Restoring the Pacific Northwest

The Art and Science of Ecological Restoration in Cascadia

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Chapter 17

Traditional Ecological Knowledge and Restoration Practice

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Ecological restoration is a process, a directed action aimed at repairing damage to ecocultural systems for which humans are responsible. Environmental degradation has impaired the functioning of both ecological and cultural systems and disrupted traditional practices that maintained these systems over several millennia. Indigenous and local peoples who depend on the integrity and productivity of their immediate environments more than the global, urbanized society are directly affected by ecosystem damage. Conversely, ecosystems have become further diminished in the absence of the cultural practices that once sustained them. Despite this clear connection between cultural and ecological integrity, however, the knowledge and interests of indigenous peoples typically are not considered in attempts to restore degraded ecosystems.

We propose that the incorporation of traditional ecological knowledge (TEK) and practices of indigenous people into contemporary restoration projects will greatly enhance the success of restoration efforts. Successful restoration in this view means not only the capacity of TEK-based restoration to enhance ecosystem functioning but also the ability to sustain indigenous or local peoples' economies and cultural practices. We explore the role of traditional ecological knowledge in restoration theory and practice and discuss key topics such as methods, reference systems, cultural values, and management practices. Differences and correlations between traditional and Western science practices and perspectives are considered as we advocate an integrated approach to ecological restoration.

TEK-based restoration projects encompass various processes and management strategies such as prescribed fire and enhancement of native species and span a wide range of systems including fisheries, riverine and estuarine environments, forest and savanna ecosystems, and wildlife and native plant species (Figure 17.1). We present a variety of case studies that demonstrate the application of TEK to restoration projects in the Pacific Northwest. These examples show how TEK has been successful not only in restoring ecosystems, habitats, or species but also in fostering the interrelationships of people and place. Finally, we suggest future directions and potential expansion of the role of traditional ecological knowledge in Pacific Northwest restoration.

A Restoration World View That Incorporates Traditional Ecological Knowledge

What principles, knowledge, and practices should modern restoration programs and projects use, whether they are implemented by government agencies, nongovernment organizations, or First Nations and American Indian tribes across the

FIGURE 17.1. Hoopa Tribal Forestry staff burning beargrass for basket material enhancement. (*Courtesy of Hoopa Tribal Forestry*)

Pacific Northwest? Should best available science be the default guiding knowledge? What is the role of indigenous knowledge and practices in restoring Pacific Northwest ecosystems?

TEK may be defined as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with the environment. . . . [TEK] is both cumulative and dynamic, building on experience and adapting to changes" (Berkes 1999:8; see also Johnson 1992).

Indigenous peoples around the world have used knowledge of their local environment to sustain themselves, maintain their cultural identity, and deliberately manage a wide range of resources and ecosystems for thousands of years. The Western scientific community has only recently recognized this accumulated knowledge as a valuable source of ecological information for understanding and managing various ecological processes, individual animal and plant species, and entire habitats and landscape systems. Restoration philosophy and practice have similarly evolved in the last two decades by incorporating cultural dimensions into restoration definitions, methods, and applications.

In the Pacific Northwest, indigenous ecologist Dennis Martinez, Eric Higgs, and other colleagues led the charge for creating a restoration world view that included aboriginal peoples' knowledge and practices in ecological restoration. In 1995, at the Society for Ecological Restoration's (SER) meetings in Seattle, Washington, Martinez organized a symposium on "Indigenous Peoples: Knowledge and Restoration," in which several practical and theoretical aspects of this issue were discussed. Although the concepts of TEK and traditional land and resource management (TLRM) had received much attention before this time (cf. Anonymous 1992, Berkes 1993, Blackburn and Anderson 1993, Freeman 1979, Freeman and Carbyn 1988, Inglis 1993, Johnson 1992, Williams and Baines 1993), the SER symposium was one of the first venues that explicitly recognized the desirability—and in some cases the necessity—of TEK input in restoration work. One important outcome of the SER Seattle meeting was the formation of the Indigenous Peoples' Restoration Network (for more information about the IPRN, see www.ser.org/iprn). Largely because of this essential groundwork and the thoughtful reconsideration of SER's definition of ecological restoration (Higgs 1997, 2003, McDonald 2003), cultural and historical dimensions are now explicitly ingrained in the general framework of restoration theory and practice.

TEK restoration practitioners have referred to the deliberate incorporation of cultural aspects into ecological restoration as ecocultural restoration. In his book *Nature by Design*, Higgs (2003) explores the cultural, ethical, and philosophical shifts that have promoted good ecological restoration. Reestablishing human relationships with the land being restored is critical for future environmental sustainability. Higgs argues that for restoration endeavors to be truly successful, they must engage people at the community level. Technologically or scientifically based restoration activities alone are not enough, and he refers to projects that bring community participants together as focal restoration. Higgs maintains that focal practices will, in the end, restore more than the environment; they will restore human relationships with that environment and thus will contribute to long-term human health and well-being.

By including traditional knowledge and practices, restoration can be a powerful vehicle for reprising or sustaining cultural vitality. As aboriginal land bases have diminished, a corresponding decrease in indigenous languages, cultural practices, and rituals has transpired. TEK-based restoration provides a mechanism for capturing and applying traditional knowledge that is often held by community elders and transmitted through oral tradition. "For First Nations/American Indians, incorporating traditional ecological knowledge can mean the maintenance and preservation of important aspects of their heritage and natural resources. Partnerships between indigenous people and restoration ecologists focusing on the reintroduction of traditional management practices and techniques could provide avenues for tribal elders and communities to pass on knowledge that is not readily available in published literature" (Ruppert 2003:4).

Barriers to Integrating TEK with Contemporary Restoration Efforts

TEK is a holistic integrative approach that incorporates the metaphysical with the biophysical. The spiritual aspects of TEK have been an awkward component of restoration that is not readily accessible to most nonindigenous people. For many indigenous people, the implementation of TEK in restoration treatments is as much a spiritual reconciliation and restitution as it is a biological and physical restoration of ecological processes, habitats, or species. The genesis of TEK is rooted in creation accounts and natural laws entrusted to human beings from the spirit beings or Creator on how to respectfully and sustainably use natural resources. This same philosophy and practice carries over into restoration ecology, where it is recognized that human beings were and continue to be a part of the natural world. In the view of many indigenous people, restoration involves a continued intimate relationship with "Nature as a hardware store, pharmacy, supermarket, and church" (F. Lake, personal communication, 2005).

Relying on best available science and adaptive management is the prevailing norm among restoration ecologists in the Pacific Northwest. However, most professionally trained and educated practitioners, as well as grassroots community restorationists, have little first-hand experience or understanding of TEK. Restoration managers' lack of familiarity and exposure to TEK in practice and academic curricula often leads to its unintentional exclusion from restoration projects (Kimmerer 2002). TEK is generally viewed as "folk knowledge" lacking the substantive quality of Western science. In many regions the reservoir of TEK resides in the collective practices and minds of indigenous people and is less documented in published or Web-based data facilities. Information relating to TEK is published more often in social science publications than in natural science journals, thus limiting exposure of science professionals. As the study and practice of TEK becomes more visible in science-based publications, restorationists may more readily perceive its application to their own projects.

Even among First Nations and American Indian tribes, where it would be assumed that TEK would readily be integrated into restoration efforts, land managers and resource specialists often overlook TEK as a valid source of information. Many restoration projects on tribal lands apply standard scientific reasoning and gauge project success based on biological measures alone, often overlooking sociocultural indicators. For example, restoration projects may not take into account the value of nontimber forest products to local community health, welfare, and economy. The reasons stem from daunting challenges: dominating scientific methods, lack of formal TEK curriculum or applied experience, and TEK's oral tradition format. Many natural resource staff people working in tribal governments are trained and educated in Western universities. Unless they are tribal members actively immersed in the group's cultural traditions and practices, it cannot be assumed that they will adopt a TEK perspective in restoration projects.

This disconnect is further compounded when cultural data and program objectives are managed by one tribal agency or group, such as the tribal preservation office or elder cultural committees, while natural resource data and program objectives are managed by a different resource group, such as the tribal land program or natural resource department. At best, there is a good flow of information and compatibility of program objectives; at worst, the programs may work at cross purposes to one another.

Another observed reason for the lack of incorporation of TEK into modern restoration efforts is its specific, place-based nature in comparison to more widely applied methods of restoration ecology. TEK is derived from careful observations and adaptive interactions with a particular place over a very long period of time (Berkes 1999, Berkes et al. 2000) It does not lend itself to simplified one-size-fits-all or short-term restoration strategies. Most Western science restoration planning approaches draw on coarser scales of data with a few specific points and lack localized understandings of potential social or ecological barriers to implementation that reflect local conditions.

Many restoration projects are funded and implemented by government agencies or firms that typically work in the absence of local community or tribal involvement. Agencies or consultants may be unaware of TEK's usefulness and application and therefore overlook it at every phase, from planning to implementation. When these groups are required to consult with First Nations or American Indian tribes, this activity often is limited to a presentation of proposed actions in which little adjustment can be made to incorporate TEK after initial planning. In comparison, even when tribes have the opportunity to include TEK in the planning process, it may not find its way into restoration proposals because of prevailing trends in restoration prioritization and funding. In some cases First Nations and American Indian Tribes themselves are reluctant to incorporate TEK into their restoration proposals, fearing that the proposal, in comparison to "strict scientific" proposals, will be rejected by funding sources in a competitive funding allocation arena.

Planning processes for restoration treatments often are short, focusing on a perceived urgent call to action to save a species or a particular degraded habitat. It is rare that sufficient funding and qualified staff are allocated to restoration planning. The collection, analysis, and critique of appropriate application of TEK must take place in the planning phase of a restoration program or project. Yet many restoration ecologists and community-based practitioners who are guided by the Western science paradigm often move forward without consulting local indigenous people for their perspectives and data, even when these would be readily shared.

At the planning stage, TEK can identify issues such as particular species–habitat relationships, human–nature disturbance regimes, or long-term ecological cycles that may have been missed by purely Western science planning approaches (Berkes et al. 2000). Unfortunately, many agencies and organizations may not see the utility of adequately funding oral history interviews and archival research to collect and organize traditional knowledge related to a given restoration topic. Even agencies that do support documentation of ecocultural knowledge may miss the linkages or key points stressed by indigenous elders or subsistence practitioners because their methods are too compressed or because they do not understand what is being conveyed.

For example, a restoration focus placed strictly on a fish species and on instream flows may discard the points mentioned by tribal elders about historical practices that included burning vegetation in part to increase water yield. Yet the elders recall the importance of linking historical season and conditions of burning to decreased evapotranspiration, which increases stream flow during critical migration phases of key fish species. This critical connection is further illustrated in the prescribed burning and fish monitoring case studies described later in this chapter.

