Restoring Indigenous History and Culture to Forest Ecosystems:

Conservation, Restoration, and Wood Timber Production in the Forest Matrix

We believe that as a community of ecologists living in times of unprecedented ecological change, we can no longer afford the questionable luxury of working solely within our own traditions if we are to learn to live sustainably. Conserving our options means, in part, conserving the diversity of ways of about problems.
-Jesse Ford and Dennis Martinez

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By Dennis Martinez
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Dennis Martinez
P.O. Box 495
Douglas City, CA 96024
iprn@snowcrest.net
(530) 623-5056 (home)
(530) 222-7576 (message)

Abstract

Native Americans inhabiting the Klamath-Siskiyou ecoregion, like indigenous people in other ecosystems of North America, managed cultural resources with selective burning at virtually all elevations. Following their relocation in 1855, the relatively open vegetation structure that had persisted for millennia, partly due to their use of fire and partly lightening caused, began to close up, increasing fire hazard, lowering biodiversity, decreasing productivity, and diminishing ecological integrity. I argue that protected habitat reserves, while necessary, are not sufficient for habitat protection without restorative management of the forest matrix with timber revenues as a byproduct of a primary restoration and conservation focus. I suggest the development of reference ecosystems for restoration which incorporate historic Indian fire regimes in their seasonality, frequency, and spatial selectivity.

Key Words: Klamath-Siskiyou ecoregion, Native Americans, fire ecology, restoration ecology, conservation biology

Introduction

I focus on the Klamath-Siskiyou ecoregion of southwestern Oregon and northwestern California to illustrate my theses, but the methods of deriving a restoration reference ecosystem from the subsistence requirements of tribal societies in pre-european settlement times can be applied to many other forest ecosystems. Indigenous peoples of the Klamath-Siskiyou ecoregion were engaged in intensive and extensive forest management for millennia in order to maintain the plant and animal resource, which sustained tribal cultures and economies. Intentional fire, supplemented by selective harvesting of plants and animals, was the primary management tool. I argue that Native American inhabitants of the Klamath-Siskiyou ecoregion, like in many other North American biomes, burned in most vegetation types at virtually all elevations in order to modify, regenerate, and increase fruit and seed production of a wide range of plant species for cultural use as well as to rejuvenate culturally important animal habitat. I argue further that the frequency, and especially the spatial selectivity, of Indian fire—in addition to lightening fires—was practiced long enough by relatively high populations of Native peoples to have had an important impact on forest structure, composition, and function over millennia, and which likely affected the genetics, distribution, and maintenance of species and vegetation types that are presently poorly distributed, missing, or undergoing detrimental successional changes. I suggest that Indians of the region were a keystone species, (Bonnickson, et al., 1993 Kay, 1994 ;) and that their removal in 1855 began a process—accelerated later by Euro-American stock overgrazing, exotic plant invasions, industrial forestry, and fire suppression—of ecological degradation which continues today. I then offer examples of how to integrate the sciences of ethnography and ecology in the construction of historical reference or baseline ecosystems which could assist in the recovery of ecological integrity by including Native cultural practices and their effects on key ecological features, along with Western science-based approaches to restoring ecosystem function, throughout the forest matrix. Matrix restoration, I conclude, could be accomplished through the use of an integrated historical-functional model in designing multiple entry timber harvest prescriptions which primarily promote conservation and restoration while yielding an economic byproduct.

Both Western ecological and ethnographic methodologies possess important strengths and weaknesses. Their integration in the task of constructing reference models for conservation and restoration could overcome their respective limitations. As I will discuss in more detail below, ecological restoration is a balancing act between historical fidelity and ecological functionality, i.e. between historical accuracy and how well *any* restored process, ecosystem, or species will work in terms of persistence, resilience, and stability (Higgs and Martinez, 1996; Falk et al., 2001).

Nature and Culture in the Western Tradition

"In the beginning all the world was America" John Locke wrote in his *Second Treatise on Civil Government* in 1690. American Indians exemplified humans in their natural state—for better or worse. Yet even before Europe found America, and until the time of the growth of cities—the civilizing of the countryside—only the pre-Socratic Greek Sophists had separated humans from nature**.** It was urbanization that gradually led to the philosophy of natural alienation. From Plato and Aristotle to Roman and Catholic thinkers, through Locke and Rousseau, and well into the 19th century, all things that humans thought about, from government to science and including the processes of thought itself, were considered "natural". The great epistemological debates of the last four centuries in the West brought into sharp relief only the way we are able to know objective reality, not whether we are part of nature or not (Tarnas, 1991).

