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OLD SCIENCE NEW SCIENCE

Incorporating Traditional Ecological Knowledge into Contemporary Management

A growing cadre of researchers is pursuing creative approaches to recovering various aspects of traditional ecological knowledge and vetting this knowledge scientifically.

By Chuck Striplen and Sarah DeWeerdt

Thomas Albert, a biologist and former large animal veterinarian, came to Alaska in 1981 to help develop a census program for the Beaufort-Chukchi-Bering Seas' (BCB) stock of bowhead whales (*Balaena mysticetus*). At the time, detailed ecological information on this species was hard to come by. Albert recalls that because he was unable to find what he needed in books, scientific journals, or academic departments, he began spending many evenings at the home of his friend, Harry Brower, Sr., talking about whales.

These conversations with Brower, an Inupiat Eskimo who worked as a carpenter at the Naval Arctic Research Laboratory (NARL) in Barrow, Alaska, led to a still-ongoing study of bowhead migration and behavior that represents one of the most successful examples of an integration of traditional ecological knowledge (TEK) and Western science.

Before Albert began his work, biologists had counted whales migrating past Point Barrow in ice-free leads and had come up with a population estimate of around 2,200 animals. But Brower said there were many more whales—some migrating under the sea ice, others passing up to 20 km offshore where they could not be seen by observers standing at the edge of the shorefast ice.

Albert knew that Brower was a skilled hunter, respected whale-hunt captain, and community elder, and he decided to follow up on Brower's

> **Habitat clues** are embedded in the Seri names for at least seven reptile species.

statements. "It was a little bit hard to believe at first," Albert recalls, "but everything else he'd told me about other species had panned out." Moreover, other whale hunters in Barrow were telling Albert the same thing.

Albert treated the statements of Brower and the other hunters as scientific hypotheses and designed experiments to test them. New census methods, most importantly the use of underwater microphones to pick up the calls of whales migrating under the ice, confirmed what Albert's Inupiat sources had said. Based on the 1993 census, the BCB bowhead stock was estimated at 8,200 whales.

Traditional ecological knowledge, the body of information about the natural world that is developed and refined through centuries of empirical observation by indigenous people, has been successfully applied to management questions not only in Alaska but in Australia, South America, and other areas around the world. Among resource managers, there is a growing interest in TEK and in employing this knowledge in creative management and restoration strategies. The journal *Ecological Applications*, for example, published an entire special feature focused on TEK in October 2000.

But so far, most successful applications of TEK to management have taken place in those rare areas, as in Barrow, Alaska, where indigenous people inhabit their ancestral lands and practice largely traditional lifestyles. In most places in the U.S., and throughout the world, indigenous culture is fragmented at best and much of traditional ecological knowledge has been lost.

So a growing cadre of researchers is pursuing creative approaches to recovering various aspects of TEK and vetting this knowledge scientifically. The three case studies presented here represent just a fraction of the research that is aimed at integrating TEK and Western science worldwide. But they illustrate the diversity of approaches and techniques—including linguistic analysis, archival research, and experimental manipulation—being employed to recover TEK, and the surprising management implications that often emerge from this recovery.

Decoding Native Names

Where Western taxonomists see one creature, the endangered green sea turtle (*Chelonia mydas*), the Seri, or Comcáac, people of northern Mexico see two. The turtle was traditionally an important food source for Seri people living along the Gulf of California coast, but the two Seri names do not, as scientists might assume, simply represent indigenous "overclassification" of an economically important species. In fact, the Seri names have a biological significance that until recently was overlooked by Western ecologists.

The Seri divide green sea turtles into two groups based on the animals' stomach contents and the taste of their flesh, says Gary Nabhan. And, he reports, biologists have recently confirmed that these two groups correspond to two distinct developmental forms of the species, which have different diving physiologies, habitat preferences, and foraging behaviors.