Finally, not all restoration projects are necessarily well suited to incorporating TEK. Attempting to draw on traditional knowledge and practice may be less effective in highly engineered projects where restoration practitioners are exclusively technical specialists whose experience is limited to megascale schemes involving large machinery and few individuals, where the goal is to complete the project and go home. TEK is better suited to projects that draw together social and ecological communities through long-term adaptive management strategies, where a long-term intergenerational community approach is used restore a degraded ecosystem or habitat or conserve threatened or endangered organisms (Berkes et al. 2000, Turner 2005).

Key Concepts in TEK Restoration

Kincentricity

A key concept in the indigenous world view is *kincentricity*, or a view of humans and nature as part of an extended ecological family that shares ancestry and origins (Salmón 2000, Martinez 1995). The kin or relatives include all the natural elements of an ecosystem; indigenous people sometimes refer to this interconnectedness as "all my relations." Kincentricity acknowledges that a healthy environment is achievable only when humans regard life around them as kin.

Kinship with plants and animals entails familial responsibilities; it tells us why we are on this earth and what our ecological role or niche is vis-à-vis our relatives in the natural world. To put it another way, it tells us that we are a legitimate part of nature, that we have responsibilities within nature, and that in exercising those responsibilities we are as "ecological" or "natural" as any other species. The indigenous land ethic holds that we can have a positive restoration effect in the very act of using natural resources. Kincentric ecology entails direct interaction with nature to promote enhanced ecosystem and cultural functioning. This is what sustainable practices are all about.

Our responsibility for participating in the "recreation of the world" (as tribes on Klamath River in northwestern California call it) is never finished. Periodic intervention by humans in nature has long been part of ecosystem dynamics in the Pacific Northwest. Given the myriad ecological catastrophes we now face, the need for active restoration will only increase. There are no finished restoration projects. Nature has self-healing powers, but these engage only after a specific harmful disturbance (e.g., a dam or invasive species) is removed or modified. Humans also can lend a hand by restoring missing species, modifying structure, and so forth. As the SERI *Primer* notes, continuing management is necessary to "guarantee the continued well-being of the restored ecosystem thereafter" (Society for Ecological Restoration 2004:6).

Pioneering Western ecologists and restorationists have come to similar conclusions with respect to kincentricity, starting with Aldo Leopold (1949) and his land community ethic, which posited that an individual is a member of a community of interdependent parts and that each citizen is ethically bound to maintain cooperative relations with the biotic community. Restorationist Stephen Packard discovered that recovering degraded Midwest landscapes required corps of dedicated volunteers to restore several thousand acres of tallgrass prairie and oak savanna (Stevens 1995). This ambitious endeavor was not possible until people invested in their home places. Environmental philosopher Andrew Light (2005) has explored the personal, moral, and environmental dimensions of making amends to our kin through the act of restoration and considers how restoration provides a venue for ecological citizenship. Kincentricity provides a basis for considering restoration as a process of engagement with nature, a way to sustain or repair relations with the living world. In doing so we develop viable cultural, economic, and ecological practices that support and nurture our shared environment.

Reference Systems

When addressing the needs of restoration today, whether at the landscape, habitat, or species level, it is important to recognize indigenous peoples as an influence in shaping and maintaining the historical condition of many different ecosystems. In this sense, the effect of past indigenous management practices should be considered part of the reference ecosystem, or more generally as providing a set of reference processes to guide a restoration effort. In the Northwest, reference conditions influenced by indigenous land use practices of a pre-European era are the benchmark.

Any reference condition or design of future desired conditions must account for humans' use and management of the environment. The scale and intensity of human use and management of the environment are important to successful ecocultural restoration and to establishing a sustainable relationship to place. Our reference window is at least as large as 10,000 years, or the postglacial Holocene period, with particular attention paid to the last 4,000 years, during which a gradual cooling trend occurred that most resembles present climatic and ecological conditions (Figure 17.2). The last 10,000 years also is the period during which humans have exerted the most influence on North American ecosystems (Egan and Howell 2005).

The use of reference ecosystems in restoration is not without controversy. It can be expensive and time-consuming to use multiple disciplines and indirect proxy lines of ethnographic and scientific evidence to establish a reasonable probability of accuracy in identifying a site at a specific point in history (see Egan and Howell 2005 for technical information regarding reconstructing historical ecosystems).

Some restoration scientists and practitioners question the value of using historical baselines to

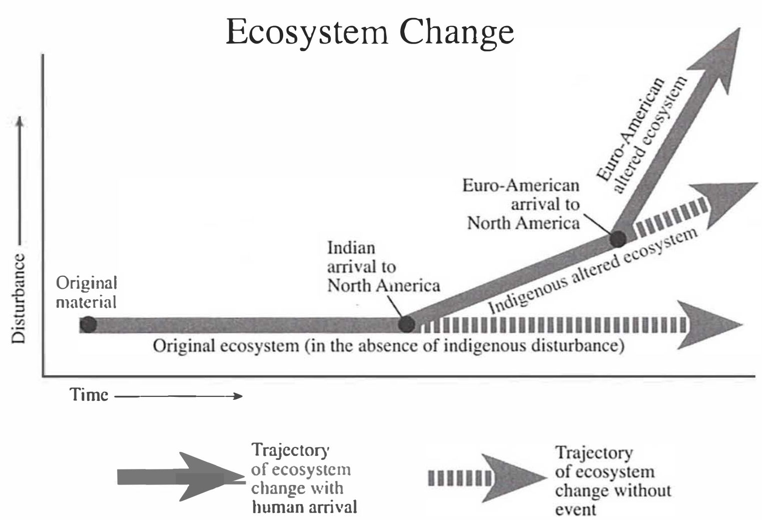

FIGURE 17.2. Ecosystem trajectory showing that humans represent an ecological force on the landscape. (*From Lewis and Anderson 2002. Copyright © 2002 by the University of Oklahoma Press, Norman. Reprinted with permission. All rights reserved.*)

guide restoration. Not only can it be difficult to reconstruct historical ecosystems because of severe changes in some environments, but why go back to an arbitrary point in history? Why choose, for example, a time before European contact as the reference? Why not just try to improve the function of degraded ecosystems? Isn't nature constantly changing?

However, TEK does not advocate that we stop change and freeze ecosystems in a particular timeframe or that we recreate a snapshot in time. After all, present conditions are also a snapshot in time. What we really need to do is connect the past with the present in order to reveal what kind of trajectory an ecosystem may be on and then nudge that trajectory just enough to restore key functions. History and function, then, are inseparable. Both Higgs and Martinez have written and spoken about balancing historical fidelity or authenticity with ecological functionality. Instead of fixing a snapshot in time, we need to rerun a moving picture, played out within boundaries determined by historical trends in disturbance regimes, including the kinds, intensities, and frequencies of disturbance with which an ecosystem has evolved.

For example, forest stand-level restoration projects are subject to constraints imposed by the greater landscape scale. Although a reference ecosystem can guide initial restoration efforts, these will be modified by larger landscape considerations (e.g., fragmentation, fire hazard, exotic species invasion, species losses), or even larger phenomena such as climate change. Anchoring the reference model in real historical time will help us to recover key features of ecosystem structure, composition, and processes within natural variability, with a look to designing the future desired condition.

Building sound reference models for ecocultural restoration requires the best Western science and the best of TEK, not one or the other. Each has the potential to reinforce the other and to compensate for inherent methodological limitations by considering history and function, quality and quantity, long term and short term, culture and ecology, economy and environment.

Successional Theory and Disturbance

Traditional ecological knowledge complements contemporary knowledge of fire ecology by providing information about historical and contemporary applications of fire by indigenous people, including fire effects on wildlife and vegetation in different environments. Indigenous knowledge of fire ecology includes but is not limited to variations in fire frequency, intensity, severity, and specificity of areas burned in different ecosystems or plant communities by indigenous people or by lightning ignitions. TEK provides knowledge about fire effects and ecosystem responses and about how physical and biological processes such as hydrology and forest succession respond to fire over time (Lewis and Anderson 2002).

Integrating multiple knowledge systems to understand the effects of fire on the remaining post-treatment vegetation or soils can lead to greater accomplishment of objectives. Thinning and spring season pile burning may be intermediate steps that help prepare the site for the reintroduction of fall season low-intensity burns that emulate Indian fire (Williams 2000). Ethnographic information and TEK may be instrumental at each treatment step, especially when one is considering restoration effects on wildlife, food plants, or non-timber forest products, resources that hold high social and ecological value to local communities (Anderson 2001).

Restoring and maintaining biocultural diversity of the landscape through integrated restoration planning involves an interdisciplinary as well as a multicultural approach. Fuel reduction projects that incorporate Indian fire will have higher levels of success in restoring and maintaining biodiversity, which in turn will support cultural diversity and local communities. This premise may hold true especially with native cultures that historically and currently rely on fire and fire-dependent landscapes for their sustenance and cultural survival (Boyd 1999). A community forestry approach can help local communities cope with likely future changes caused by climate change and intensified demands of natural resources.

Defining Scale

Issues of ecological and social scale are important considerations in restoration work. Any restoration program directed toward a given geographic area must carefully define the scale at which it will operate. For example, will projects focus on a single species or population, a particular habitat, or an entire watershed? Will restoration engage the collaboration of an individual, a community, or a national organization or institution?

Indigenous ways of understanding and relating to the environment provide useful models for framing restoration efforts at the appropriate scale. In coastal Pacific Northwest environs, individual families traditionally were responsible for a particular resource base at a specific location (e.g., shellfish beds). Villages were organized around specific places along stream reaches, and an affiliated tribal group (distinguished by common linguistics) managed a given bioregion (J. James, personal communication, 2001). Appropriate technologies and resource management practices were ritualized to maintain healthy functioning of the system at all social and ecological scales.

Defining the scale of operation provides context for our individual actions linking with others' actions across or up in scale. TEK provides an operational framework that addresses the integration of the various ecological and social scales, situated within temporal scales (Figure 17.3; Berkes et al. 2000). The perspective of scale can also be reflective in that the strengths and weaknesses of TEK and Western science are evaluated in the context of the restoration program or projects being planned, implemented, or monitored.

