CHAPTER 5

Local, Traditional, and Accidental Ecological Observers and Observations

One of the most notable features of an observation-driven approach to ecology is that *data can come from anywhere*. There are virtually no limits on the types of observations that might become part of a scientific study of changing ecological systems. Old photographs, a naturalist's field notebook, seafood-restaurant menus from a bygone era, long-forgotten scientific papers, a gambling contest, feathers of a bird preserved in a museum, stories passed down from generation to generation, and even a centuries-old pack-rat midden preserved by generations of pack-rat urine have all been used recently in ecological studies. This openness is both a benefit—it creates limitless opportunity for ecological studies and also invites all sorts of people to become part of a new ecological understanding, regardless of their scientific training, means, or geographic location—and also a curse—how do we sift through it all to find out what is useful, and once we find what we are looking for, how much can we trust all these uncontrolled observers?

With this open view of ecological data, the high-tech wizardry we gushed over in the last chapter is put into proper perspective as just one means of achieving a larger ecological understanding. Some of the best observations of nature come from people who have little or no technology at their disposal. This chapter is about humans who have observed the environment closely for long periods of time and passed these observa-

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tions down through generations, and about what they can contribute to scientific ecology.

Ecological Knowledge from Local and Traditional Observers

Humans have developed a number of ecological observing systems that rely on both their innate senses (Chapter 3) and culture, rather than technology, to transmit and improve the accuracy and utility of their findings. Moments before the devastating 2011 tsunami in Japan, for example, fishermen who were out to sea and felt the trembling of an earthquake remembered their grandfathers' observations that "tsunami do not rise in deep water," and quickly stopped fishing and moved further offshore, letting the tsunami wave gently pass under them (Shimbun 2011).

Although it may have been first developed as a survival mechanism, culturally transmitted ecological knowledge is not limited to ecological concerns of immediate relevance to our survival. Much of it arose as part of the intergenerational preservation of cultural identities expressed in artwork and mythology built around natural organisms or natural phenomena (Dayton and Sala 2001). Other data has long been amassed for the sake of maintaining both the seasonal and long-term ability to harvest plants and animals (Fleischner 2005). These types of data and practices have come to be known as Local Ecological Knowledge (LEK) and Traditional Ecological Knowledge (TEK), the latter of which has been defined by the Ecological Society of America as "adaptive ecological knowledge developed through an intimate reciprocal relationship between a group of people and a particular place over time" (www.esa.org/tek). LEK differs somewhat from TEK in that it does not necessarily require a tradition of knowledge handed down through generations (Gilchrist, Mallory, and Merkel 2005). A first-generation fisherman, for example, may acquire excellent local knowledge of the local ecology through the course of her life's work.

Often these nature observations have been made as a routine part of daily life. Traditional and local knowledge holders have spent abundant time in direct connection with nature—as ranchers and farmers, herbalists and artisans, fishermen and foresters. Through this connection they are able to observe far more and with far greater context than a scientist might in a limited field season.

In fact, the beginnings of science were marked by the systematization of traditional observations. As natural sciences evolved, there developed a division based on the authority of observers (qualified vs. amateur) that ultimately devalued TEK and LEK. Nonetheless, scientists have long been aware of the value of traditional knowledge in gaining ecological understanding.

Consider again Samuel Lockwood's "Something About Crabs" paper from *The American Naturalist* in which he noted, "We knew some years ago an old crabber, wholly illiterate, but whose intelligence was above average. . . . Often when supplying the family with fish, has he been closely questioned by us about the crabs. . . . " (Lockwood 1869) There is a clear note of condescension discernable in Lockwood's account and this reflects the treatment of traditional and local ecological knowledge holders and their data for much of the history of ecological science. Nonscientists were commoners whose charming anecdotes might add some color to a scientific exploration but could never achieve the precision or depth of understanding attainable by a man of letters.

But science is increasingly recognizing the value of data gathered by nonscientists, a trend that Gary Nabhan has tracked and discusses in Box 5.1. This new wider acceptance is due in part to a new-found respect for nonacademic knowledge and non-Western lifestyles, but it is also purely pragmatic—the halls of science have failed over the last century to produce much of the data we would like to have if we are to understand our changing planet (Dayton 2003).