"In the beginning all of the world was America…" and in a state of nature, Locke went on to argue in his *Treatise* in the chapter "On Property", land belonged to no one. Echoing St. Thomas' labor theory of value, Locke believed that only by laboring on the land could we claim ownership. Indians were viewed by Europeans then (as well as by Western environmentalists now) as living *passively* off the land. Like nature, Indians were passive and exploitable. Europeans could claim Indian land honorably, they thought, because natives were not doing anything to bring the land up to its full productive potential. All that colonists had to do to own land was to till it. (The Catholic Church at the time of the invasion and conquest of Mexico formulated a similar justification for colonization called the Doctrine of *Terra Nullis* or "empty lands".)

Protected lands currently under control of the U.S. National Park Service (NPS) were by no means historically empty. Contrary to the revisionist assertion by the NPS that Indians, termed "first visitors" in park brochures, used present parklands only seasonally, if at all, is simply not true. All-year Indian use of even high elevation parks like Yellowstone, Glacier, and Yosemite is well-documented. The truth is, as ethno-historian Mark Spence has documented in *Dispossessing the Wilderness*: it was only the creation of reservations for relocated Indians that made national parks possible (Spence, 2001).

The guiding ethos of the NPS was best expressed in the 1963 NPS authorized Leopold Report which required "vignettes of primitive America" to be preserved, and restored if needed, as windows to a supposed virgin past undefiled by the presence of humans, including native humans. The 1964 Wilderness Act defined wilderness as "an area where the earth and the community of life are untrammeled by man".

Just as philosophers like John Locke justified colonization, and his intellectual descendants continue to justify colonization, by a "state of nature" which included indigenous peoples as savages requiring civilization, so the NPS justifies Indian removal from parks on the basis of another "state of nature" rationale, i.e. the absence of Indians historically from parks. Current scientific dogma goes a step further: even where Indigenous peoples did reside for millennia, they were not a *natural* part of ecosystems, and indeed, had little if any positive or lasting effect on the environment (while at the same time supposedly exterminating megafauna at the end of the last ice age); (Martinez, 2004).

The development of the scientific rationale for Indian removal took form gradually and in line with a nascent NPS policy which perceived Indians as inimical to wilderness preservation. The real issue of course was the desire for absolute control of all NPS holdings. Partly assimilated Indians in white man's clothes didn't seem to fit the romantic image of the historical Indian as a *pure* and undefiled child of nature. Park mangers wanted a "pure" wilderness. Besides, Indian removal would further the popular new policy of assimilation. Hunting and intentional burning, both considered "unnatural", had already been banned (although enforcement was, and in Glacier still is, problematic). Biologists like Joseph Grinnell of the University of California, George Wright of the NPS and other scientists lent credibility to this new wilderness policy. *As the historical Indian disappeared, so would the memory of their integral role in the ecology of their homelands disappear* (Spence, 1999; Martinez, 2004). (It should be humbling to remember that the important ecological role of fire was only rediscovered by science in the 1970s.)

Western Ecological Sciences

Western scientific methodology in ecology is based on quantitative analysis and experimental replicability with the goal of explaining and predicting natural phenomena. While some ecologists of late have rejected rigid mechanistic methodologies—indeed the prevailing ecological paradigm is in such a state of flux that it is difficult to adequately and completely categorize—I think that it is also true that the main thrust of the ecology of the last half century, under the influence of modern technologically sophisticated economies and the cyber revolution of the 1970s and 1980s, has been to reduce the complexities of natural systems to the simplified and abstract bioeconomics of food chains, niches, productivity, yields, etc., and simplified ecosystem analyses and indicators like focal species and species absence\presence models. Generally speaking, modern ecology has been individualistic in its conception of plant-to-plant and animal-to-animal interactions and mechanistic in its explanation of plant community development—many denying the ecological realty of "community" and the social-cultural dimension of animals (although the new science of behavioral ecology is already confirming some indigenous understandings of animal social behavior [Fox, 2003]); (Gleason, 1926; Elton, 1927; Tansley, 1935; Lindeman, 1942; Agee, 1993; Worster, 1994).