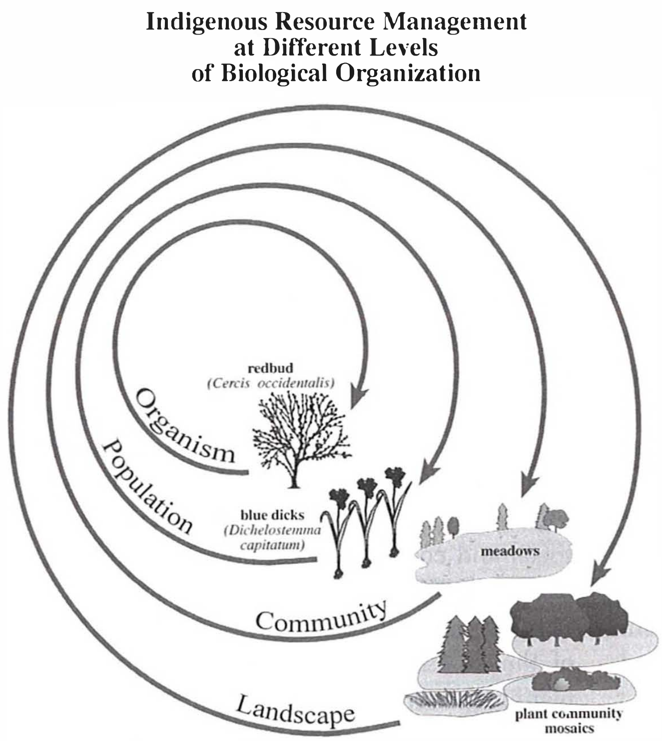

FIGURE 17.3. Scale of potential management effects. (*From Lewis and Anderson 2002. Copyright © 2002 by the University of Oklahoma Press, Norman. Reprinted with permission. All rights reserved.*)

Pacific Northwest TEK Restoration Projects

Cultural Fire Regimes and Prescribed Fire

Every ecosystem in the Pacific Northwest and throughout North America has been modified in some way by a fire regime implemented by indigenous people (Boyd 1999). Forest science, including vegetation classification, evolved from Gifford Pinchot–era observations of forests transitioning in condition from indigenous fire management to postsettlement fire suppression. Scientific understanding of forest processes therefore may be based largely on an atypical, transitional landscape (Kimmerer and Lake 2001).

Cultural fire regimes specific to certain ecosystems and plant communities (e.g., oak savanna or subalpine parkland) were intentionally created and maintained primarily by indigenous people. These indigenous fire regimes may or may not have occurred in conjunction with natural wildland fires ignited by lightning, volcanic eruptions, or other nonhuman causes (Lewis and Anderson 2002). Cultural fire regimes historically affected the composition, structure, function, and productivity of particular habitats, especially the culturally defined resources therein. The distinguishing features of cultural fire regimes include alternate seasons for burning under different kinds of settings; frequencies with which fires are set and reset over varying periods of time; corresponding intensities with which fuels can be burned; specific selection of sites fired and, alternatively, those that are not; and a range of natural and artificial controls that humans use in limiting the spread of human-set fires, such as time of day, winds, fuels, slope, relative humidity, location of streams and snowbanks, and natural and human-created firebreaks (Lewis 1982, in Bonnicksen et al. 1999).

How have habitats been altered as a consequence of fire suppression and the cessation of indigenous land use practices? Consider the effects of fire suppression and the resulting changes in the composition, structure, function, and productivity of habitats that many indigenous people rely on for food, medicine, materials, and spiritual and cultural survival. The results of fire suppression and other contemporary forest management practices are at the heart of our national "healthy forests" debate today (Figure 17.4). In many areas of Pacific Northwest, First Nations and Native Americans historically and currently rely on fire-induced conditions of the environment through subsistence activities to support their cultures and livelihoods. Conversely, Western forests are deprived of the sus-

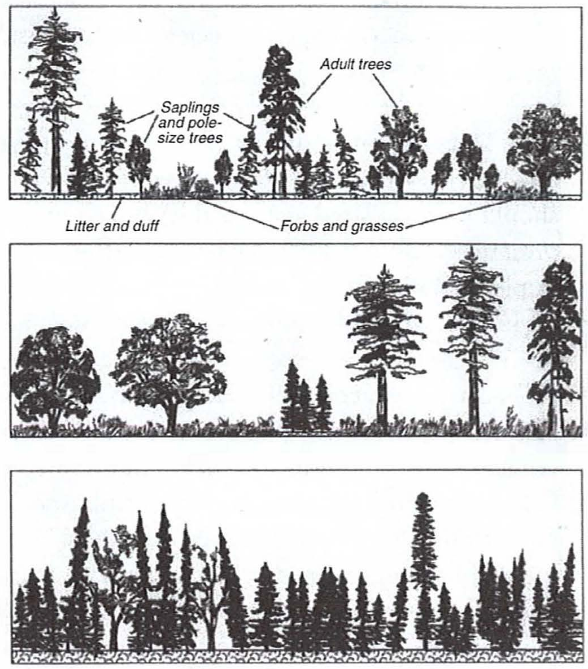

FIGURE 17.4. Forest types created by different forest regimes: *(top)* a lightning fire regime; *(middle)* a cultural fire regime, or prescribed burning; *(bottom)* a fire suppression regime. Note that a fire regime that incorporates both cultural and natural fires results in increased diversity of understory species, decreased litter, and less dense tree canopy. *(Concept diagram by M. Kat Anderson and Michael Barbour. Courtesy of the University of Wisconsin Press)*

tainable human interventions that promoted their former health and abundance and the expressions found in systems ranging from old-growth Douglas fir to oak savanna.

Do restoration prescriptions address the broader ecological role of plants for social, cultural, or spiritual uses? Land managers and the public should not view vegetation as merely fuel. The ecological and cultural significance of a plant varies but generally should be considered in light of its role as food, medicine, material, or habitat in relationship to the danger it may pose as fuel in its present setting. Many fuel reduction prescriptions do not account for the differences in the ecological or cultural function of specific plants. For example, many understory plant species may be considered dangerous ladder fuels, yet their complete removal may be ecologically or culturally undesirable. How a plant, shrub, or tree responds to fire, and the ecological and cultural services it provides, should be considered at a broad level with project prescriptions and at a specific level with the project implementation at a given site.

In general, fall burning was more widely practiced by indigenous people than spring burning. Fall burning was conducted because the response of culturally important plants and wildlife habitat vegetation was more in line with cultural needs. Fall burning favors nonsprouting brush species that are preferred by wildlife, and seeds of these species often need fire for germination. Fall fire also induces new growth on both sprouters and nonsprouters in early spring, a time when stored food supplies for people typically were running low (Lewis 1993, Boyd 1999). Indigenous fire regimes and selective harvesting probably modified the genetic structure and species dispersal of both cultural and noncultural plants and animals (Bonnicksen et al. 1999).

In many fuel reduction projects, intermediate treatment steps are taken to reduce the risk, intensity, and severity of fire on physical, biological, and social processes or conditions. For example, as a first treatment step mechanical thinning may reduce the connectivity and bulk density of fuels in areas near human settlements (USDA Forest Service 2001). Thinning may be followed by pile or broadcast burning in the winter or spring. Even if the historical seasonality of Indian burning was in the fall, the intensity of a fall burn in current forest conditions can be greater and more damaging to vegetation and soils. Thus a spring burn, after initial thinning, might be prescribed to reduce these risks. Later, when conditions are less conducive to a high-severity fire, the original pattern of fall burning may be resumed.

Case Study: The Karuk Tribe of Northern California and Local Fire Safe Councils—Fuel Reduction Projects, Wildland Urban Interface, and Fuel Breaks

> Lack of knowledgeable traditional stewardship has created landscape conditions that have ignored and devastated traditional resources and now threatens the well-being of both the forests and the forest based communities. The management of traditional resources through implementation of specific forest management practices requires addressing an intricate complex of political, cultural and technical issues. Building the Tribe's capacity to play an appropriate role in ecosystem management is the only means by which ecosystem restoration, cultural survival and community prosperity will be achieved. (Karuk Tribe, Department of Natural Resources Web page: karuk.us/)

In northwestern California, the Happy Camp and Orleans/Somes Bar Fire Safe Councils are working with the Karuk Tribe, the U.S. Forest Service, local native basket weavers, and private landowners to implement fuel reduction projects that achieve the objectives of reducing fuel loads while considering the importance of culturally significant native plants, wildlife habitat, and nontimber forest products. Vegetation is not viewed simply as fuel. Rather, during the planning and treatment phases, vegetation is judged from the perspective of fire danger as well as ecological and cultural importance. The key to incorporating TEK into the fuel reduction projects is to work closely with local communities. Collaboration between tribal elders, practitioners, and Western scientists is essential to restoring fire-adapted ecosystems from which many culturally valuable resources are used (USDA Forest Service 2001).

Information is collected on multiple perspectives held by local tribal members, landowners, and scientists on the functional role of trees, shrubs, forbs, and grasses. The various perspectives are incorporated in the prescription treatment. Local native basket weavers and tribal members may prefer that a combination of plant species be retained or removed and may favor spring and fall burning. Each project treatment is evaluated separately, given the social and ecological issues present at that site.

Acknowledging local tribal knowledge with respect to the importance of plants for wildlife habitat, cultural uses, and anticipated fire response is vital at all phases of the project. Because native cultural burning was a historically important agent in influencing the composition, structure, function, and productivity of low- to mid-elevation areas along the mid–lower Klamath River corridor (Pullen 1996, Lewis 1993), many members of the local community, both Indian and non-Indian, think it is appropriate to reinstate similar cultural burning practices as part of fuel reduction treatments (Orleans/Somes Bar Fire Safe Council 2005).

The most common integrated project elements include reducing hazardous fuels, restoring California black oak (*Quercus kelloggii*) and California hazel (*Corylus cornuta*) habitats, supporting basketry management practices, and improving wildlife habitat. Black oak- and hazel-dominated habitats were historically more prevalent before government fire suppression policies. Black oak–hazel habitats are ecologically and culturally significant in low- to mid-elevation communities (see Chapter 4). Yet shrub and conifer encroachment has threatened the black oak–hazel habitat quality and productivity. Current fuel reduction projects target removal of 2- to 50-year-old Douglas fir (*Pseudotsuga menziesii*), reduction of understory shrub density and crown area, and opening of forest floor.

After thinning operations and spring pile and broadcast burning, selected hazel clumps are spot or patched burned to promote shoot growth for basket materials (Anderson 1999). Native shrubs, forbs, and grasses that are important for wildlife habitat or forage and culturally useful for materials, foods, or medicines are rejuvenated after thinning and burning activities. Other habitats where TEK is integrated with fuel reduction and prescribed burning include sandbar willow (*Salix exigua*) riparian patches, pine (*Pinus ponderosa* and *P. lambertiana*) habitats, Oregon white oak (*Quercus garryana*) habitats, and higher-elevation meadows. Similar restoration projects are taking place on the Hoopa Valley Indian and Yurok Reservations in northwestern California.

In 1995 the Karuk Tribe presented the "Karuk Tribal Module for the Main Stem Salmon River Watershed Analysis" to the Klamath National Forest for inclusion in the agency's Final Forest Plan, as required by the Northwest Forest Plan. Ecosystem management was to be the guiding force behind forest management. Nearly all of the tribe's ceded ancestral lands were controlled by the Klamath, Six Rivers, and Siskiyou national forests. Consequently, the Karuk took the position that comanagement between the Klamath Forest and the tribe was imperative for two reasons: ecosystem management could not be accomplished without input from tribal members who used forest resources and therefore knew their turf better than the Forest Service, and the tribe could not stake its cultural and economic future on designated cultural resource areas that were too small to remain viable given continuing drought-driven catastrophic wildfires and other ecological degradation.