Valuing the Role of Different Observers in Ecology

The large gaps in ecological information have opened the door for the acceptance of data that otherwise would have been dismissed. Informal and traditional cultural sources of data are filling these gaps and being used in ecological science and conservation management. In his paper "The Case for Data-less Marine Resource Management: Examples from Tropical Nearshore Finfisheries"—a title likely to have rankled

BOX 5.1

Traditional Ecological Knowledge and Observation-Based Ecology

GARY NABHAN

The traditional ecological knowledge of place-based indigenous and peasant cultures is perhaps the oldest fund of observational ecology or natural history data extant on this planet. However, because most of it has been orally transmitted over the decades and centuries, most Western scientists have had neither access to it nor much respect for its value. That is ironic, for the seeds of modern ethnobiology were planted at about the same time as those of modern ecology, between the 1860s and 1890s; since that time, an ample and often insightful literature of traditional ecological literature has emerged that should rightly be studied and celebrated by all observational ecologists, regardless of their cultural origins.

Contrary to popular misconception, ethnobiology demonstrates that traditional knowledge of plants and animals extends far beyond their names in indigenous languages and their uses by subsistence cultures. In fact, it can be argued that indigenous ecological knowledge includes true intellectual inquiry into the relationships among plants, animals, cultures, and their habitats rather than merely being a utilitarian resource-management practice. Traditional ecological knowledge embraces the domains of biosystematics, anatomy, physiology, phenology, chemical ecology, community ecology, and even agro-ecology. It, like much of observational ecology and natural history, analyzes “found experiments” such as lands differentially affected by wildfires, floods, weather shifts, or grazing to infer ecological effects or certain “treatments.” In its interpretations, traditional ecological knowledge is certainly imbued with orally transmitted knowledge from other generations, so it often discerns cause-and-effect relationships that do not necessarily reflect from observations made exclusively during just one lifetime. It typically uses no statistical methods to discern longitudinal patterns, but does intuitively integrate many observations taken over long periods of time.

professional fisheries managers who rely on reams of data and complex mathematical models to determine “optimal yield” targets for fishing efforts—R. E. Johannes outlined cases from South Pacific cultures where traditional knowledge regarding fishing practices was at least as effective as quantitative “scientific” management (Johannes 1998).

As such, it harbors within its fund of knowledge observations that could have not been made by Western-trained scientists who have more recently arrived in the same habitats.

For instance, Seri Indian elders recall observations of California condors on Tiburon Island in the midriff of the Gulf of California from the 1920s and early 1930s. Hopi elders also orally transmit similar observations of condors made by their ancestors, observations that predate condor extirpation in the Grand Canyon around the 1890s. Such orally transmitted data points derived from traditional ecological knowledge may be used to broaden or refine options for the recovery of endangered species.

Similarly, the Seri have already played a role in the recovery of endangered sea turtles through providing conservation biologists with an extraordinary set of data on leatherback turtle nesting-beach location and feeding-ground location, as well as their diet and behavior. The probability of conservation biologists independently coming upon such a wealth of observations regarding this rare marine reptile—given the species' low population density and level of endangerment—is exceedingly low.

And yet, the complexities of how the Seri use their native language and Spanish to communicate such knowledge remains a barrier to fully integrating such knowledge into species-recovery plans. It takes someone conversant in their language and familiar with sea turtle biology to fathom the depth and utility of the Seri's understanding of leatherbacks. Such depth cannot be "extracted" or "downloaded" in a single interview or even a single season.

If observational ecologist or natural historian is the world's oldest profession, it is also among the most endangered of professions due to language loss, oppression, and economic domination of indigenous peoples. Nevertheless, the indigenous youth of today are surely among the rightful heirs to the legacy of natural history as a cultural practice.

Hundreds of scientific papers in the last decade discuss TEK and LEK, and although scientific ecology was slow to admit them into actual research projects (Gilchrist and Mallory 2007), papers are increasingly using these forms of knowledge to address subjects as varied as climate change's effects on phenology (the timing of natural events like flowering or hibernation), harvesting effects on natural populations, food-web structure, and migration patterns (Salomon, Nick M. Tanape, and Huntington 2007). For example, a March 2011 search on the Web of Science revealed 275 papers that cited the seminal paper “Rediscovery of traditional ecological knowledge as adaptive management” (2000), which introduced much of the ecological science community to the value of TEK and the prospects for incorporating it into their research. Most of these papers present examples in which TEK or LEK was used to gain ecological insight or was applied to management issues. Jeffrey Herrick and colleagues have shown that national ecosystem assessments, with outcomes suitable for affecting management and policy decisions, can be developed by combining ground observations, remote sensing, and cell-phone data recording with LEK and more quantitative scientific observations (Herrick et al. 2010). The Ecological Society of America now has an active section on Traditional Ecological Knowledge that aims to foster the respectful use of TEK as well as to encourage more active participation of indigenous people in ecological science. In other words, noninstitutional forms of knowledge are becoming institutionalized.

