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From the Classroom to the Countryside

The University of California's Natural Reserve System and the Role of Field Stations in American Academic Life

PETER ALAGONA AND TIM PAULSON

FIELD STATIONS—SITES SET ASIDE FOR RESEARCH AND TEACHING IN an outdoor, on-location environment—are essential components of any major college or university in the twenty-first century. Since the establishment of the first university-run marine laboratories and natural reserves more than a century ago, academic institutions in the United States, and throughout the world, have acquired or set aside spaces for teaching, research, and public service in the agricultural and environmental sciences. On some campuses, they are well-kept secrets, but they are nearly everywhere.

Most colleges and universities that run field stations have just one site. Harvard University, for example, has administered its single field station, the Harvard Forest, since 1907. Campuses that have large agricultural programs, such as Iowa State University, with its fifteen research and demonstration farms, may be exceptions to this rule. But most institutions that run two or more sites tend to do so to meet distinct purposes. Stanford University, still known locally as "the farm," does not have an agricultural program. But it does run two field stations—one terrestrial reserve and one marine laboratory—to serve the needs of faculty and students.

There is one university system, however, that stands out from the rest. The nine-campus University of California administers more than seventy field stations of various kinds and purposes. It has at least two observatories, two botanic gardens, two marine laboratories, two freshwater hydrology stations, four experimental forests, and fourteen agricultural and ranching extension centers. The University of California Natural Reserve System (NRS) alone includes at least thirty-nine sites covering more than 750,000 acres—about the size of Yosemite National Park. These reserves span from

rain forests to deserts, islands to mountaintops. Some have laboratory, teaching, and lodging facilities, while others do not contain a single built structure. Some are within sight of campus classrooms and double as neighborhood parks, while others are closed to the public and inaccessible for more than half the year due to snow-covered roads. For those who prefer balmier conditions, the University of California also runs a marine laboratory on the island of Moorea in French Polynesia.

This paper has three objectives: first, it will explain how field stations became must-have facilities for so many modern colleges and universities; second, it will show how the University of California became a global leader—or at least a global outlier—in the creation of environmental science field stations; and third, it will describe what sorts of places these field stations are today, in terms of what one might expect to encounter on-site, what roles they play in American society, and how their roles are evolving in an era of global environmental change. Although this paper aims to address broader trends, we will focus on the University of California Natural Reserve System, the world's largest and most diverse network of university-run field stations.

Field Stations and the American University

To understand how so many universities became custodians of so many field stations, it is useful to start with the establishment of the earliest such sites. The first field station was probably the experimental farm created in 1850 at the Mockern estate, near Leipzig, Germany. In the Mockern station's first report, one of its founders, Wilhelm Crusius, wrote that "[t]he science of agriculture is founded on experience, but experience requires a foundation in the causes of its appearances."[1] According to Crusius, the Mockern estate fostered basic scientific knowledge by enabling researchers to conduct "comparative experiments under the free heavens."

In the United States, the Morrill Act of 1862 authorized the federal government to transfer land to the states for the creation of colleges that would conduct research and teaching in the agricultural, mechanical, and liberal arts. Over the next two decades, several of these land grant colleges, including the universities of Connecticut and Wisconsin, founded experimental farms. The Hatch Act of 1887 accelerated this process by providing funding to the land grant colleges—initially in the amount of $15,000—to create more such sites. Beginning with the Gold Rush of 1848, and continuing for the first few decades of statehood, California's economy depended on mining. By the 1860s, however, agriculture emerged as a major industry, with a wheat boom in the Sacramento Valley and the planting of extensive fruit and nut orchards in the Santa Clara Valley and elsewhere. The University of California, a land grant institution founded in 1868, moved to establish its own agricultural experiment station. Its first such facility opened in the 1870s under the direction of Eugene Hilgard, a German-born geologist, botanist, and agricultural chemist.[2] The university greatly expanded these efforts a few decades later: in 1907, it founded the Citrus Experiment Station in Riverside County, east of Los Angeles; and in 1909, it created the University Farm, in the town of Davisville (later shortened to Davis), west of Sacramento (Figure 8.1).

FIGURE 8.1
The Citrus Experiment Station, in Riverside, California, grew into a major research institution by the 1930s. Reprinted with permission of the Special Collections and University Archives, UCR Library, University of California, Riverside.