Although legally recognized comanagement has not yet been implemented, the Karuk work closely with the Forest Service on restoration projects. The key point is that for tribes to realize true sovereignty, they must have access to cultural resources on ceded ancestral lands, equity in treatment by the Forest Service (defined as comanagement), and the capacity to use traditional forest management practices such as prescribed fire. The Karuk are continuing their efforts to restore the fisheries and watersheds of the middle and lower Klamath River drainage in collaboration with the Klamath Restoration Council (formed in 2004), with participation from the Yurok and Hoopa tribes, environmental organizations, scientific and cultural consultants, the Indigenous Peoples Restoration Network, and local community members.

Case Study: Lomakatsi Restoration Project, Southern Oregon

The nonprofit Lomakatsi Restoration Project in southern Oregon is actively restoring sugar and ponderosa pine, black oak, and Oregon white oak habitats on public and private lands. Harvesting of mature conifers and fire suppression activities have allowed the expansion and encroachment of manzanita (*Arctostaphylos* spp.), ceanothus (*Ceanothus* spp.), and Douglas fir into former pine- and oak-dominated habitats. Manzanita, ceanothus, and Douglas fir encroachment has increased fuel loads and potential fire hazard. Former forb and grass openings associated with pine–oak habitats have been lost, endangering many native plants and degrading wildlife habitat quality.

The Lomakatsi Project has incorporated TEK into restoration prescriptions of pine–oak habitats. Restoration crews have undergone ecocultural workforce training, and native restoration practitioners have been hired to train crews. Fuel reduction projects involve hand equipment or chippers along access roads to remove small-diameter trees and shrubs before selective single or small-group tree harvesting.

Mature dense thickets of manzanita and ceanothus are thinned and pile burned in an effort to release pine and oaks and to restore openings (Figure 17.5). Retention patches of mature manzanita and ceanothus are left in clumps distributed across the project site in order to maintain overall diversity of species and habitats. Douglas firs, commonly 2–50 years old, are selectively thinned to favor sugar and ponderosa pines and mature and seedling black and white oaks across project sites. Native grasses and forbs locally harvested are also dispersed in burn piles and across the site. Native trees and shrubs reared at local nurseries are planted in project sites to restore diversity, and large conifer snags and downed wood are retained for wildlife habitat and soil formation.

The overall approach to restoration forestry thinning prescriptions by the Lomakatsi Project can be described as variable density or retention management (see Chapter 5). The intent is to restore enough variability in stand structure and composition to provide sufficient redundancy or repetition for suitable wildlife habitat where we lack knowledge of the lifeways of many species—a kind of risk spreading (Lindenmayer and Franklin 2002). Even if pines or oaks are favored over Douglas fir, some Douglas fir are preserved, and all potential native species and age classes are represented in the finished project. Another important feature of the Lomakatsi Project is the restoration of the herbaceous forest understory, because most cultural plants and wildlife habitat occur at the grass, forb, and shrub level, and many of these species are being lost to shading out by invasive conifers. (For more details see www.lomakatsi.org).

FIGURE 17.5. Lomakatski restoration project: thinning and burning manzanita and ceanothus to restore oaks and pines. (*Photo by Frank Lake*)

CASE STUDY: HUCKLEBERRY CROP MANAGEMENT

For First Nations and Native American people of the Pacific Northwest, several species of huckleberry (*Vaccinium* spp., especially *V. membranceum*, black mountain huckleberry) have always been important cultural foods (Mack and McClure 2002, Deur 2002). Historically, huckleberry patches were managed with fire and pruning to maintain and increase berry production. Cessation of Indian burning practices combined with suppression of natural ignitions has caused encroachment in many traditional huckleberry-gathering areas by conifers and other shrub species (Figure 17.6). Competition for light, nutrients, and water has reduced the abundance of berries and the former extent of berry patches (Minore 1972).

In a cooperative project between the U.S. Forest Service, the Mt. Hood National Forest, Oregon State University, and the Confederated Tribes of the Warm Springs, traditional ecological knowledge combined with Western forestry practices were used to examine the effects of different silvicultural treatments on the productivity of huckleberries (Communities Committee of the Seventh American Forest Congress 2000, Anzinger 2003). Silviculturists working with tribal members and elders are learning that huckleberry patches cannot be managed in isolation but are part of a complex, dynamic landscape mosaic of diverse and shifting successional patches. Elsewhere across the Pacific Northwest, other tribal and First Nations groups are incorporating traditional huckleberry management practices with forest restoration to increase the extent and production of huckleberries, a food source important for wildlife and human consumption.

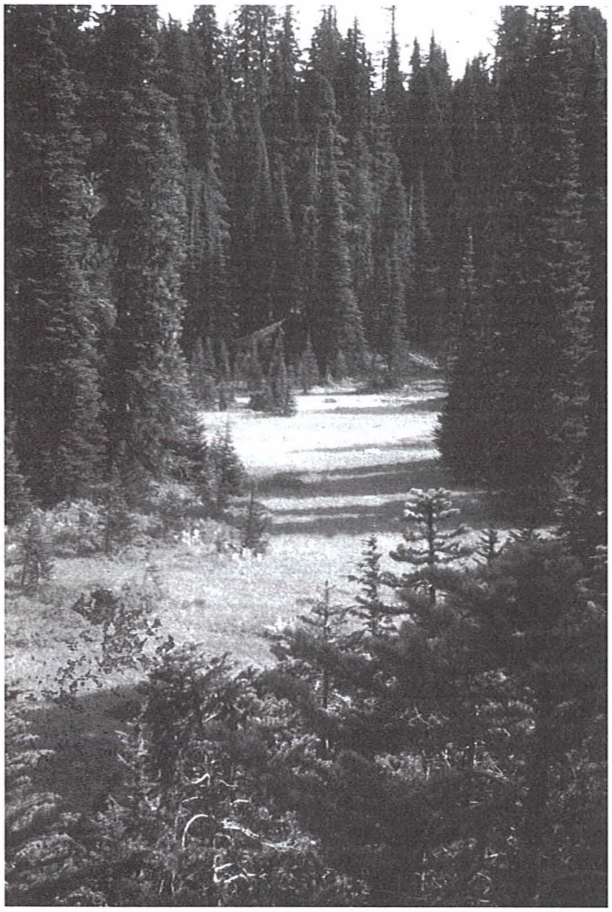

FIGURE 17.6. Southern Washington Cascades huckleberry meadow historically maintained by indigenous burning is now encroached on by subalpine forest. (*Photo by René Senos*)

Traditional Ecological Knowledge and Wildlife Restoration

In both historic and contemporary cultures, wildlife species have occupied a major role in indigenous diet, clothing, tools, arts, stories, ecology, and cultural and spiritual life. As one Salish elder on the Flathead Indian Reservation in western Montana observed, "Wildlife aren't just animals. They are our medicine, our clothes, and our relatives. Wildlife are sacred" (P. Pierre, personal communication, 2003).

Traditional ecological knowledge offers several key practices and strategies that may be combined with scientific methods to enhance wildlife habitat and populations. For example, species monitoring is a practice shared by both disciplines. Traditional resource users regularly observe and communicate the status of a wildlife species and adjust habitat management and harvesting practices accordingly. Several indigenous practices entail the protection of vulnerable life stages of species or the preservation of key habitats. Temporal or spatial restriction of harvest is another common traditional practice, whereby hunting, fishing, and trapping areas are periodically rested to ensure healthy populations (Berkes 1999, Berkes et al. 2000). These seasonal or periodic restrictions on wildlife harvest typically are codified and ritualized into cultural and spiritual practices.

Resource rotation, or the activity of rotating harvest areas to allow wildlife species time to recover, is widely practiced. Unfortunately, the institution of a private property land system, prohibited access to usual and accustomed traditional resource areas, and habitat loss accelerated by human development all impose serious obstacles to resource managers' ability to rotate harvest areas. Greater pressure is thus placed on limited wildlife pools restricted to fragments of their former range. Thus restoration practice needs to include creative conservation strategies, such as enhancing wildlife corridors across multiple-owner boundaries.

Integrated system management is an important strategy that TEK offers to restoration practice. Rather than targeting a single species in the course of resource management, traditional practitioners use multiple-species management across multiple habitat types. This holistic world view of resource management often is expressed in phenological calendars maintained by many indigenous groups (Figure 17.7). Phenological cues are seasonal markers, such as the flowering of a particular plant species, that tell the observer when to engage in a resource activity, such as harvesting a specific ani-

FIGURE 17.7. This Salish calendar illustrates the connection between seasonal markers, environmental practices, and cultural traditions. (*Courtesy of the Salish Cultural Committee*)

mal species. Connections are drawn between seemingly disparate natural events, management practices, and cultural traditions. Furthermore, phenological cues coupled with traditional rituals or ceremonies strengthen cultural cohesiveness and identity (Garibaldi and Turner 2004, Lantz and Turner 2003).

Northwest tribes are engaging in the restoration of many key wildlife species that are essential to their peoples' ecology and culture. For example, First Nations peoples in interior British Columbia are conducting oral histories to determine historical riparian conditions. These oral histories will help them incorporate TEK into cottonwood (*Populus balsamifera* spp. *trichocarpa*) and willow (*Salix* spp.) restoration planning to enhance riparian habitat for a key migratory bird, the yellow chat. The Nez Perce are leading wolf recovery efforts in Idaho and are also working to restore wildlife habitat in their traditional homeland, the Wallowa Valley in northeastern Oregon. An instrumental partnership with the Trust for Public Land enabled the Nez Perce Tribe to acquire a 10,000-acre cattle ranch to manage as a wildlife refuge in order to replace habitat lost with the construction of Columbia River dams (Mahler 2004). The Elakha Alliance, a partnership that includes the Confederated Indian Tribes of Siletz, is working to restore sea otters on the Pacific coast. Traditional ecological knowledge coupled with scientific testing was instrumental in distinguishing the Pacific coast otter as a unique and separate species and providing crucial information for their future recovery (see www.ecotrust.org/nativeprograms/elakha.html).

Case Study: Wildlife Crossing Design on the Flathead Indian Reservation

The Salish, Kootenai, and Pend d'Oreille peoples formerly occupied a vast territory that included northwest Montana and parts of Idaho, Wyoming, and southern British Columbia. They currently reside on a portion of that territory known as the Flathead Indian Reservation, a diverse landscape that contains part of the Continental Divide, the Bitterroot Range, and an extensive system of valleys, wetlands, and rivers. The land is also home to myriad bird, fish, amphibian, and wildlife species that range from painted turtle to grizzly bear. These species and their habitats are carefully managed by various agencies within the Confederated Tribes of the Salish, Kootenai, and Pend d'Oreille government and by cultural groups such as the Salish Cultural Committee and the Kootenai Cultural Committee. The tribes have engaged in restoration and management of several wildlife species and critical ecosystems, including the Jocko River.

