooks science teachers are likely to be assigned by their teachers and by their school districts will at best be a point of departure, useful mainly for revealing currently prevailing ecocidal assumptions. As Cajete suggests, "The contemporary development of indigenously based, environmental education curricula can take a myriad of forms. It is an area of curriculum development that offers tremendous possibilities for creative exploration and truly inspired teaching and learning experiences" (p. 115).

This work will need to be undertaken by science educators themselves, ideally in mutually supportive partnerships with professors in schools of education and scientists in the field. An essential first step will require the abandonment of romantic notions of first nations people as noble savages who lived in an idyllic state of perfect harmony with nature, and whose primitive cultures vanished in the inevitable advancement of modern technological civilization. In order to counter the stereotypes and denial embedded in existing subject-specific curricula, teachers will need to develop more and better ways of working together across traditional subject-matter boundaries. Another Pearson textbook, *Teaching Secondary School Science* (2004), aimed at science teacher educators and aspiring science teachers, acknowledges the growing interest in this approach, but then advises caution for those inclined to stray further than the border between science and mathematics.

> Although many advocate interdisciplinary studies, there are some who urge caution. [One teacher] … has expressed … concerns [which] grew out of work on a unit that combined science and history. After designing and teaching … "Seeds of Change," she realized the theme and teaching approach did not help students connect with the important concepts, especially science, that she had first thought they would. (p. 139)

One hopes that this teacher has kept trying, and has done so together with at least one colleague who teaches history so that concepts from both subjects are integrated into both classes for the same groups of students in mutually reinforcing ways. Adopting a specific set of objectives that draws upon but also supercedes both subjects (such as exploring the origins of and alternatives to global ecological devastation) rather than being interdisciplinary for its own sake would also help. Wildcat (2001) points out that preserving rigid boundaries in science teaching actually contradicts some of the very concepts now emerging in science that teachers need to teach.

> In spite of new research in the areas of ecology, complexity, the phenomenon of chaos, the process of emergence, and much of cutting-edge physics, science as taught in most schools is reductionist—in terms of what counts as reality, knowledge, and the appropriate methods for acquiring knowledge. (p. 11)

One content area generally relegated to elective status that any science teacher can incorporate into any lesson or unit is often referred to as "Current Events." Without necessarily recommending that this concept be extended to embrace the notion of "Future Events" it is possible to identify one further implication for pedagogical practice. In and of itself, relating science to local, national and world news with an eye toward indigenous world views has the immediate effect of liberating Indian cultures and people from their current position in most schools as artifacts of a vanished past. Writing of California, Anderson identifies a situation that also has relevance everywhere else in the United States.

> Despite the history of genocide, dispossession, and assimilation … California is still home to approximately 150,000 people who trace their ancestry to the state's

> original indigenous inhabitants. … Many California Indians … are working actively to preserve their cultural heritage and ethnic identities. (p. 309)
>
> Today, each tribe's use of particular plant [and other] materials marks its distinctive cultural identity. (p. 326)
>
> This work, in its rediscovery of the linkages among restoration, maintenance of field populations of specific species, and judicious use of nature, will create exciting new models of human interaction with nature different from the restore-and-leave-nature-alone models that currently exist. (p. 339)

Anderson stresses that this process must not fall prey to the all-too-common tendency toward cultural appropriation or exploitation, but must rather be based upon "concern for the well-being of the cultures in which the knowledge was fostered" (p. 354). This means that science teachers (with all other teachers) who are committed to instilling new attitudes and skills for life on Earth will do well to establish partnerships with Indian educators, community leaders and elders in their regions who are striving to revitalize traditional languages and cultures as part of their struggle to resist continuing encroachment upon their rights as sovereign nations as well as upon the rights of all our relatives.

Edward O. Wilson, surely another "of the great scientific minds of our time and of all times", includes in his book *The Creation: An Appeal to Save Life on Earth* (2006) a paragraph that offers common ground for concerted action.

> According to archaeological evidence, we strayed from Nature with the beginning of civilization roughly ten thousand years ago. That quantum leap beguiled us with an illusion of freedom from the world that had given us birth. It nourished the belief that the human spirit can be molded into something new to fit changes in the environment and culture, and as a result the timetables of history desynchronized. A wiser intelligence might now truthfully say of us at this point: here is a chimera, a new and very odd species come shambling into our universe, a mix of Stone Age emotion, medieval self-image, and godlike technology. The combination makes the species unresponsive to the forces that count most for its own long-term survival. (p.10)

Not only its own. For yet another 100 species today (so the scientific evidence we continue to ignore, in part because of how we teach science, estimates) it is already too late.

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