Analysis of vegetation in terms of individual species moving willy-nilly along a temperature-moisture-soil gradient—and not communities with an co-evolutionary history and future—could lead in some cases to minimizing the significance of blended ecotones between two or more vegetation types; and which could be at least partly composed of modal species which only occur in abundance in an intermediate part of a light-shade continuum, e.g. savanna modal species which are communities and not just individual transitional species between prairie and forest (Pimm, 1991). As I will argue below, Indian burning kept vegetation development in many plant communities in a state of arrested seral succession. This could be viewed from the perspective of the prevailing ecological paradigm as a negative example of forest fragmentation and not as the maintenance of stable forest conditions or modal ecotone species assemblages which are not targeted for conservation because they are not defined as a community. This is not to deny the detrimental effects of fragmentation by roads and staggered-setting clearcuts in some habitat types; I'm only suggesting that we need to be more discriminating about our evaluation of what we perceive as the negative effects of fragmentation. This actually happened in the upper Midwest when most ecologists were denying the existence of oak-tallgrass prairie savanna ecosystems and of modal species associated with an intermediate place on the light spectrum; the matter was finally resolved when Steve Packard of The Nature Conservancy found modal savanna species as a result of historical research, and successfully restored them on sites in the greater Chicago metropolitan area (Stevens, 1995). Modal ecotone communities may not be limited to the pine or oak savanna vegetation types but could be disappearing in middle to high elevation mixed conifer forests due to shading out, with one result being the elimination of natural evolutionary processes where "natural" includes human management. Unfortunately, North American ecologists have traditionally separated humans from nature when doing ecosystem studies. Historian Mark Spence tells the story of the gradual separation, in scientific and U.S. National Park Management thinking, of indigenous peoples from their role in managing their homelands in *Dispossessing the Wilderness: Indian Removal and the Making of the National Parks* (1999). See also Martinez (2003).

The problem with reductionist methodology for our purposes here lies in its exclusion of factors thought to be external to any given experimental focus. There is always a tradeoff between information content and reliability. Replicable experimental tests are only reliable or rigidly determinate when the scope of their questions has been greatly limited (Kraus, 1974; Ehrenfeld, 1978). Putting ecology on an exclusively quantifiable basis necessarily leaves out qualitative analyses like the part that human culture and history have played in the development of forest structure and composition. Anchoring reference ecosystems in real past time, at least as a beginning point in forest restoration analysis, could overcome the predictive limitations of Western reductionist methodologies. We are currently experiencing a gigantic and unprecedented experiment in secondary succession as a result of industrial forest practices, overgrazing, and fire suppression, the outcome of which is highly unpredictable even with the most sophisticated computer modeling.

Ethnography

Ethnographic research, which forms the bulk of my argument for the current ecological relevance of past indigenous land management practices in the Klamath-Siskiyou ecoregion, can provide the cultural and historical context which could suggest hypotheses that the ecological sciences can test with their experimental methodologies. The fundamental methodological problem with historical disciplines like ethnography and ethnohistory is that, like the reconstruction of climate history, they rely mainly on indirect or proxy lines of evidence.

In this paper I hypothesize that Native American tribes of the Klamath-Siskiyou ecoregion would have had to burn a considerable number of plants to maintain their economies and cultures. But my hypothesis assumes much larger pre-European settlement (precontact) populations than agreed upon by all scholars. Ethnographer James Mooney was the first to attempt an estimate of North American (U.S. and Canadian) Native populations in 1910; he came up with 1.15 million (Denevan, 1976). Mooney's estimate stood until Henry Dobyn's (1966) controversial estimate of 10 million for North America, and 90 to 112 million for the Western Hemisphere (Dobyn, 1983). Even Dobyn's most vehement critic, David Henige (1983), came up with numbers significantly higher than Mooney. The higher numbers currently have the most scholarly support.

Dobyns used a novel method of estimating population size base on educated guesses of the number of Native persons killed by European diseases. He figured 95% losses. His bichronic method took into account the numbers lost to disease before the original local counts were made years *after* first European contacts. He then took the lowest point in indigenous populations (e.g. 500,000 in 1900 in North America), and, assuming 95% losses, calculated backwards to a population of 10 million.

We will never know with certainty the actual precontact population numbers, but it is fairly certain, based on recent scholarship, that Mooney's original estimate is far too low. Modern scholarship has pushed both Indian populations and length of time spent in this hemisphere significantly higher and longer than heretofore believed (Dobyns, 1983; Fiedel, 1987; Ramenofsky, 1987).

Recent research indicates that European diseases may have spread rapidly enough to decimate Indian populations in the Pacific Northwest between 1550 and 1600. Pullen

(1999) quotes ethnographer Melville Jacobs, Notebook 125, in which the Indian informant refers to the time before the last great famine (1830's?): "Long ago lots of people lived in Applegate River in one village there…" He goes on to explain how inter-marriage with the Shasta allowed the Da-ku-be-te-de, inhabiting the Applegate Valley, to go to the Shasta, near Yreka, California, and obtain food and avoid starvation. This suggests a larger population than the usual low estimates noted in the literature. Deserted villages were commonly seen. (See Reg Pullen, p. IV - 2, Melville Jacobs, Notebook 130). Pullen (p. IV-3) quotes early southwestern Oregon resident Dr. Lorenzo Hubbard who speaks about theTututni of the Lower Rogue River in 1856:

> According to tradition, many years ago they were far more numerous than at the present time, wars and diseases having in some instances destroyed whole tribes. The marks of old towns and large settlements everywhere found, now entirely deserted, are strong evidence of their traditions.