U.S. Highway 93 is a north–south corridor that bisects the reservation. When the Montana Department of Transportation proposed widening the predominantly two-lane road to a four-lane highway, the tribes opposed the plan because of the project's potential impact to cultural and ecological values. The existing highway already impeded wildlife migration across the valley floor, disrupted hydrologic flows of dozens of streams and rivers, cut a swath through a half dozen rural communities, and affected several geological and ecological features directly tied to the peoples' origin stories.

Nonetheless, the highway was one of the most dangerous roads in the country, resulting in many fatalities. After a several-year impasse, the tribes, in collaboration with the state and federal highway departments, hired a design team to develop road alignment and design concepts and eventually to design a final project. The design team consisted of landscape architects Jones & Jones, engineers Skillings-Connolly, Inc., tribal resource agencies (both natural resource and tribal preservation agencies), and the Salish and Kootenai cultural committees. Additional assistance was provided by other restoration specialists, including the Western Transportation Institute, wildlife biologist Tony Clevenger (Banff National Park), Bitterroot Restoration, Inc., and other subconsulting landscape architecture and engineering firms.

Several important design concepts evolved out of this collaboration, which was driven by a context-sensitive approach to place and culture. First and foremost was the concept of respecting Spirit of Place and treating the road as a visitor. Out of this simple but powerful idea grew a project that better supported the ecological and social values inherent in the Flathead Indian Reservation. The process of rebuilding the road became one of restoring the lost or impaired functions that the original highway had compromised.

Instead of a four- or five-lane, straight highway in the present alignment, a variable-lane road was laid out in a curvilinear alignment that avoided sensitive resources. Tribal representatives, including both elders and resource managers, indicated the areas to avoid. A comprehensive restoration plan was developed in coordination with the elders, tribal resource managers, landscape architects, and biologists. The plan included restoration of sixteen different native plant communities, several wetland and riparian areas, and, most critically, the construction of nearly fifty wildlife crossings throughout the corridor length (Figure 17.8).

The location and individual design of each wildlife crossing were predicated on tribal wildlife data, traditional ecological knowledge, and independent scientific and design input. Tribal elders

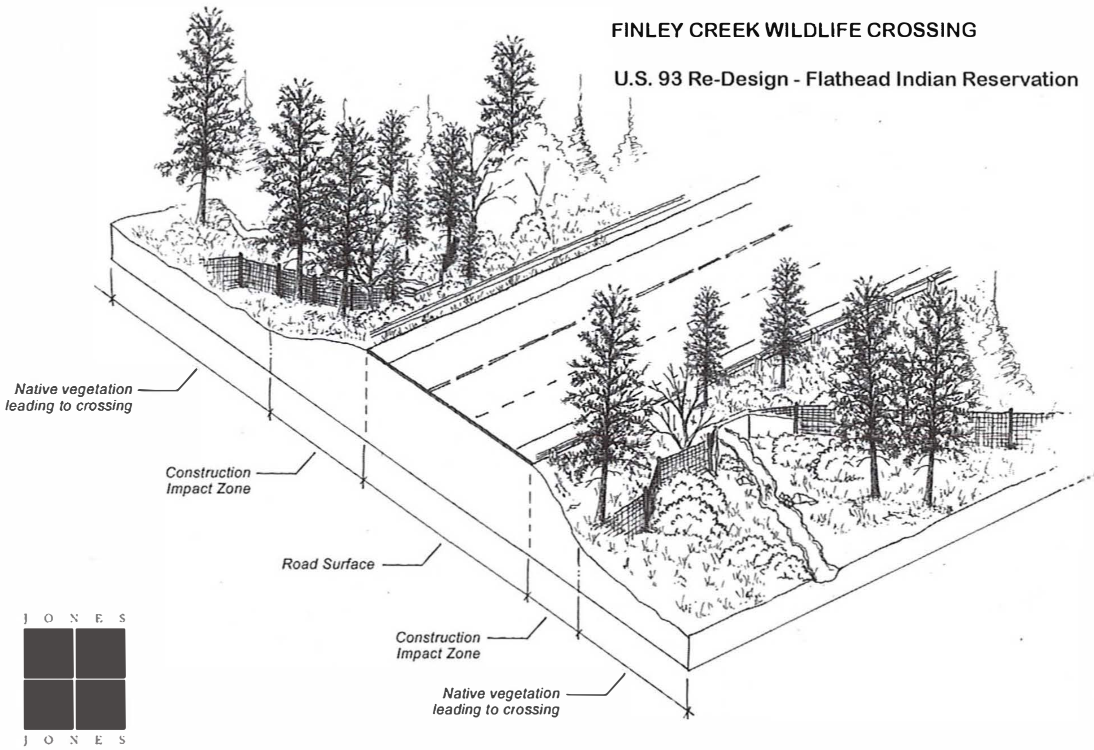

FIGURE 17.8. Conceptual drawing of one of nearly fifty wildlife crossings to be constructed as part of U.S. 93 redesign on the Flathead Indian Reservation. (*Drawing by Jones & Jones Architects and Landscape Architects*)

and the respective cultural committees have actively held and conveyed a very long record of cultural traditions, lifeways, and practices. This cumulative record of a people living in one place for several millennia is transmitted from one generation to the next through oral tradition, stories, language, arts, and specific cultural practices. On the scientific side, tribal wildlife managers have monitored populations and habitat conditions for several years and also maintained wildlife mortality records along U.S. 93. The scientific data of tribal wildlife managers, coupled with the traditional knowledge of the elders and guidance from the Tribal Preservation Office, identified key animal corridors and habitats.

The wildlife crossing structures range from 4 by 6 feet (1.2 by 1.8 meters) and 12 by 22 feet (3.7 by 6.7 meters) box culverts to bridges that span full floodplains and include one wildlife overpass. The structures accommodate a wide range of species, including painted turtles, fish, amphibians, numerous small mammals, deer, elk, coyote, wolf, moose, grizzly, and black bear. Critically, the crossing structures tie into restored plant habitats and key ecosystems. Construction began in the fall of 2004, and when completed the highway will contain more wildlife crossings than any other road in the United States. More importantly, the project design promotes the cultural and ecological values actively practiced by the Salish, Kootenai, and Pend d'Oreille people.

Ecocultural Restoration of Pacific Northwest Fishery Habitat and Populations

Fisheries are a mainstay of Northwest ecology and culture, and tribes throughout the region are fervently engaged in restoring fishery populations and habitats and sustaining the traditional cultures that coevolved with species such as the salmon. Like Pacific forests, fish have been thrown into the hotbed of politics and science. Hatcheries, dams, fish ladders, barges, and other artificial means of support are substituted for healthy, functioning rivers and streams. Still, many salmonid populations are declining to the brink of extinction.

In the midst of this crisis, tribes have organized individually and collectively to restore watersheds, estuaries, marine habitats, and fish and marine animal populations. Major coalitions provide a support network for tribal fishery restoration in the Northwest region: the Klamath River Intertribal Fish and Water Commission in the Klamath Basin; the Columbia River Inter-Tribal Fish Commission, based in the Columbia Basin; the Northwest Indian Fisheries Commission, based in Olympia, Washington; and the Fisheries Centre at the University of British Columbia. These organizations provide a visible forum for promoting indigenous fisheries and exchanging knowledge—both scientific and TEK-based—in restoration and conservation strategies.

The University of British Columbia Fisheries Centre strongly advocates the integration of TEK and science methods: "The Fisheries Centre at the University of British Columbia recognizes the tremendous value and importance of the Aboriginal perspective in fisheries conservation and management. . . . The partners are also working together to develop a framework for the inclusion of traditional ecological knowledge with quantitative fisheries management. This holistic approach will contribute to ecosystem restoration, habitat conservation of precious fisheries resources and pragmatic and feasible plans for sustainable fisheries use" (Endowed Chair 2002:2–3).

There are numerous case studies of Northwest fishery restoration; the ones that follow exemplify a restoration approach that creatively uses both traditional ecological knowledge and Western science, with promising results.

Case Study: Pacific Lamprey Research and Restoration

An oral history interview project conducted by the Confederated Tribes of the Umatilla Indian Reservation's Department of Natural Resources, in collaboration with the Columbia River Inter-Tribal Fish Commission, the Oregon Cooperative Fishery Research Unit, Oregon State University's Department of Fisheries and Wildlife for the U.S. Department of Energy, and Bonneville Power Administration's Division of Fish and Wildlife, has incorporated traditional ecological knowledge in a project to restore Pacific lampreys (eels; Figure 17.9). The restoration approach included a river subbasin method of collecting data on historical and present Pacific lamprey distribution and abundance. Collected indigenous knowledge will be used in an adaptive management process to make changes to factors inhibiting the passage and propagation of lampreys (Close et al. 2004).

In the central Coast Range of Oregon on the Siletz River, oral histories were conducted of local tribal members about factors leading to the decline of Pacific lampreys and about the extent and quality of spawning and rearing habitat. The Oregon Department of Fish and Wildlife is using this information in the management and restoration of habitat and populations of Pacific lamprey. Traditional knowledge was incorporated "by using the database queries to understand relationships between land

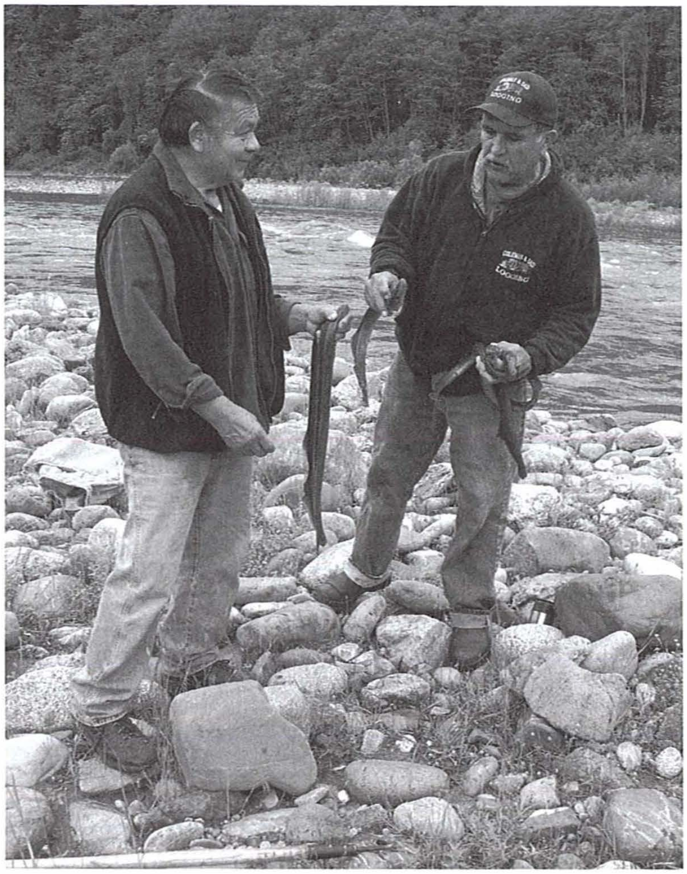

FIGURE 17.9. Elders and eels. Karuk elders Alme Allen and Eugene Coleman with lampreys harvested from a basket trap. (*Photo by Frank Lake*)

use and habitat or ecological parameters" in which "resource managers can focus their restoration techniques in the most cost-effective manner" (Chapin et al. 1998).