At the same time, in a world increasingly populated by observant humans, some important data for understanding ecological dynamics are collected with no thought beyond their immediate use. These might be past scientific studies aimed at particular narrow questions, or what we might call “AEK” (Accidental Ecological Knowledge)—information that only later was discovered to have ecological significance. For instance, a photo of the Swiss Alps may have been created for a tourist postcard but now is an important data point in a worldwide study of retreating glaciers (Webb, Boyer, and Turner 2010). Rafe analyzed data from each year of an 87-year-long series on the exact time in spring when the ice in the Tanana River in Alaska melted and found that trends in the timing of spring melt coincided closely with both long-term climate warming and multi-decadal variations in warm and cool periods throughout the twentieth century (Sagarin and Micheli 2001). The source of these data wasn't a long-term scientific study but an ongoing gambling contest in which participants had to guess the exact minute in which a wooden tripod put out on the ice in winter would fall through the thawing spring ice. With $300,000 on the line and hundreds of people camped out on the riverbanks in anticipation of the moment when the tripod falls, the overall record is both the most accurate record of spring ice melt (many observers are watching and ensuring that the time is correctly documented) and the most precise record (it is recorded down to the minute, rather than day, or week, of melt).

In this case, the value of the data doesn't come from any particular local wisdom (the vast majority of participants in the ice melt contest guess the wrong time), but from simply being the only reliable data source available. While there are some long-term scientific temperature records from interior Alaska, they suffer from large temporal gaps in recordings, known inaccuracies, and frequent movement of weather stations (which exposed recording equipment to very different microclimates at different points in the record). For these reasons, it has been noted, ironically, that ice-melt records may be "more accurate long-term indices of air temperature than air-temperature records themselves" (Assel and Robertson 1995).

The Limits of LEK, TEK, and AEK

Local knowledge can at times be too narrowly focused. Local resource users may have unparalleled knowledge of the species they harvest and some of their immediate ecological relationships, but if they group all other species into a less important category, then the quality and quantity of available knowledge may not match what is needed for an ecological study. Indeed, the narrowing of traditional ecological knowledge likely began, long before recorded history, when we first became agriculturalists and needed to cultivate more-specialized knowledge about particular species and ecological phenomena (Fleischner 2005).

Data sources in historical ecological studies also inevitably suffer from being too narrow in scope. Whether taken accidentally or deliberately as part of a scientific investigation, historical data sources almost never have as much spatial or temporal resolution, taxonomic diversity, or detailed description of the "metadata" (the information about how and why the data were taken) as we would like (Sagarin 2001).

The stability and utility of informal ecological knowledge rests, sometimes precariously, with the individual knowledge holder and with the cultural context in which the knowledge is generated and held. For example, although informal ecological knowledge has been important in evaluating the effects of climate change, some of these forms of knowledge may be unable to keep up with rapid changes to social and ecological systems. Johannes, for example, showed that generations of South Pacific fishing communities thrived with "data-less" management, but he acknowledged that more quantitative data and scientific methods will be necessary to continue sustainable management in the current era of rapid change (Johannes 1998).

As with all forms of data, the accuracy of informal knowledge can degrade over time. Two groups of researchers working in different parts of the Gulf of California found that younger generations of fishermen considered the maximum size of any particular fish species to be significantly smaller than fishermen from older generations (who had personally seen much larger fish), and younger fishers were also much more likely than older fishers to think that little change had occurred in their fishery (Lozano-Montes, Pitcher, and Haggan 2008; Saenz-Arroyo et al. 2005). But these studies also showed the value of learning from the knowledge of people with a long history of interaction with nature, before their knowledge is gone forever. Both the passing of individual observers and the more troubling passing of entire cultures and language groups have long caused concern among anthropologists, but this should be a concern to ecologists as well (Davis 2010).

How do traditional sources of knowledge stack up against more mainstream data sources? Local and traditional methods of ecological observation can be compared directly to more mainstream methodologies when they are both used in the same study. Gilcrest and colleagues evaluated LEK of Inuit people against scientific studies related to populations and distributions of four marine bird species and found a full range of accuracy, from low to very high (Gilchrist, Mallory, and Merkel 2005). They conclude that LEK can be an essential complement to more mainstream means of achieving ecological understanding, but that it can rarely stand on its own as a basis for guiding conservation management in an era of rapid and widespread ecological change. At the same time, Brook and McLachlan caution that when we compare mainstream "scientific" data and informal data sources we should avoid the preconception that data collected in a typical scientific design create the "correct" baseline against which to test the "suspect" traditional or local knowledge—indeed, several cases have been found in which LEK provided more-accurate pictures of ecological cases than did scientific studies (Brook and McLachlan 2005).