Finally, much of ethnography is what Western scientists call anecdotal, and is not usually accepted as hard or reliable evidence. But, in combination with physical evidence from ecology, it could be used in a mutually reinforcing way. That in fact is the principal objective of this paper: how to use the somewhat sketchy ethnographic record of southwest Oregon (and the more complete record of northwest California) to provide explanatory hypotheses where physical evidence of precontact forest structure and composition is missing or ambiguous. For example, see Pullen 1995 for ethnographic descriptions of forested lands capes under Indian management. Techniques of the newly emerging field of historical ecology as well as conventional ecology can then test those hypotheses. Anecdotal information, in the history of science (my original academic field of study), has often played an important role in suggesting explanations of natural phenomenon which were later experimentally tested.

Balancing Historical Fidelity with Ecological Functionality in Reference Ecosystem Models for Restoration and Conservation

The Society for Ecological Restoration International (SER-I) has defined ecological restoration as follows: “Ecological restoration is the process of assisting the recovery and management of ecological integrity. Ecological integrity includes a critical range of variability in biodiversity, ecological processes and structures, *regional and historical context, and sustainable cultural practices* (emphasis added).” (See SER website for extended discussion of this definition at<www.ser.org>.)

The development of a reference ecosystem model requires balancing historical fidelity with ecological functionality (Higgs and Martinez, 1996; Martinez, 2002; Higgs, 2003). The preindustrial historical model, which includes as much of key ecological structure, composition, and processes (i.e. function) as is possible to retrieve using the tools of the newly emerging field of historical ecology (Egan and Howell, 1999), can serve as an *initial guide* to a reference ecosystem and as a conceptual tool with which to assess current forest conditions. How close we are able to come to historical reference conditions at the stand level is usually determined by conditions of the larger forested landscape in which the stand is embedded. Because of fragmentation, fire suppression, exotic plant invasions, etc. some level of periodic human intervention will probably always be necessary. Because of changed environmental conditions at the landscape scale, it needs to be integrated with ecological functionality. Function can be measured with standard scientific tests, e.g. net primary productivity, nutrient cycling, etc. (Covington, 1997).

Forest conditions are constantly changing over time. Our point of reference in the past is not static: Rather than a snapshot in time, we are rerunning a long moving sequence of ecological variation resulting from periodic disturbance events which were historically bounded in kind, intensity and frequency. Native management is part of that circumscribed natural flow, By attempting to approach preindustrial conditions, we hope to get the rate and extent of change back within this historical range of variability (HRV). The question is not change, but what kind of change. Like medical doctors, ecological restorationists “work with natural process, intervening no more than necessary to nudge nature just enough to change its natural trajectory from a human caused downward spiral to one that is potentially positive” (Martinez, 2003).

Indigenous Land Management Practices in the Klamath-Siskiyou Ecoregion and their Relevance to Conservation and Restoration

Given the apparent longevity of the indigenous societies of the Klamath-Siskiyou ecoregion (perhaps as long as 12,000 years and at least 4000 years), what kinds of resources were managed, and how extensively and intensively were they managed in order to ensure cultural survival? Would intentional fire in lower elevation valleys and foothills where permanent villages were located have been sufficient for all of their fire-dependent cultural needs? What kinds of important cultural resources would then have gone unmanaged? Would these resources have required fire management to have been culturally useful? Would lightning fires have been sufficient to prepare culturally important plants at higher elevations for intensive and prolonged human use?

Ethnobiologist M. Kat Anderson and ethnographer Thomas C. Blackburn point out the enormous quantities of burned plant material which would have been required to maintain the material culture of California Indian societies and conclude "that only careful and effective management could have supplied the phenomenal quantities of raw materials required to support such a community over long periods of time" (Blackburn and Anderson, 1993). Cordage was certainly one of the critical needs. Blackburn and Anderson note that just one 40 ft. deer net containing 7000 feet of cordage required the harvesting of 35,000 plant stalks of milkweed (*Aesclepias* spp.) or dogbane (*Apocynum* spp.) burned the season before. When all of the fire-modified plant material in ten major cultural use categories are considered, including deer and elk habitat, it is clear that significant burning was a prerequisite for tribal survival.

Since it is generally accepted that Indians burned lower elevation valleys and foothills regularly, as often as every year, to enhance culturally important plant foods like corms, acorns, grass and forb seeds, basket plants, etc., I will focus on cultural resources at middle and upper elevations in the Applegate and Rogue River watersheds of the eastern Siskiyous. (For more detail on lower elevation burning see Reg Pullen [1996] and Jeff LaLande [1995].)