In northwestern California the Karuk and Yurok tribes have conducted oral history interviews with tribal elders and community members on the past and present distribution and abundance of Pacific lamprey and perspectives on the factors contributing to Pacific lamprey decline. The Yurok tribal fishery program completed a preliminary report on Pacific lamprey (Larson and Belchick 1998). Pacific lamprey monitoring and inventories by the Karuk and Yurok tribal fishery programs involve river habitat substrate sampling, outmigrant traps, and spawning surveys. Currently, traditional knowledge of tribal Pacific lamprey harvesters in the Klamath River and its tributaries about the historical abundance, food processing techniques, management practices, and habitat needs of Pacific lampreys is being gathered from local tribes. These data will be used to formulate restoration and conservation strategies (R. Peterson, personal communication, 2005).

Case Study: Salmon Restoration in the Pacific Northwest

Numerous federal and crown, state and provincial, American Indian and First Nations, and local community groups are actively working on salmon restoration in watersheds throughout the Northwest. Most approaches to salmon restoration are guided at two levels: Western scientific disciplines focusing at larger scales, such as watersheds, hydrologic units, and evolutionary significant units (ESUs), and local community-based practitioners at the river and stream system or reach level. Rarely, even with First Nations and American Indian fishery programs, has TEK been actively incorporated in restoration policies, planning, and project implementation.

Some of the best examples of salmon restoration not only integrate TEK and Western science methods but also work collaboratively across organizations. For example, the U.S. Fish and Wildlife Service and the Confederated Tribes of Warm Springs are working together for salmon recovery. Scott Aikin, a Native American liaison of the U.S. Fish and Wildlife Service, commented, "The tribe's traditional knowledge of the ecosystem and the salmon's role in it is vitally important to successful fish conservation in the Deschutes Basin, a tributary to the Columbia River. The service and tribe continually work together, melding their areas of knowledge into an effective process to protect this remaining wild stock of salmon" (Ikenson 2003). A similar approach is used by members of the Columbia River Inter-Tribal Fish Commission for the Columbia River basin and the Klamath Intertribal Fish and Water Commission in the Klamath River basin, working with other agencies and community groups to recover salmon species and habitat.

Case Study: Paleoecology and Salish Sea Restoration

The Center for the Study of Coast Salish Environments, based in Anacortes, Washington and encompassing the northern Puget Sound and northern Georgia Straits, has three main goals: to provide scientific support for sound stewardship of the Samish Historic Territory, including treaty rights; to prepare Samish tribal members for careers in the sciences and engineering; and to generate Samish tribal employment and income from research and conservation projects. Funding is provided by competitive sources, such as the National Science Foundation, and research contracts with state and federal agencies that share management responsibilities for the "Salish Sea."

The center actively recruits teams of Samish undergraduate science students to work year-round on its research projects. The program also attracts doctoral and postdoctoral science students as researchers and mentors for Samish scientists and creates partnerships and research-sharing arrangements with major Northwest universities and government research laboratories. Ongoing projects include archeological work on Fidalgo, Orcas, and Lopez islands; studies of native oysters in Fidalgo Bay and salmon at reef net sites on Orcas and Shaw islands; and estuary restoration activities (including genetics, geology, and botany) on Orcas and Lopez islands.

A major focus of the center is paleoecology, or the history of environmental change, including the ways in which Samish people shaped and were shaped by the ecosystems in which they lived, fished, and hunted. Paleoecology demonstrates that Samish ancestors successfully managed a complex and ever-changing marine environment for thousands of years. The center asserts, "Precise knowledge of how our ancestors took care of particular islands, bays, beaches, fish, and shellfish will give us guidance for the future protection and enjoyment of the resources that form our biological legacy" (Samish Research Center Web site: www.samishtribe.nsn.us/dnr/dnr_1.html).

Paleoecology entails the study of natural sediment deposits in estuaries and bays as well as cultural deposits, or vast shell middens that persist throughout the Northern Strait islands, which provide a record of what the Samish ancestors harvested, ate, manufactured, and traded. The center's mission is not only to survey and study the Samish archeological and cultural sites but also to help protect them. The center's SamArc database, created by Russell Barsh and Megan Jones, systematizes information on more than 500 historical and archeological sites in the Samish Historic Territory in Excel and geographic information system (GIS) formats.

The SamArc GIS database links archeology, ethnography, historical information, and fishery data in a comprehensive assessment of indigenous peoples' interaction with the marine environment across 300 islands and thousands of years. The center connects TEK with scientific research to study genetic evolution and coadaptation between humans and fisheries. The center has conducted a compelling study showing how human behavior has shaped salmon biology and demonstrating the intricate relationship between historic Samish reef net sites, Northern Straits kelp bed ecology, and sockeye salmon migratory patterns.

Northern Straits reef net fishing was a technology specialized to the Samish and other Straits Salish people (Stewart 1977, Claxton and Elliott 1994). Over millennia, Samish and Saanich reef net stewards cut paths in kelp beds for canoe access, a practice that influenced kelp bed growth, crustacean populations, and subsequent salmon migratory patterns. These reef net sites located offshore of Northern Strait islands were very important places connected to the field ecology of salmon, probably serving as way stations for genetically distinct salmon runs (Barsh and Hansen 2003, Turner and Berkes 2005).

To date there has been little scientific understanding of sockeye migration patterns and the importance and function of island systems. The Northern Straits region is rapidly developing, yet less than 5% is under protection. The center's research articulates the connection between traditional practices and fishery health and sheds light on the key elements that need to be in place for sockeye salmon restoration.

Case Study: Back to the Future

In the Strait of Georgia, British Columbia, the concept of "Back to the Future" encourages knowledge sharing between scientists, First Nations, fishers, historians, archeologists, and other interested parties to construct computer models of historical and contemporary ecosystem conditions. Past abundance and diversity form the basis for determining restoration goals that reflect productive potential rather than present scarcity. Research has included ecological studies and analyses of different fish species, marine mammals, birds, mollusks, and plankton from various parts of the ecosystem. Crucial information on the location, presence, and abundance of living organisms was obtained from historical records and documents, ethnographies, linguistic studies, archeological data, oral histories, and traditional ecological knowledge of the First Nations groups living around the Strait of Georgia.

Qualitative and quantitative data were used to construct mass-balanced models of the Strait of Georgia. The model was created with Ecopath, an ecosystem modeling software suite, and consists of two dozen or more functional groups. The epistemological, conceptual, and methodological issues brought forward by this interdisciplinary process served as a framework for ecosystem reconstructions and as a guide for future restoration. The "Back to the Future" model includes reconstruction of past and present ecosystems as a way to inform policy choices for fisheries. The assessment of alternative ecosystem management strategies, the design of restoration techniques, and the monitoring of ecosystem recovery are all factors that may generate powerful support among diverse stakeholders (Preikshot and Hearne 1998).

Invasive and Exotic Species Management

Because many First Nations and American Indian groups rely on multiple habitats or ecosystems in their aboriginal territory for ceremonial, spiritual, subsistence, and commercial purposes, they are often the first to recognize the presence, rates of spread, and reaction to disturbance by invasive and exotic species. Just as indigenous people observed and evaluated each native species for its potential habitat contribution as a food, medicine, or material or as wildlife habitat, the same criteria historically and currently are applied to exotic species. First Nations and American Indian groups adopted some exotic plants for use as medicines, foods, and materials. For example, in British Columbia, a number of elders recall eating watercress (*Rorippa nasturtium-aquaticum*) and dandelion greens (*Taraxacum officinale*), and broad-leaved plantain (*Plantago major*) is widely used as a medicinal poultice for burns, cuts, and bee stings. Exotic species that were observed exhibiting invasive traits were evaluated as to how they affected natural communities and cultural uses.

In northwestern California, tribes and tribal organizations working with fuel reduction, prescribed fire, and forest restoration projects prefer nonherbicide methods of invasive species control. Traditional knowledge of how different invasive native and exotic species respond to disturbance, the rates and methods of spread, and nonherbicide methods of control have been used to control invasive species (Salmon River Restoration Council 2005 and Mid-Klamath Watershed Council 2005). For example, the Karuk Indigenous Basketweavers organize with local fire safe and watershed councils, the Karuk tribe, and the U.S. Forest Service in mechanical

FIGURE 17.10. Karuk basket weavers and community members pulling Scotch broom at ceremonial sites to promote native plant production in the Klamath Basin. *(Photo by Luna Latimer)*

and hand pulling of Scotch broom (*Cytisus scoparius*) around tribal ceremonial grounds and highly infested areas (Figure 17.10).

Native Geophyte or Plant Bulb Restoration

Most terrestrial plant community restoration efforts in the Pacific Northwest focus on native tree, shrub, or grass species. Fewer projects focus on forbs, particularly native geophytes, plants with edible underground parts such as bulbs or tuberous roots. Many of the native geophytes that were culturally significant to Native Americans and First Nations present as understory forbs associated with threatened forest, prairie, and wetland habitats. Many native bulb plants belonging to the family Liliaceae (e.g., camas [*Camassia* spp.], onions [*Allium* spp.], and blue dicks [*Dichelostemma* spp.]) were managed and harvested by aboriginal peoples for food, medicine, and materials (Figure 17.11). At the foundation of this selective plant use was a well-developed

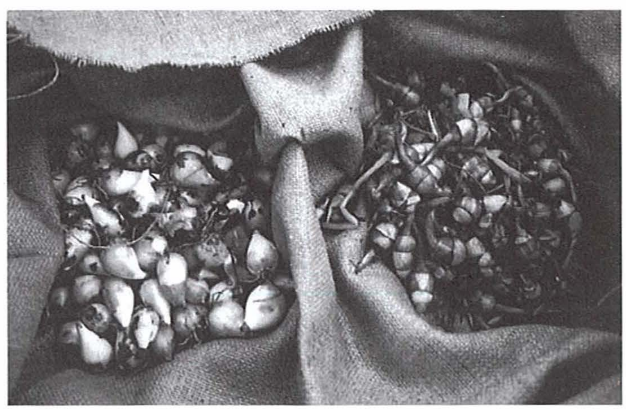

FIGURE 17.11. Camas bulbs *(left)* and wapato bulbs *(right)* were major staple foods to Western indigenous peoples. *(Photo by Nancy Turner)*

form of traditional knowledge particular to each species or assemblage of species occurring in similar habitats (Anderson and Rowney 1998). Traditional ecological knowledge held by aboriginal peoples or located in ethnographic literature provides substantial insights in support of restoration and establishment of native geophytes.