Indeed, the benefits of using traditional knowledge may be overlooked if we only consider what gets published in the "Results" section of a typical scientific paper. Attum and colleagues, for example, tested the efficacy of experienced human observers against radio telemetry for tracking endangered tortoises in Egypt. They found that both methods yielded similar results in terms of efficiency and accuracy, but employing human observers provided the added benefits of creating incentives for conservation and greater interest in the long-term research goals than if the scientists had simply used remote sensing with radio tracking (Attum et al. 2008).

The incongruence in conclusions based on different sources of data highlights a key point about the fallibility of any human observers. Even the most admired observers of nature have sometimes drawn incomplete or wholly inaccurate conclusions about the natural world, hobbled by their inability to see across large spans of time or space. John Muir, a keen observer of the world who could convey the grand scope of California's Sierra mountains and valleys to generations of readers, and who even witnessed the destruction by dam of his beloved Hetch Hetchy Valley, nonetheless grossly underestimated the ability of humans to alter natural systems, writing, "Fortunately, Nature has a few big places beyond man's power to spoil—the ocean, the two icy ends of the globe, and the Grand Canyon" (Muir 1918). In struggling through the figures for their next edition of the Pacific Coast field guide *Between Pacific Tides*, Ed Ricketts confided his confusion to his co-author Joel Hedgpeth about the average ocean temperature data (isotherms) that he was receiving from the Scripps oceanographer Harald Sverdrup, which didn't coincide with previous records. "The only other explanation is that the isotherms have changed," he wrote. "This is known to have happened in the past, but I always thought of that in terms of the geological past. If not even the mean isotherms are going to stand stationary long enough for them to be standardized, where are we?"* And although Ricketts consciously sought to achieve a much larger view of ecological understanding—what he called the "toto picture"—by his own admission he often fell short of that goal. Along with his friend John Steinbeck, he wrote of their disappointment, after an eight-week journey through the Gulf of California, that they "could not yet relate the microcosm of the Gulf to the macrocosm of the sea" (Steinbeck and Ricketts 1941), meaning that despite all their intensive observation, the connection between their relatively small body of water and the larger oceanic ecosystems was still not clear.

The passage of time, the compounded impacts of human activities, and new technologies developed by humans have both revealed the limits of these earlier observations and their importance as baselines for marking how much has changed. Muir would be horrified to learn—although it is common knowledge to almost all ecology students today—that the Grand Canyon, the oceans, and the poles have all been radically and irrevocably altered by humans. By contrast, we are equally struck to know that less than 100 years ago such impacts could not even be predicted by the most ardent environmentalist. It would only be a few decades after Ricketts's death in 1948, through the use of observational data taken as part of a long-term oceanographic monitoring program developed at Scripps, that we would learn that the mean isotherms of ocean temperatures were, in fact, changing rapidly, and that the most likely agent of change was human-caused climate warming (McGowan, Cayan, and Dorman 1998; McGowan 1990). Yet these changes could never have been discovered without the prescient vision of Ricketts, who publicly called for a long-term oceanographic monitoring program (Ricketts 1945–47), and the Scripps scientists who made such a vision a reality. And when Rafe

*Ed Ricketts, letter to Joel Hedgpeth, 9 December 1945. Edward Flanders Ricketts Papers, 1936–1979. Special Collections M0291, Stanford University Libraries, Department of Special Collections and University Archives.

and several other scientists returned in 2004 to the same locations studied by Ricketts and Steinbeck in 1940 to document changes to the Gulf, the microcosm and the macrocosm that Ricketts failed to connect could easily be reconciled in observations of coastal development, emerging zoonotic diseases, overfishing, loss of top predators, and climate warming, all of which have altered the Gulf and many parts of the world's seas in parallel (Sagarin et al. 2008). Yet this connection could not have been made without the detailed and insightful literary record laid down by Ricketts and Steinbeck.

The promise and pitfalls of informal ecological observations are an intensified reflection of those facing all scientific data. We believe that the benefits of a much more inclusive ecological science far outweigh the costs, both in terms of their present value and in terms of the positive feedback cycle that is generated by getting more people and perspectives involved in observing nature and its changes, developing or validating their own sense of biophilia, and this in turn stimulating a desire to protect and restore natural systems. Moreover, both mainstream scientific investigations and local ecological knowledge can be improved with reference to one another, and likewise both scientists and local communities can benefit from mutual sharing of ecological observations. Opening up ecological science so widely is already creating a rush of new data. Nonetheless, these data aren't evenly available everywhere and to everyone, and their quality varies widely. In the next chapter, we show how the continued success of observational approaches depends critically on how we create, analyze, share, and care for observational data.