Conventional wisdom on the fire history of the Klamath-Siskiyou ecoregion holds that lightning was the primary ignition source for middle to high elevation mixed evergreen/conifer forests (Frost and Sweeney, 2000). I will argue that Indian burning was in fact done in these higher elevation forests, and that both lightning and Indian fire shaped forest structure and composition. I will base this argument on the kinds of cultural plants and animals which needed to be fire-managed in predictable and effective ways for the material culture to be maintained. Lightning fires are not predictable in their timing, location, extent, and effectiveness. While lightning fires did affect forest conditions, the result was far too random for Native resource managers who required regular fires at specific intervals in particular places (patches or "yards"), usually in a rotational pattern of varying fire return intervals, in order to meet different resource needs dictated by a variety of environmental and societal imperatives (Lewis, 1973; Bonnickson et al.).

Critical Middle to High Elevation Cultural Plants and Animal Habitat of the Klamath-Siskiyou Ecoregion

Here I will briefly examine several categories of critically important cultural plants which would have to have been extensively used—and therefore maintained in great abundance—by relatively high populations of precontact Indians, but which are now as a whole fairly scarce or poorly and unevenly distributed. While a few of these species also grow at lower elevations, most (and these were usually the most desirable) grow at middle to high elevations. All require regular light ground fires to be productive or culturally useful. The ranges of all of these species have been reduced. (More detailed information can be found in the *Final Report for World Wildlife Fund\U./S. Forest Service Upper Glade National Pilot Stewardship Project*, Dennis Martinez, 2001; see also Reg Pullen, 1996.)

Basketry and Cordage plants include beargrass (*Xeropyllum tenax*), hazelnut (*Corylus californica*), *Iris chrysophylla* and other Iris species; milkweed, (*Asclepias* spp.), and dogbane (*Apocynum androsaemifolium*). These species are found in scattered locations up to around 5500 ft. [1676 m.] (Barbara Mumblo, Applegate Ranger District botanist, pers. comm., 2001). *Iris chrsophylla* was on the California Review List until

1994 (Report by Richard Brock and Richard Callahan, 1994, on file with the Applegate Ranger District). Beargrass, the most important basket plant, is rarely found in quantity. Fire suppression and shading out by encroaching conifers constitute the primary reason for the scarcity of beargrass as well as other basket and cordage plants (author's observations).

Food plants include higher elevation nuts, the most important of which were hazelnut, black oak (*Quercus kelloggii*), and Sadler's oak (*Quercus sadleriana*). These latter two species produced two of the three most popular acorns. But without regular management by fire, hazelnut patches and oak stands stagnate, acorn production declines, and regeneration eventually ceases due to shading out (author's observation). Other foods include geophytes (corm producing herbaceous plants) like *Lilium*, *Fritillaria*, *Camas*, *Tritelia* (two species of which are on ONHP Review List and California Watch List), *Perideridia*, and *Calochortus* species, which grew historically on high elevation meadows but which are disappearing because of brush and tree encroachment (author's observation). Only one patch of camas—the most prized edible corm—is known in the eastern Siskiyous (Chant Thomas, pers. comm., 2001).

Important higher elevation berries include greenleaf manzanita (*Arctostaphylos patula*), elderberry (*Sambucus cerulea*), thimbleberry (*Rubus parviflorus*), serviceberry (*Amelanchier alnifolia*), gooseberry (*Ribes* spp.), and huckleberry (*Vaccinum* spp.). *Ribes marshallii* is on the ONHP List 2 and California Watch List. Again, fruit production and patch size\abundance have declined because of shading out due to lack of fire (author's observation).

Medicinal plants are well represented at higher elevations. Osha root (*Angelica arguta*) is found at elevations of 5000 to 6000 ft. [1524 to 1829 m.] It is the most important Indian medicine that I know of in the Klamath-Siskiyou ecoregion. (I collect and use it regularly as an anti-microbial agent.) *Lomatium nudicaule* (also known as Indian consumption plant, or Indian celery), another osha, species is found in forest openings at middle elevations, as is *L. triternatum* (Barbara Mumblo, pers. comm., 2001). Mules-ears (*Wyethia angustifolia*) is another very popular medicine plant found at middle elevations which is poorly distributed. The ranges of the two tobacco species (*Nicotiana* spp.) have severely contracted (Donn Todt, pers. comm., 2001). The most popular tobacco species, *N. quadrivalvis*, was grown at higher elevations. I have personally never found it in the Klamath-Siskiyou ecosystem. Neither has Donn Todt.