Nabhan, Director of the Center for Sustainable Environments at Northern Arizona University in Flagstaff, has been studying the languages of indigenous peoples in the southwestern United States and northern Mexico for over 20 years. He argues that the ecological knowledge encoded in Native languages could help scientists develop management and recovery programs for the green sea turtle and other endangered species.

"A lot of names contain habitat information," he points out. Habitat clues are embedded in the Seri names for at least seven reptile species, for example. Such information could help scientists understand where to look for a species when they're designing surveys and, in this, way ensure an accurate census.

Most of the ethnobiological studies that have been conducted in the past have been primarily descriptive, cataloging the names of economically important species and their usefulness to humans. But indigenous languages are much richer in ecological insight, Nabhan has found. The Seri language, for example, reveals knowledge of ecological processes and relationships among species that aren't directly useful to humans.

For example, the Seri name for a certain bean species, *hamooja ihaap*, or "pronghorn its-wild-bean" (*Phaseolus filiformis*), has given scientists a lead on crucial winter forage for the endangered Sonoran pronghorn antelope (*Antilocapra americana sonoriensis*). Although neither the bean nor the Sonoran pronghorn was abundant on Seri traditional lands, Seri language nevertheless encodes a relationship between these two species. Biologists are currently investigating whether the tiny remnant population of Sonoran pronghorn in northwestern Sonora eat the bean. If the connection pans out, Nabhan suggests, perhaps some of the antelope could be translocated to areas where the bean is especially abundant in winter.

"Rather than dismissing the names and associated information as irrelevant to science, if we fully translate the names in their cultural and ecological context, we'll have a tremendous amount of biologically useful information," Nabhan says. In other words, Nabhan, like Thomas Albert, sees TEK as a source of hypotheses about the natural world that can then be tested scientifically.

Recently, Nabhan helped conduct a comprehensive study of desert tortoise (*Gopherus agassizii*) biology in which Seri and Tohono O'odham elders were interviewed about their knowledge of tortoise reproduction, habitat, and behavior. Ecologists and Seri collaborators then conducted field investigations to test various hypotheses about tortoise biology that had been developed from the investigation of TEK.

In that study, Nabhan and his collaborators learned that the Seri refer to six different plant species as *xtamoosni oohit*, or "desert tortoise's forages." Western ecologists had previously identified over 100 plant species eaten by the desert tortoise, but the species ranges from Nevada to northern Mexico, and many local populations have distinct diets. In this case, the linguistic research contributed some important local details. Four of the six species referred to by the Seri as *xtamoosni oohit* had not been previously identified in tortoise diets in the Sonora Desert, although one is known to be eaten by tortoises in the Mojave Desert and another is closely related to a known forage plant. A fifth species, an inconspicuous, brief-blooming wildflower, was recently confirmed to be an important component of tortoise diets in the Sonora Desert. In the past, finding habitat with sufficient, diverse forage has been a crucial—and difficult—part of defining protected areas for the desert tortoise, and Nabhan suggests that the knowledge gleaned from the Seri language could help scientists design new wildlife refuges in the future.

Nabhan believes that the broad knowledge and abstract principles characteristic of Western science and the place-based, profoundly local knowledge characteristic of traditional ecological knowledge can work together. "I want to see indigenous knowledge and scientific knowledge used in complementary rather than conflicting ways," he says.

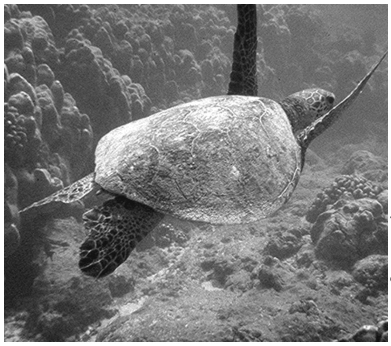

Photo by David Vogel/USFWS

Where Western taxonomists see one creature, the endangered green sea turtle (*Chelonia mydas*), the Seri, or Comcáac, people of northern Mexico see two.