Camas was widely distributed throughout the Pacific Northwest, from coastal headlands to inland montane meadows, yet the ecology of camas production is a sensitive balance of moisture, soils, nutrients, and specific management practices such as burning, cultivation, and bulb division. Several projects in the interior Pacific Northwest focus on camas restoration. For example, the Kalispel and Nez Perce tribes are restoring camas to prairie lands or other areas after catastrophic wildfires (Marshall, in Goble and Hirt 1999). Other groups are working in the coastal regions of the Pacific Northwest to restore camas. Traditional ecological knowledge of Native American root harvesters is used to guide geophyte plantings in microsites that will facilitate improved establishment, as evidenced in the following case studies.

Case Study: Rekindling the Fire of Camas Production

Like with many contemporary First Nations, the Songhees Nation, of southern Vancouver Island (a Straits Salish community) developed a keen interest in their ecological heritage, not just for its historical value but also for cultural and practical reasons. The Songhees, like indigenous peoples all around the world, are negatively affected by the global "nutrition transition," the widespread conversion from a diverse, generally healthful diet of locally produced food to a diet of refined, marketed, mass-produced food, high in fat and simple carbohydrates. Although just a few generations ago diabetes was extremely rare in the Songhees Nation, today many people have developed or died from this disease (Songhees Nation 2004). Reintroducing some of their original food, the Songhees thought, would improve their health and strengthen their cultural identity.

Because of acculturation, Songhees people had largely forgotten most of their traditional plant foods; no one had eaten camas bulbs in any quantity since the eldest members of the community were children. Yet camas bulbs were once a staple—a cultural keystone species—central to people's livelihoods and cultural identity (Garibaldi and Turner 2004). Camas (*Camassia quamash* and C. *leichtlinii*) was featured in families' seasonal harvesting rounds, trade and reciprocity relations between communities and families, feasting, language, and stories. There was much traditional knowledge about its ecology and management. Formerly, camas patches were cleared and tended (Babcock 1967–1969), and people harvested the bulbs tremendous quantities: hundreds of thousands of bulbs annually from southern Vancouver Island (Deur and Turner 2005).

Camas, once a dominant element of the vegetation over most of the Greater Victoria landscape, has significantly diminished in both range and density and probably in productivity as well (Turner 1995, Beckwith 2004). Most of the remaining extensive patches of this liliaceous plant exist in local parks and protected areas, although some residual patches still remain on offshore islands, such as Discovery and Chatham islands, which include Songhees reserve lands. Decades of sheep grazing and invasive species introductions, coupled with fire suppression, have allowed the encroachment of coniferous forest where savanna prairie once existed (Moravets 1932, Norton 1979, Boyd 1999). Therefore, these patches were severely degraded. Nevertheless, Songhees land manager and historian Cheryl Bryce was determined to begin a process of reclaiming her heritage of camas tending and harvesting (Figure 17.12). She invited former residents of the islands, including her colleague

Joan Morris, to take part in the harvest on Discovery Island. Together with other band members and youth and accompanied by then-doctoral student Brenda Beckwith, Eric Higgs, Nancy Turner, and other nonindigenous participants, they first dug camas bulbs, pit-cooked them according to traditional methods, and ate them along with other root vegetables at a festive and memorable event.

The next step was to burn over areas of former camas meadow on the islands and ceremonially scatter camas seed over the charred ground; the Songhees accomplished this activity with the assistance of Brenda Beckwith and a group of volunteers (Beckwith 2004). Subsequently, there have been a number of pit-cooking events on Songhees lands and, as described in *Nature by Design*, Higgs was profoundly affected by the powerful message conveyed by the Songhees initiatives in ecocultural restoration (Higgs 2003).

These events are just the beginning of a series of focal restoration projects grounded in Coast Salish knowledge, practice, and beliefs that will include reintroducing regular burning regimes, promoting community participation and active experiential learning, reintegrating humans with the landscape, and once again tending and using the restored places and their resources in ways that sustain both people and their habitats. The students and faculty of the Restoration of Natural Systems Program and School of Environmental Studies at the University of Victoria have taken an active and ongoing interest in the Songhees community's reconnections to their traditional lands and resources. Through courses and individual student projects, the educational and participatory components of this ecocultural restoration endeavor are continually expanding.

In June 2005, a camas festival at the University of Victoria, organized by Cheryl Bryce and honors environmental studies student Pamela Tudge, continued the work of linking the Songhees with their traditional territory, this time on the university campus, with traditional food. In the presence of many youth and elders of neighboring First Nations, the participants ceremonially harvested camas bulbs using traditional methods and prepared the bulbs in an earth oven for tasting. Such activities are intended to reconnect and revive these peoples' relationship with their home place.

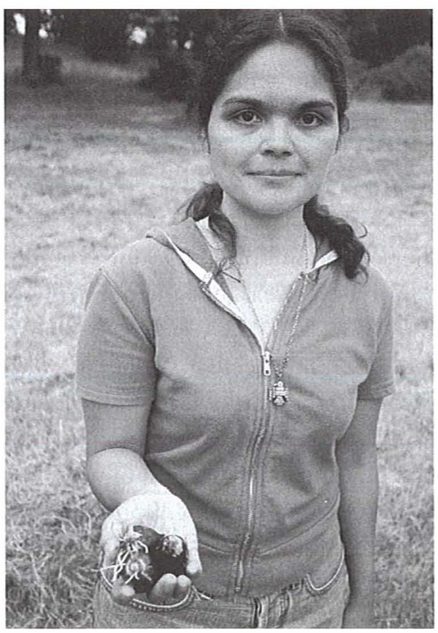

FIGURE 17.12. Songhees historian Cheryl Brice is determined to reclaim her people's tradition of tending camas. (*Photo by Nancy Turner*)

Case Study: Restoring Wapato on Shuswap Lake

Another example of ecocultural restoration of a former cultural keystone species is Ann Garibaldi's work with wapato (*Sagittaria latifolia* Willd.). Dr. Mary Thomas, a Secwepemc elder from Salmon Arm on Shuswap Lake, guided and helped inform the research. Born in 1917, Mary Thomas was raised in the vicinity of Salmon Arm, where she and her brother and sister spent much of their time learning from their grandmothers. She has witnessed tremendous environmental change over her lifetime. One of the most alarming transformations has been the deterioration of the wetland ecosystem at the delta where the Salmon River flows into Shuswap Lake, after its passage through the Neskonlith Reserve lands where Mary grew up.

Mary Thomas recalled going down to the mouth of the river with her grandmother "Macreet" (Marguerite, Mrs. Dick Andrew) as a child to dig the small egg-shaped tubers of *ckwalkwalul's* (wapato) in the spring, along with the finger-like roots of water parsnip (*Sium suave*), called *etsmáts* in the Shuswap language (cf. Turner 1997). Children gathered up the roots that the adults, wading out in the water, threw onto the bank. They rinsed and ate the water parsnip roots raw, but the wapato was placed into large baskets to be carried up and cooked for a much-enjoyed family meal (M. Thomas, personal communication, 1995). Extensive patches of these plants extended over wide areas together with many other culturally valued wetland species, such as highbush cranberry (*Viburnum opulus*), cattail (*Typha latifolia*), and, on higher ground, Indian hemp (*Apocynum cannabinum*). The songs of red-winged blackbirds (*Agelaius phoeniceus*) and western bluebirds (*Sialia mexicana*) filled the air, and many types of waterfowl and other wildlife were abundant (M. Thomas, personal communication, 2004).

Then, as Mary described to Ann Garibaldi, a whole series of changes took place: the CP Railway was rerouted and the trans-Canada highway built above the wetlands. To accommodate this development, some wetland areas were filled in, and the hydrologic regime was subsequently altered. Townspeople built houses along the shoreline of Shuswap Lake, and the number of boats and houseboats using the lake increased exponentially. The river became silted, in part because cattle grazing and farming along the riparian zone reduced vegetation and increased riverbank erosion. Logging on the upper slopes of the watershed also affected the ecosystem. The river was rechanneled through the delta for flood control and to allow construction of a wharf, and the open water was covered with oil every summer to reduce mosquitoes. Large numbers of cattle were allowed to graze over the area, and hayfields were planted to provide them with feed.

Today, much of the delta below Mary's house has dried out and become covered with invasive reed canarygrass (*Phalaris arundinacea*) and other weeds. The land is leased to a cattle owner who grazes his herd in the delta. Mary Thomas mourned, "There's not one plant left down there. Let alone a cattail where the birds used to sing beautiful music. You don't hear that anymore" (Thomas et al. unpublished manuscript).

Learning about the loss and apparent extirpation of these important species, particularly wapato, Ann Garibaldi designed a research experiment to assess the reintroduction of wapato in one of the remaining pond areas in the delta. She obtained tubers from a native plant nursery, grew them for one season, and then planted them in controlled, monitored plots across a gradient of water depth. Suspecting that the original wapato may have been destroyed in part by grazing or uprooting caused by ducks or introduced carp, which are known to have drastically reduced wapato populations on the Columbia River (Darby 1996), she established wire exclosures around a portion of the plantings, designating others as a control. Her results are reported in her thesis (Garibaldi 2004), and as of the summer of 2003, the wapato in the exclosures was flourishing.

Mary was delighted, and she used the plantings as a mechanism to introduce her own family and other members of the Secwepemc community to this forgotten root vegetable. People were able to taste wapato, and some have replanted it in other locations in Secwepemc territory. Again, as with the Songhees' efforts with camas, this example is just the beginning of a trend in ecocultural restoration in Mary's community. Plans are under way to build a Secwepemc center for ecocultural education in Salmon Arm, including a trail to the wapato experimental pond and an ethnobotanical garden to be planted around the main building. The garden is intended both for education and for production of plant materials, such as cattail, for use by schoolchildren, tourists, and any others wanting to learn about and experience the cultural and environmental importance of plants.

Mary Thomas is one of the last elders in her community to recall that wapato existed at this traditional gathering site and to remember its Secwepemc name, ***ckwalkwalul's***, and associated harvesting and cooking methods. She is what Ann Garibaldi and Brenda Beckwith call a cultural refugium: a person who takes on a role metaphorically parallel to that of an ecological refugium, bringing cultural and ecological knowledge forward through times of great change and stress and then teaching that knowledge to others, fostering its renewed dissemination and the increased awareness that it brings. People such as Mary Thomas, Cheryl Bryce, Joan Morris, Brenda Beckwith, and Ann Garibaldi are all key players in ecocultural restoration. It is through the collective efforts of such people that the knowledge, practices, and approaches of indigenous peoples become the key ingredients in focal restoration.

Future Directions and Opportunities

Ecocultural restoration offers a strong model for restoring degraded environments to healthy, functioning systems that support social and ecological vitality. TEK is not folklore or a romantic way of viewing nature. Rather, this longstanding practice of cultures sustainably interacting with their bioregion over time is especially relevant in our rapidly changing world. Clearly science alone does not have all the answers to the alarming list of environmental and social problems. Traditional ecological knowledge not only offers creative, new solutions to the field of restoration but also asks different questions than would otherwise be posed.