Deer and elk habitat was burned every 3 to 5 years to rejuvenate browse. As is typical of Indians inhabiting interior montane forests, deer and elk hunting were more important than salmon and steelhead fishing. It is difficult to overestimate the importance of deer to tribal economies in the interior Klamath-Siskiyou Mountains. Besides providing meat, deer supplied sinew for sewing, leather for clothes, and a vast miscellany of bone and antler tools and implements. High deer populations were maintained by creating forest openings (yards) through intentional fire, burning hundreds of acres in one fire, thus enhancing the natural carrying capacity of the range. Ridges were travel corridors and were kept open to facilitate deer and elk drives and to provide easy access for packing large quantities of meat back to villages where it was smoked for winter use. Ridges also were important beargrass sites—another reason for regular burning of the ridges. And when stored food supplies were getting low in the hunger moons of late winter, before salmon runs and Indian greens were available, new palatable browse from the early fall burns of the previous year attracted elk and deer to middle elevation ridges and forest openings. Up to 3 hunts were undertaken per year; 150 deer snares and nets were utilized per hunt. Notably, a single 40 ft. deer net took 35,000 stalks of milkweed or dogbane, which had been burned the year before (Pullen, 1996).

Agroecological diversity of various sizes and shapes of forest openings created a complex mosaic of repeating edges or transitional ecotones which in turn created diverse kinds of animal habitat as well as ecological niches which supported a rich flora of both conservative and generalist species supporting complex food webs. Agroecological diversity contributed to cultural resiliency (Turner et al., 2003). Ecosystem function, then, would have been enhanced by Indian fire. As pioneer ecologist Eugene Odum noted: "…it seems likely that ecotones assume greater importance where man has greatly modified natural communities" (Odum, 1971; See also Lewis, 1973)**.** In this way, climatic climax, resource-poor (i.e. poor in cultural resources, species richness, and wildlife habitat) coniferous forests contained "hot spots" or islands of biodiversity through fire-driven arrested seral succession.

Many places were left unburned for a variety of reasons, including animal habitat needs (e.g. thermal cover for deer and elk) and the fact that it was unnecessary to burn everywhere in order to satisfy cultural needs. Spatial selectivity of Indian fire (i.e.. where they burned) would have been sufficient to create refugia for animal and plant species which otherwise would have been rare in montane coniferous forests. Riparian zones are only 2% of the land area of typical watersheds, but are used by 80% of species at some point in their life cycles.

Spatial extent (number of acres burned) is difficult to ascertain, but spatial *selectivity* is really the more germane ecological consideration because selective fire favors ecotone creation and maintenance which is productive for wildlife and humans out to proportion to its actual size. Geographer Thomas Vale has estimated that North American Indians actually occupied only 0.02% of the continent's area, and therefore, he concludes, Native American fire affected little land area and had virtually no effect on the landscape (Vale, 2000). Dr. Vale apparently forgot about seasonal harvesting rounds across all elevations and the far-reaching effects of even a single fire event, both in spatial extent and in its effects on non-cultural plants and habitat.

I tend to find greatest plant diversity at present on serpentine opens - - most in the process of closing up with chaparral and invading trees - - and on roadcuts within middle elevation coniferous forests when I do Threatened, Endangered, and Sensitive (TES) vegetation surveys. The spottiness of regular low intensity fires was the key factor in creating productive ecotones. Major stand-replacing fires--probably rare in the precontact Klamath-Siskiyou ecoregion due to lack of fuel buildup--burn more uniformly and thus, as Lewis and Ferguson (1973: 84) note: "the very 'spottiness' and much higher frequency of very localized Indian burning seem to have affected a much more complex overall ecosystemic pattern than would have been the case with only natural fires."

Fire in the Klamath-Siskiyou Ecoregion

Some ecologists have questioned the view that the Klamath-Siskiyou ecoregion was characterized by mostly low to moderate severity fires. They claim that it was a region of mixed-severity fire that included at least some high severity fire and extensive stand-replacing events. This view is part of the ongoing debate over fuels versus weather as the principal driver of fire events and has political overtones .

Evan Frost has stated that "…conserving ecological integrity in the Klamath Mountains depends on the extent to which fire is allowed to play its essential role in the ecosystem…[and]…that to be effective over the longterm, ecosystem management strategies for federal lands should restore fire using historic patterns of frequency, intensity, seasonality and spatial extent." Frost also notes that "relatively few fire history studies have been completed in the Klamath Mountains compared to neighboring forest regions…[and]…only a few different sites have been studied, and these fail to represent the full range of regional variability that exists within these forests." He further notes that fire frequency is better studied than fire size and severity (Frost and Sweeney, 2000).

Clearly, we need more fire studies in the Klamath-Siskiyou ecoregion. Still, the overwhelming evidence to date is in favor of low to moderate severity fires. Tom Atzet, Rogue-Siskiyou National Forest regional ecologist, has estimated the mean fire event to have been 49 acres in size (Atzet, pers. comm., 1995); the Klamath Natural Forest estimates a range historically of one to 1000 acres per event (Martinez, 1995).