Most early field stations blended agricultural, biological, and environmental research. The first sites to focus on the biological and environmental sciences were marine laboratories.[3] In the 1870s and 1880s—following the model of Anton Dorhn's Stazione Zoologica in Naples, Italy—marine laboratories and summer schools popped up along the East Coast, particularly in Massachusetts. Louis Agassiz, of Harvard University, briefly ran a station at Penikese Island in Buzzards Bay; Alpheus Packard, of Brown University, operated a summer school through the Peabody Academy of Science in Salem; and Alpheus Hyatt, of Boston University and the Massachusetts Institute of Technology, ran a laboratory, supported by the Women's Educational Society of Boston, at Annisquam on Cape Ann. Farther south, William Keith Brooks, of Johns Hopkins University, founded the Chesapeake Zoological Laboratory in Beaufort, North Carolina.[4]

These operations were all short-lived. In 1888, however, a new field station, the Woods Hole Marine Biological Laboratory, on Cape Cod, opened its doors with a different

FIGURE 8.2
Summers at the Woods Hole Marine Biological Laboratory included both work and play. Gideon S. Dodd, "Group on the Nan," 1909–10, Marine Biological Laboratory Archives, Woods Hole, Mass.

vision (Figure 8.2). During the first five years of its founding, Woods Hole constructed extensive lodging, classroom, library, and laboratory facilities; built a wharf; and acquired a small fleet of watercraft. In an 1893 account of the opportunities at Woods Hole, Dallas L. Sharp, a student at Brown University, raved: "What a happy hunting ground! What variety of forms! What wealth of numbers! What a paradise for the naturalist! The sandy shores, the rocky points, the muddy bays, the tide-pools, holes and bottoms from the depths in Vineyard Sound to the shallows of Buzzard's Bay, are all astir with life which the student may study at first hand."[5] Between 1890 and 1910, the first terrestrial field stations arose in diverse locations across North America.[6] Some were affiliated with private foundations, but others were owned by the nation's growing research universities. Most had a hybrid feel, as they combined aspects of field and laboratory research. The Carnegie Institution of Washington's Station for Experimental Evolution, at Cold Spring Harbor, New York, provided a base for field research in the surrounding area, but also contained experimental gardens and a poultry run. The University of Pennsylvania, Princeton University, and the University of Illinois all established campus laboratories called vivaria that provided facilities for biological research on animals under natural and experimental conditions. Farther afield, the universities of Minnesota, Michigan, and Montana founded lakeside stations for outdoor research in wilder environs.

Field station founders and directors often spoke in lofty terms about their missions and unique capacities to produce practical and theoretical knowledge for the benefit of humankind. But field stations also served more prosaic purposes. They functioned as

summer camps, where students, staff, faculty, and their families could convene in rustic accommodations that encouraged bonding and blurred the lines between work and play.[7] Swimming, hiking, rowing, team sports, communal cooking, and evening campfire gatherings drew researchers and their guests year after year, forging long-lasting, multigenerational scientific communities at many stations.

These early stations also provided a boost to the field of ecology, which only coalesced as a discipline in the 1910s. The leaders of this new discipline—including Stephen Forbes, Charles Adams, and Victor Shelford (the first president of the Ecological Society of America)—dedicated significant time and effort to creating new field stations and nature reserves to support their teaching and research. According to Charles Kofoid of the University of Illinois, field stations "bring the student and the investigator into closer connection with nature, with living things in their native environment . . . They encourage in this day of microtome morphology . . . the old natural history or, in modern terms, oecology."[8] On campus, biological sciences like microbiology were moving toward reductionist methodologies, but researchers at field stations could still view nature as a whole, studying broad patterns and interconnections that were invisible under a microscope in the laboratory.

The first field station boom lasted from the 1880s to the 1930s. By World War II, foundations and universities had established at least forty-eight field stations around the United States for study in evolutionary biology and ecology.[9] But creating a new field station—and keeping it in business—was never an easy task. Field stations posed logistic, funding, liability, and management problems for university administrators and lawyers, many of whom frowned on the idea of retaining remote properties for the purpose of nature study. Even some biologists doubted the value of field stations in an era when laboratory science was on the rise and natural history on the decline in American universities.[10] Nonetheless, some stations maintained solid leadership, funding, and institutional support, while new ones continued to form. The University of California's Blodgett Forest Research Station, in the western Sierra Nevada, which was donated by the Michigan-California Lumber Company in 1933, was one example.[11] But as budgets tightened, the rate of station establishment slowed, and several older stations, such as the Bass Biological Laboratory, in Florida, closed.[12] For a time, it seemed as though the golden era of field stations had come to an end. Only the strongest—that is, those with charismatic leaders and secure sources of funding—would survive.