Of course, restoration practitioners need to evaluate the appropriateness of any method to a specific project, and TEK is no exception. More often than not, however, restorationists may overlook the opportunity to include indigenous knowledge in a restoration project. We advocate a restoration approach that seeks out and engages the community of people who are invested in the place. If the community includes an indigenous group, it is the responsibility of the management agencies and restoration practitioners to solicit the input of that group through a consultation process. Community knowledge in general, and TEK specifically, will greatly enhance practitioners' understanding of a particular ecosystem and the subtle interactions that sustained it over multiple generations. Additionally, community investment is needed to care for a place over time, after the resource managers and scientists walk away.

Looking forward, there are numerous potential applications for TEK in the sphere of Pacific Northwest restoration. In addition to the possible avenues discussed in earlier sections, other opportunities for TEK-based restoration integrated with Western science include the following.

Climate Change

Given recent scientific understandings of potential global climate change and subsequent environmental changes in the Pacific Northwest (Rapp 2004), TEK probably will be more effective than strict science-based approaches to understanding local or finer-scale ecological changes. As vegetation communities shift in response to climate changes (e.g., trees and shrub migrate north) and corresponding management regimes such as prescribed fire are modified, Southern American Indian groups probably will exchange TEK with Northern groups.

Global warming is increasingly recognized as imposing some constraints on historical reference models. However, the restoration of as much biodiversity and redundancy as possible may contribute to sufficient genetic diversity for thermal adaptation by many species. Even so, a major problem will remain for high-elevation plant species, which cannot migrate much higher, and perhaps for many aquatic species as well.

Restoring old-growth trees not only will help sequester carbon but will cool temperatures in the understory enough to mitigate higher wind speeds and drying of live and dead fuels in forest openings. Moreover, long-established herbaceous species in these openings will contribute carbon to the soil through continual root decomposition. Thinning in some forest types to reduce crown-to-crown and ground-to-crown contact will lower fire risk and therefore prevent carbon from being lost to stand-replacing wildfires.

TEK regarding environmental change, adaptive management, and cultural practices that increase biodiversity can greatly enhance our ability to respond to climate change and allow us to actively tailor our restoration efforts accordingly.

Ecotones and Cultural Transitional Areas

Research of First Nations and American Indian tribes whose aboriginal territories encompass the boundaries of several ecosystems or physiographic provinces, described as ecotones or cultural transitional areas, have a greater breath of knowledge and inherent social-ecological resilience regarding species whose ranges converge (Turner et al. 2003). An ecotone is a transitional zone rich in species diversity and productivity that links major ecosystems or physiographic provinces. Indigenous peoples' territories encompassed such transitional zones, and through their cultural activities and practices they created or expanded these areas to enrich and diversify resources (Turner et al. 2003).

A major type of ecotone in several regions of the Pacific Northwest is the transition zone between forest and prairie. Native peoples purposefully set fires to enhance numerous patches and meadows of varying sizes and shapes in forest ecosystems (Boyd 1999). Prescribed burning and other management activities expanded the range of prairies or open meadows that facilitated high production of both plant resources (e.g., huckleberries and geophytes) and wildlife (e.g., deer and elk). These cultural ecotones were part of the overall mosaic of forest structure and composition and undoubtedly contributed to overall ecosystem diversity (Lewis 1993). Ecotone prairies enhanced opportunities for people and for other species and thereby increased their resilience.

The role of deliberate creation of ecological edges, an important aspect of indigenous knowledge and practice, often is disregarded today because of peoples' loss of access to their traditional territories, fire suppression, and other management practices, and it should be reinstated wherever appropriate. Landscape patches, corridors, and mosaics have constantly shifted in size, shape, and location while changing under the influence of factors such as weather patterns, moisture regimes, and successional cycles. Restoration cannot be a static, predetermined activity; instead it must flexibly incorporate transition zones if it is to reflect historic anthropogenic activities and cultural landscapes. Furthermore, restoration must enhance ecotones and ecocultural complexity at a range of temporal and spatial scales. TEK integrated with Western scientific modeling can provide a scaled, local to regional or global approach to defining the future desired conditions and the design of restoration treatments (Turner et al. 2003).

Local Knowledge and Community Participation

There are ample opportunities for applying TEK in contemporary restoration projects, both where science practitioners lack knowledge of ecosystem dynamics and species linkages and where fostering social approval and participation is important (Anderson and Barbour 2003, Ruppert 2003). Restoration researchers and practitioners are learning what communities have discovered on their own: Restoration is a vehicle for reconnecting with place. Scientists and practitioners now realize that community-based restoration may be a mutually beneficial activity whereby people develop stronger relations with each other and their local environment in the process of restoring a place. In many regions, restoration is an important process of community building. In the Pacific Northwest, for example, citizens' understanding of bioregional community health developed when they expanded their focus beyond saving single species to community-based restoration (Senos 2006, House 1999). As increasing numbers of degraded systems need our attention and intervention, ecological citizens are urgently needed to restore their respective home places.

TEK is not simply a repository of environmental information. It represents a diverse array of systems that integrate cultural and environmental knowledge, practice, and belief over various scales of time and space. Restoration practitioners and local communities can also draw on the social, cultural, and economic lessons implicit in TEK systems. Restoration specialists coming into a community need to foster social relationships and be as inclusive as possible while working with the community members who hold the resident knowledge. Exercising diplomacy while grasping the local political and cultural environments is key to successful restoration. TEK also shows us how we might reconceive restoration across nested social scales, from individual to family to affiliated group to the larger community. TEK challenges us to think beyond our own life spans and consider the implications of our actions in terms of at least seven generations.

TEK provides a model for how community members may interact with their local environments in ways that support or enhance social and ecological functioning. Stewards of TEK operate from an ethical point of view; similarly, accountability is required in our relations with each other, our bioregion, and our restoration work. We are called on to be attentive observers of our home places and to understand the intricate connections between individual actions and entire systems. To do this we must stand in place over time. Our role is not a passive one; instead we must actively intervene in nature to nurture its unique biotic relationships and landscapes. Our task as restorationists is not to simply put things back together the way they were in a technical sense but to apply our knowledge and awareness to creating dynamic, reciprocal relations with nature. As we re-story the landscape, we will perhaps develop new social codes, rituals, and language to describe and reinforce our cultural identity (Senos and Lake 2004).

Cultural Continuity

Restoration is an essential tool that can revitalize cultural traditions and practices in the course of repairing fragmented landscapes. As indigenous people reclaim their sovereignty, their land base, and their culture, restoration may assist the recovery of interrelated ecological, social, and cultural systems. Restoration serves a crucial role in activating traditional knowledge and practices that are at risk of disappearing. The process of restoring a lost prairie or a struggling species may become one of recovering knowledge, language, and environmental management techniques. As demonstrated in the geophyte case studies and numerous projects across the Northwest, as restoration practitioners and tribal resource managers seek out elders and community members for answers to environmental questions, the restoration project becomes a watershed event for the community.

Successfully restoring culturally significant resources and landscapes depends on how the goals and objectives of restoration are defined. Best available science must be relevant to local communities. Restoration programs should apply an intergenerational, cross-gender, and multicultural approach to planning, implementing, and evaluating projects. Youth ought to be involved with elders, men and women working to support each other, and various cultural values represented in each restoration project. Restoration practitioners should also consider how language, whether it is scientific jargon or local terms, Spanish, French, English, or indigenous, influences our understanding and ability to express a world view and relationship to place.

Language greatly influences the formation of one's world view and relationship to place. TEK is deeply entrenched in indigenous languages, and much of what is encoded in Native linguistics relates to environment and management practices (Salmón 1996). Ecological restoration can be strongly linked to indigenous language restoration. Interestingly, indigenous peoples in the Pacific Northwest who have remained in their ancestral territories have the highest indigenous language retention and use, continuity of cultural practices, and least degraded habitats and ecosystems (Schoonmaker et al. 1997). Indigenous languages describe ecological conditions and processes, cultural–ecological relationships, and a way of understanding the environment that can complement Western science.

Many First Nations and American Indian tribes believe that restoration projects should be inclusive of youth, elders, tribal practitioners, scientists, and non-Native community members. The Karuk involve local youth in their fish monitoring and restoration activities. Elder traditional fishers teach youth how to harvest fish, identify fish species, read local river hydrologic conditions, and understand how the river's environmental condition compares with past and likely future conditions. They also teach the indigenous language and terms used to describe these things. Karuk youth learn important scientific principles and techniques from the Western fishery biologists, including scientific vocabulary, proper measuring and aging techniques, and a broader context of how their monitoring studies are important in assessing fish health and abundance (Figure 17.13).

Partnerships and Collaboration

Collaboratively planned, designed, and implemented restoration projects between indigenous people and restoration practitioners that allow the reintroduction of traditional land management practices such as burning and horticultural techniques probably will show longer-term success both socioculturally and ecologically. For many indigenous groups, being recognized as contributors of the reference condition environment provides a critical opportunity for them to shape the future desired condition by participating in restoration activities today. Collaborative restoration of habitats historically significant to indigenous people facilitates the integration of knowledge systems, strengthens the human–nature relationship, and fosters sustainable use of the environment.

Formal agreements between American Indian and First Nations groups and government agencies that clearly define the roles and responsibilities of involved parties can greatly facilitate the integra-

FIGURE 17.13. Karuk youth learn both traditional dip-net harvesting and scientific monitoring techniques. (*Photo by Frank Lake*)

tion of cultural land use practices with restoration treatments. Working together, stakeholders can evaluate each style and technique of differing restoration practices and learn effective restoration strategies and practices (Ruppert 2003, Berkes et al. 2000). Joint endeavors acknowledge that social capital restores natural capital. The success of many restoration projects hinges on the ability of the parties involved to cooperatively build trust, prioritize recovery goals, and develop and assess restoration treatments.

Restoration projects are likely to be more successful when the restoration priorities, goals, objectives, and criteria used to measure project success are derived from the local community. Is the restoration ecologist's criterion the same as that of the local community, which depends on the successful outcome of restoration projects? Often the measure of success used to evaluate restoration projects differs between the managing agency and the community that relies on the cultural benefits and ecological services of restoration. Land managers and restoration practitioners need to align their restoration goals and objectives with the goals and objectives of local or tribal communities.

Each section of stream or river restored equates to higher fish numbers, which bolsters the opportunity for fishers to put local food on the table and has direct implications for indigenous peoples' diet and cultural sustenance (Harden 2005). Similarly, each unit area of forest or prairie successfully restored by fuel reduction and prescribed fire strategies may be measured by a biological index of vegetative species richness conducted via intensive survey methods. Yet local communities using these same sites may measure success in terms of the quantities of high-quality foods and medicinal plants harvested in the years after the restoration treatments. Project leaders come and go, but in the end our grandchildren will be our effectiveness monitors, and the landscape and waterways will be testimony to our collaborative efforts.

See Plate 12 in the color insert for a wildlife connectivity map.

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