Weather-driven stand-replacing fires can certainly occur in most fuel-load categories, but it seems to me that these occurred relatively infrequently in the Klamath-Siskiyou ecoregion. Fuels (including fire ladders and contiguous tree crowns), all other factors (e.g. topography, weather) being equal, set the upper limits of severity. And, compared to other regions, fires of high severity still occur less often. In the 1987 Silver Fire in southwest Oregon, for example, 9% was high severity, 32% was moderate severity, and 59% was low severity; the patches of high mortality were less than several hundred acres each. Similarly, the 1994 Dillon Fire and the Big Bar and High Fires in 1999 (Klamath and Shasta-Trinity National Forests respectively) were mostly of low severity (Frost and Sweeney, 2000).

Because fuel loads were much lower before Indian removal and fire suppression, most burning was probably of low to moderate intensity and severity. In fact, one important reason, among many, for burning was to reduce fire hazard. Fuel loading was so low that fires were set at the bottom of slopes and allowed to burn uphill (Warren Corbett, Mountain Maidu elder; Frank Lake, Karuk, pers. comms.). Fires did get away occasionally, of course, especially when weather was more of a factor than fuels.

If we are going to "restore historic patterns of frequency, intensity, seasonality, and spatial extent",(and selectivity), we need to include Native burning regimes to the extent that they are retrievable. Here is a good example of the usefulness of both ecological and ethnographic knowledge sources when major gaps occur in the data. Indian burning patterns, based on indirect lines of evidence which include maintaining considerable cultural resources, created a patchy landscape which, along with the natural diversity of topography, parent rock material and soil types of the Klamath geological province, favored high biodiversity. As Frost and Sweeney (2000) conclude: "The patchiness associated with moderate severity fires has been instrumental in promoting species and habitat diversity in the Klamath-Siskiyou region."

Integrating Island Biogeography Theory With An Historical Indigenous Reference Ecosystem Model

Island Biogeography Theory was initially developed by Robert MacArthur and E.O. Wilson in the 1970s and further refined by many population biologist, including Daniel Simberloff, John Wiens, Larry Harris, Michael Soule' and Reed Noss. Suitable animal habitat was perceived as "islands" in a 'sea" of non-suitable habitat (matrix). The theory holds that large areas support more species than small areas, and that a balance is always achieved between colonizing species and extinctions, the number of species being derivative of island size and location (Diamond, 1975).

Two models derived from Island Biogeography theory in wide use today are the Corridor-Patch-Matrix model and the Landscape Continuum model. The former model tells us about vegetation structural patterns across a fragmented landscape, while the latter is oriented to the function of a given landscape across a structural gradient of vegetation cover (a variegated landscape). Both models ignore the matrix ("ocean") as neutral or hostile habitat. Yet the discounted matrix exerts considerable ecological influence over habitat patches and corridors. It may support source populations of organisms; regulate the movement of organisms; buffer sensitive areas and reserves; and maintain the integrity of aquatic systems. And, of course, it can provide for the production of commodities and services (Lindenmayer and Franklin, 2002 : 7) In fact, matrix conditions may be more important for species survival than factors such as patch size, shape, and isolation; and may provide better connectivity than wildlife corridors for species that disperse randomly (Lindenmayer and Franklin, 2002: 35).

Productive capabilities of the two models are problematic. They are "hampered by mismatches between spatial and temporal scales at which we make measurements and the scale at which ecological phenomena influence patterns of species occurrences and an incomplete knowledge of a species' life requirements" (Scott, et al., 2002 :1). There is also a bias toward large mammalian vertebrates as well as endangered species. (There are 100 North American bird species which have 5 or fewer literature references.) And finally, modeling presence\absence of abundance (quantitative analysis alone) is not sufficient for determining habitat quality (Scott et al., 2002 :3).

Because our lack of knowledge of the life requirements of most species is so profound, we may find that animals will perceive "suitable habitat islands" very differently than conservation biologists. Reductionist methodology, by boiling the rich and complex texture of animal behavior down to a few irreducible numerical indicators, my in fact lead to serious anthropogenic projections by default. It is instructive to keep the following principle well in mind when planning for conservation: "*A species or system may simply not operate in the way envisioned by the theories applied to it*." (Doak and Mills, 1994).

Let's return to the criticism of Scott et al: "predictive capabilities are hampered by mismatches between spatial and temporal scales at which we make measurements and the scale at which ecological phenomena influence patterns of species occurrences…" While the intent of this criticism was to highlight the very routine and common problem of measuring ecological phenomena without sufficient understanding of their spatial and temporal causal dimensions, it can be expanded to include the mismatch between a solely present-oriented perspective and longterm historical and evolutionary causality in determining suitable animal habitat. For example, allowing wildfires to burn in backcountry roadless areas whose frequency may be within the historical range of variability (HVR), but where fuel loads and plant species composition and distribution are completely outside of the HVR, i.e. a case of temporal-spatial disequilibrium.