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Searching Ecological Libraries

The rows of locked cabinets that fill a football-field-sized room in the basement of a University of California, Berkeley gymnasium contain thousands upon thousands of shells, human bones, pieces of jewelry, animal remains, and other artifacts. All were uncovered in early twentieth-century excavations of Native American shellmounds around the San Francisco Bay area. Stored elsewhere at the university are reams of photographs and microfilm of the excavators' original field notebooks and detailed sketches of stratigraphic excavations. Researchers are now mining these vast stores of raw, unassembled data to reconstruct some of the landscape management techniques once practiced by the Bay Area's Native inhabitants.

Greater interest in Native management practices was recently sparked by a San Francisco Estuary Institute (SFEI) effort to produce detailed maps of the San Francisco Bay estuary around the time of European contact. A coalition of environmental organizations and government agencies commissioned the maps to guide restoration and management projects around the region. Assembled painstakingly from over 1,000 archival sources, SFEI's maps reveal that the past appearance of the estuary was quite different—and perhaps more extensively influenced by humans—than ecologists had assumed.

Most experts had envisioned the estuary's vast marshlands as relatively homogenous plains of pickleweed, well drained by tidal creeks that left little standing water. But SFEI's maps showed marshes with numerous ponds of various size and salinity. The habitat at the edges of these marshes, which ecologists previously hadn't paid much attention to, turned out to have been remarkably diverse, with stands of valley oak, bunchgrass prairies, lush wildflower meadows, and willow thickets.

Current understanding of successional processes in the region suggests that some of these previously unsuspected features of the landscape, such as the salt ponds, open bunchgrass prairies, and willow groves that dotted the bayside and terraces, may have been shaped and maintained by human management. Without active management such as burning, much of the bunchgrass prairie habitat, for example, would likely have given way to Bay oak woodlands and chaparral over time.

Moreover, some of those lost landscape features would have provided habitat for a number of species that are now threatened or endangered. The willow flycatcher (*Empidonax trailii*) and the California tiger salamander (*Am-*

bystoma tigrinum californiense) would have thrived in the region's long-vanished willow groves and associated wetlands, for example.

The maps produced by SFEI have already begun to influence how major restoration projects around the Bay Area are planned and what managers are aiming to restore. For example, there is at least one marsh restoration project that has involved the rather radical step of creating ponds with backhoes.

On another level, "The maps have raised questions about how Native people influenced the ecosystem" says Robin Grossinger, an environmental scientist at SFEI who worked on the San Francisco Bay Area Historical Ecology Project, under whose auspices the maps were produced. "That 50,000-plus people over thousands of years had a significant effect we can probably assume. But how? Did people have something to do with those salt ponds and willow groves being there?" Such questions have now sparked a number of collaborative investigations—including the research on Bay Area shellmounds—of native landscape management.

Berkeley archaeologists Kent Lightfoot and Ed Luby, along with local tribal scholars, paleoecologists, and researchers from SFEI, began their investigations with general clues about Native management gleaned from a variety of archival sources, including photographs, ethnographies, oral histories, Spanish land grant records, maps, tribal archives, and Bureau of Indian Affairs documents. The early and quite organized colonization of the region by Europeans, beginning intensively in the 1770s, resulted in a rapid and almost total loss of Native subsistence practices—but it also made the San Francisco Bay estuary one of the best documented estuaries in the world. Explorers' journals, for example, contain frequent descriptions of Native fires; one Spanish explorer wrote that it was difficult for his party to find patches of unburned ground on which to graze their horses.

These clues are then used to guide contemporary analysis of the shellmound data collected a century ago. Hundreds of shellmounds—middens of shell, earth, bone, and cultural artifacts up to 10 meters deep and 200 meters wide—have been excavated around the Bay. These assemblages represent ecological libraries that provide a stratified snapshot of changes in resources over time. But the early twentieth-century researchers who conducted the first shellmound studies did not have the benefit of modern techniques of isotope and chemical analysis, palynology, and dendroecology. So Lightfoot and his colleagues are applying these state-of-the-art methods to hundred-year-old soil cores in order, they hope, to fix some of the details about Native management and subsistence practices.