In the 1960s, this trend began to reverse itself for three main reasons. First, during the Great Depression, U.S. government agencies acquired vast tracts of land as part of the Roosevelt administration's economic recovery program. These public lands required expert managers and scientific knowledge, both of which university field stations could help produce. Second, the postwar baby boom created a huge generation of affluent young people. Most universities grew during this period, accommodating new interests and agendas as well as acquiring new facilities. Third, the environmental movement brought a host of related issues to the forefront of politics and culture. Looking back in 1979, A. Clay Schoenfeld, of the University of Wisconsin, noted that U.S. universities had begun the postwar era poorly prepared to address complex environmental

problems.[13] According to Schoenfeld, they still had a long way to go, but over the previous two decades, they had invested in myriad initiatives, from hosting events to hiring faculty and creating interdisciplinary environmental studies programs. They also acquired more field stations for conservation, education, and research.

This postwar growth was not limited to stations that focused on environmental science. Research universities expanded in nearly every discipline, including in the more traditional areas of agricultural and animal sciences. During this period, none grew faster than the University of California. Consider just a few examples. The Oakville Station, opened in 1947, provided facilities for research on viticulture and enology in the heart of Napa Valley. The 5,300-acre Hopland Research and Extension Center, created in 1951, focused on sheep production in the Mendocino County coastal ranges. The West Side Research and Extension Center, established in 1959, dealt with issues of large-scale agriculture—including pest, nutrient, and water management—in the industrial farming landscape of the San Joaquin Valley. The Sierra Foothill Research and Extension Center, cobbled together out of several smaller parcels during the 1960s, initially emphasized cattle ranching, but later took advantage of its location on the Yuba River, east of Sacramento, to host research in watershed and fisheries science.

There are no better examples of this growth, however, than the two University of California agricultural stations that became their own, full-fledged university campuses. By 1954, the Citrus Experiment Station had increased in size from thirty to one thousand acres, with a staff of 265 employees working on diverse issues related to fruit cultivation. That year, the university founded its sixth campus, the University of California, Riverside, on the site, and in 1960, the station became part of a new system-wide University of California College of Agriculture. A similar process occurred at the University Farm in Davis. By 1951, the Davis site encompassed some three thousand acres, with a host of research centers and academic programs. In 1959, on the farm's fiftieth anniversary, the regents declared both it and Riverside "general campuses" of the University of California system.

Today, Riverside and Davis are, in most ways, typical research university campuses, but both retain aspects of their historic identities as agricultural experiment stations. The University of California, Riverside, is still home to the Citrus Experiment Station, now called the Citrus Research Center and Agricultural Experiment Station, and one of the world's top institutions for plant sciences. The campus is also known for its horticultural beauty and diversity, including a botanic garden and hundreds of citrus trees that line its thoroughfares. The University of California, Davis, meanwhile, is home to the College of Agricultural and Environmental Sciences, with twenty-seven undergraduate majors and thirty-three degree-granting graduate groups. It is considered one of the country's top universities for agricultural and animal sciences. The Davis and Riverside campuses thus blend their field station past with their present status as full-fledged research universities.

The number of environmental science field stations, both terrestrial nature reserves and marine laboratories, also has grown rapidly in recent decades. California has more than one hundred field stations, including not only the University of California stations

but also sites administered by the United States Geological Survey, National Park Service, California State University, Claremont Colleges, environmental advocacy groups, and land trusts. Worldwide, there are at least 963 field stations representing a remarkable diversity of places, institutions, ecosystems, and landscapes.[14] Around 74 percent are affiliated with universities, 14 percent with governments, and 11 percent with nongovernmental organizations. These figures vary by region, with universities playing an outsize role in the United States. As with agricultural experiment stations, nowhere are these trends—growth, diversification, and university leadership—more apparent than in California.

A Field Station "Mecca"

The University of California Natural Reserve System is, by far, the largest system of university-run field stations in the world. The story of how this came to be is long and complicated, but a handful of factors account for much of the result. Some of these factors, such as geography and scientific history, are unique to the state, while others, such as the university's postwar expansion and the influence of the environmental movement on academia, are microcosms of national and global trends.