Integrating Conservation Biology and Ecological Restoration With Wood Fiber Production In the Matrix

Laura and Dana Jackson, in their recent book, *The Farm as Natural Habitat: Reconnecting Food Systems To Ecosystems*, argue that species and habitat are not going to be saved unless we find a way to grow food which is more ecologically appropriate (Jackson and Jackson, 2002). I believe that the same is true for wood fiber production. We need to design timber harvesting prescriptions which reconnect with forest ecosystems.

A reference ecosystem model which includes Indian burning patterns (fire seasonality, frequency, spatial extent, intensity, and site-selectivity) as a supplement to lightening burning regimes needs to be translated into harvest prescriptions which further conservation and restoration in the matrix. We have seen above in the section on indigenous management the enormous quantities of fire-modified cultural plants that were required to support the material culture of large Indian populations in precontact times. Indians of the Klamath-Siskiyou ecoregion made seasonal rounds from snowmelt to snowfall while tending and harvesting resources at virtually all elevations.

Their rotational burning pattern (fire intervals ranging from one to 20 or more years) created a mosaic of patches of varying sizes and shapes and including a variety of vegetation types and age-classes at the landscape level. It was a forest perforated by openings which served simultaneously as cultural plant patches and refugia for sun-loving, fire-dependent plants and the animals which this managed habitat sustained.

Larger meadows below the subalpine zone were similarly maintained for deer and elk forage

Guessing at where suitable habitat occurs, and then creating reserves to protect that assumed habitat—given our poor predictive capabilities at present and our lack of knowledge of the life requirements of most at-risk species—is not enough. The matrix can influence dispersal and recolonization rates, provide suitable habitat, and affect the type and magnitude of edge effects (Lindenmayer and Franklin, 2002; Noss, 2002; Rabinowitz,, 2002; Fox, 2003; Stokes, 2003).

The matrix can also provide connectivity. Connectivity is species specific. A map of vegetation cover, based on the Patch-Corridor- Matrix or Landscape Continuum models derived from Island Biogeography theory may not correspond to a map of connectivity for a given species. Therefore, as Lindenmayer and Franklin conclude, silvicultural practices which favor conservation\restoration in the matrix may provide better connectivity than wildlife corridors for species that disperse randomly.

Lindemayer and Franklin suggest a variety of silvicultural approaches to restoration. They call this "risk-spreading": "the implementation of a range of strategies at different spatial scales. *Management for diversity calls for diversity of management*…" (emphasis added). They then suggest the "use of knowledge of disturbance regimes in *natural* forests to guide mature management." (emphasis added) (Lindenmayer and Franklin, 2002). While the authors are sometimes ambivalent on the question of indigenous peoples and their management activities as a natural part of ecosystems, they do state so in one citation. (Lindenmayer and Franklin, 2002). I would add that cultural practices—ancient or modern—are "natural" if they are ecologically familiar to the forest over long stretches of time, i.e. they are within the historical range of variability in their frequency, intensity, and extent.

Variable Density Management in the Matrix

In advocating restoration and conservation matrix management with timber revenues as a byproduct, I want to also emphasize that reserves are still necessary—just not sufficient. The nuts-and-bolts of multiple-entry restorative thinning, prescription fire, collecting and sowing seeds of missing native plant species, etc. can be found in my World Wildlife Fund report (2001) and unpublished but available Collaborative Learning Circle funded draft *Holistic Restoration Forestry Manual* (2003). See also Lindenmayer and Franklin (2002) for a complete discussion of variable density management.

The objective of variable density management or risk-spreading is to restore sufficient redundancy in vegetation types, seral stages, vegetation structure and composition, light and shade, denseness and openness, etc. in order to provide suitable habitat in places where we usually lack specific information about the life requirements of target species. Wood fiber is provided while doing structural restorative thinning, fire reintroduction, and composition recovery. The primary focus of harvest prescriptions is on restoration and conservation. Economy follows ecology.

The Native historical reference model for the Klamath-Siskiyou ecoregion suggests the restoration and maintenance of a perforated forest matrix at middle to high elevations, in Mixed Conifer\Upper Montane forest types, of openings of various sizes and shapes and including meadow restoration in the Upper Montane\Subalpine transition where meadows are being invaded by brush and trees. In sum, millennia-long fire management of upper elevation forests and meadows contributed to the creation and maintenance of a distinctive vegetation structure and composition which may have fostered the survival of many modal species and communities, and maintained adaptive co-evolutionary processes between plants, animals, and indigenous humans. We have long recognized the role of humans in the modification of plants and animals in traditional old world agriculture; we need only now recognize the same dynamics in new world agroecology and restore not only indigenous history and culture to the Klamath-Siskiyou ecoregion, but renew that ancient relationship as part of our own native heritage.

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