The fires described in explorers' journals, for example, wouldn't be recorded in tree rings or other sources of data that have previously been available to researchers. But they might show up in the chemical signatures of dust and ash deposited in the soil cores. How often did Natives burn various habitats around the Bay? How intensive were the burns, and how did they affect the vegetation in the area? What happens to the ecosystem in the absence of fire—and could fire be reintroduced in the context of today's urban environment? The answers to these questions could provide more details about what reference ecosystems we should aim for and what restoration strategies we should use to reach them.

Restoring Traditional Culture and Foods

When the U.S. Forest Service (USFS) acquired a six-hectare parcel of overgrown wet meadow located in Oregon's Willamette Valley in 1994, the site hardly seemed promising for restoration. Blackberry bushes, Queen Anne's lace (*Daucus carota*), Scotch broom (*Cytisus scoparius*), and other non-native plants had invaded the site, which had been part of a ranch for the previous half century. Oregon ash (*Fraxinus oregona*) and various conifers were growing in the hummocky meadow. Eight years later, the site, known as Camas Prairie, is being restored to what USFS archaeologist Tony Farque refers to as a "traditional cultural landscape."

Soon after the USFS acquired Camas Prairie, botanist Alice Smith's survey of the site revealed the remnants of a rich cultural and ecological heritage. Camas (*Camassia quamash*) plants were growing on the site, even though the encroaching trees and exotic plant species threatened to crowd them out. "We were surprised there were any camas left after such a long period of grazing," Smith says, "but there they were."

The edible roots of camas, also known as Indian potatoes, were once a staple food of indigenous groups throughout the Pacific Northwestern United States. The plants grew with other wildflowers and native grasses in meadows that were visited by a variety of native insect pollinators and large grazers such as Roosevelt elk (*Cervus elaphus*) and pronghorn antelope (*Antilocapra americana*). The first European settlers who came to the Willamette Valley 150 years ago would have seen these open meadows covering broad swaths of the valley floor. Similar habitats stretched over thousands of hectares, from British Columbia in Canada to southern California.

Photo by Terry Tuttle/BLM/Oregon

The edible roots of camas (*Camassia quamash*), also known as Indian potatoes, were once a staple food of indigenous groups throughout the Pacific Northwestern United States.

Under the region's natural regime of infrequent fires, these meadows would gradually have given way to dense stands of oak, then eventually to conifers. But in the Willamette Valley, periodic burning by indigenous peoples had maintained the open landscape for over 6,000 years. Since European settlement, as Native burning has given way to ranching, much of this habitat has been converted to conifer stands or exotic grasslands. Several species that depended on the meadows, including the Willamette daisy (*Erigeron decumbens* var. *decumbens*) and the Oregon silverspot butterfly (*Speyeria zerene hippolyta*), have become threatened or endangered.

As USFS managers began to understand that their six hectares had once been part of a much larger—and very different—landscape, they decided the area should be managed and restored cooperatively. An informal collaboration between the USFS, the Grand Ronde and Siletz Tribes, the Bureau of Land Management (BLM), Oregon State University, and Lane Community College soon arose. Although the groups all had different goals, in this case these goals proved compatible. The tribes, for example, sought to renew gathering and eating of camas roots, while the USFS wanted to restore a crucial piece of meadow habitat. And the first step in both endeavors was to bring back fire.

Ethnographic and archaeological evidence gave the coalition confidence about some of the details of the traditional burning regime for camas. Native groups burned camas meadows in the late summer or fall, when the meadows would have been dry and the camas seed pods would have already opened and released seeds into the soil, for subsequent spring and summer harvest of the roots. Camas meadows probably were burned relatively frequently, and the consequent scarcity of fuel would have made the burns relatively light in intensity.

No one knows the precise frequency of burns under traditional management. The tribes

To Find Out More

Indigenous Pages, at the Netherlands Organization for International Cooperation in Higher Education, is an excellent resource for anyone interested in indigenous knowledge (IK). The breadth of the site goes well beyond traditional ecological knowledge, but the easy-to-navigate style and the impressive search engines allow you to hone in on your particular topic or geographic region of interest. There is an extensive database of experts in the field, lists of conferences, links to periodicals, and other IK organizations—all worldwide. *www.nuffic.nl/ik-pages/*

Best Practices on Indigenous Knowledge, by the Centre for International Research and Advisory Networks (CIRAN) and UNESCO's Management of Social Transformations Programme (MOST), is a collection of IK case studies from around the world. Although the focus is mostly on humanitarian issues, e.g., using IK to establish land rights and improve farming practices, there is overlap with ecological issues—especially for local community conservation projects. *www.unesco.org/most/bpindi.htm*

The Center for Indigenous Knowledge for Agriculture and Rural Development at Iowa State University is a clearing house of IK information. Its resources include links to other resource centers, searchable archives of periodicals and newsletters covering IK topics, and updates of working groups around the world. *www.iastate.edu/~anthr_info/cikard*

Traditional ecological knowledge may be the epitome of what is now called **adaptive management.**

and the USFS decided that initially the site would be burned every 2 years, but their decision had less to do with the traditional burning regime than with the current characteristics of the site. "We wanted to keep the pressure on the Oregon ash and Himalayan blackberry (*Rubus discolor*) that was growing at the site," Smith explains. Eventually, as these undesirable species are eliminated, the site may be burned less frequently.

Tribal fire crews carried out the first burn on two hectares of the site in fall 1998. The following summer, Smith, students from Lane Community College, and volunteers collected tens of thousands of camas seeds to reseed and expand the site after subsequent burns. Some of the seeds were also given to the BLM, which planned to raise camas bulbs for planting. The USFS also established several experimental transects that they are using to monitor the response of weedy species to the burning regime. The third burn will take place in fall 2002.

In 1963, Portland State University archaeologists found fire-cracked rocks near the site that they speculated could be remains of an ancient camas oven. The Grand Ronde Tribe constructed a new oven last year, and the Siletz Tribe plans to use it this fall to conduct the first traditional camas bake at Camas Prairie in over 150 years.

At the moment, gathering and use of camas from the site by the tribes is primarily ceremonial or symbolic—but eventually, Farque says, it's conceivable that this practice could be expanded. The ancestors of the Grand Ronde and Siletz Tribes depended on camas not only for subsistence but also as the basis of their economy, trading large, pancake-like camas wheels with other tribes in the area. Farque muses, only half-jokingly, about the possibilities of developing "camas Power Bars," perhaps a future step towards renewing traditional practices in a changed landscape.

Bringing the Past into the Future

Traditional ecological knowledge may be the epitome of what is now called adaptive management—an evolutionary process in which centuries of accumulated observations were continuously updated and integrated, and interaction with the landscape adjusted accordingly.

Despite the recent interest in this "old science" among Western managers, broadly applicable methods for rediscovering TEK and applying it to management have yet to be developed. The best methods will probably vary from place to place and depend on the "cultural intactness" of local indigenous groups.

Where indigenous people still live subsistence lifestyles and rely on traditional resources, reconstruction of past landscapes is within reach—by the season, by the roots and shoot, by the schedule of the hunt. Meanwhile, in regions where early colonization took place, creative interdisciplinary coalitions and assembly of large amounts of historical data are required.

Eventually, we would like to see regional institutes established for the study of restoration and indigenous resource management. These institutes would be centers for teams of scientists, anthropologists, and traditional practitioners to focus on the common goal of restoring form and function to natural landscapes.

In the meantime, there are other lessons here. Human and ecosystem needs can be met, especially on a small, local scale. Moreover, the Western hands-off style of conservation, with the goal of restoring "pristine" landscapes, may not be the most fruitful approach when active human management shaped the landscape slated for preservation or restoration in the first place. In this case, the best available science may in fact be a combination of old and new. ❧

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