California contains the greatest biological, physiographic, and climatic diversity of any state. Nineteenth-century naturalists recognized this, and they celebrated California—with its towering peaks, vast deserts, rugged coastlines, remote islands, and lush forests—as a must-visit destination.[15] Geological surveying and natural history expeditions to the High Sierra, Death Valley, and elsewhere in California rank among the most famous episodes in the scientific history of the American West.

Despite this early attention, the state's homegrown scientific community and academic institutions lagged behind those of the Northeast and Midwest. This left Californians with few reliable donors or other funding sources; meager research facilities, libraries, and laboratories; and scant resources for travel to field sites abroad. They did, however, have a vast, wild, and varied landscape in their backyard. Historian Robert Kohler has called these late nineteenth- and early twentieth-century western hinterlands—areas that were fairly remote and lightly populated, but easily accessible from burgeoning cities like San Francisco—the "inner frontiers" of Progressive-era field science. In California, which abounded with such inner frontiers, the result was a proud tradition of in-state natural history research that, decades later, would inspire the founding of numerous environmental science field stations.[16]

The key figure in the early decades of this story was Joseph Grinnell. Grinnell grew up mostly in Pasadena, where he earned a reputation as an avid collector of animal specimens and a prodigy in the field of natural history. He attended graduate school at Stanford University, and became the first director of the Museum of Vertebrate Zoology at the University of California, Berkeley, in 1908. The museum and his position were funded by Annie Alexander, the heir to a Hawaiian sugar fortune, a member of the state's growing patrician class, a generous donor, and an accomplished collector and naturalist at a time when few women engaged in such pursuits. Grinnell soon emerged

as one of the country's foremost zoologists and evolutionary biologists. He also built the museum into the leading institution of its kind: a research-oriented (not exhibition-oriented) facility dedicated to studying the fauna of western North America, with a focus on California.[17] Since helping to found the museum, however, Grinnell and his students had been practicing a kind of salvage biology. During the first half of the twentieth century, California's population increased from less than 1.5 million to more than 10.5 million people, and its economy boomed with agriculture, oil, manufacturing, real estate speculation, and urban growth. Unique wildlands throughout the state were disappearing. Under Grinnell's leadership, the museum's staff, most of whom were his students, set out to preserve relics of the state's vanishing wildlife diversity (Figure 8.3).

Although Grinnell sought to influence the policy for and management of the state's wildlife almost as soon as he arrived in Berkeley, he generally tried to maintain a low profile, keep the museum out of controversy, and work through his students (who went on to prominent positions in academia and public service). In 1939, however, he set out to define a new role for the museum that would go beyond assembling the vestiges of a lost landscape. He arranged for the university to accept a donation of land—the old Hastings family ranch in Monterey County—for natural history teaching and research. "My imagination pictures," Grinnell wrote, "in due course, the Hastings Reservation as a recognized 'Mecca' to which will come, for periods of undistracted research, advanced students of ornithology, mammalogy, botany, entomology, ecology . . . a pleasant picture, truly" (Figure 8.4).[18]

FIGURE 8.3
In the 1900s and 1910s, field research through the Museum of Vertebrate Zoology focused on California's "inner frontiers," such as Death Valley. Reprinted with the permission of the Museum of Vertebrate Zoology, University of California, Berkeley.

FIGURE 8.4
Joseph Grinnell working in the field camp, around 1910. Permanent field stations enabled work that was not possible given the logistical constraints of mobile camps. BANC PIC 1973.044, FIG. 9—PIC, courtesy of the Bancroft Library, University of California, Berkeley.

By 1964, Hastings director John Davis could brag that scientists knew more about Hastings than any area of equal size in the United States. The following year, Hastings became the oldest unit of the new University of California Natural Land and Water Reserve System, later shortened to the Natural Reserve System.[19] One feature that distinguished Hastings from many older field stations was that Grinnell rejected farming and other forms of commodity production, labeling them inappropriate activities for a natural history reserve. Hastings would provide an example of "'agriculture in reverse'; for the purpose is to observe the sequence of biotic events on an area long grazed and in part cultivated, toward recovery of 'primitive' conditions of flora and fauna . . . which will now be allowed to go 'back to Nature.'"[20]

Preventing such uses was not as simple as decreeing a policy or vision. Fences needed to be maintained, allies needed to be cultivated, neighbors needed to be educated, and trespass laws needed to be enforced. The place sometimes even needed to be protected from the university itself. In March 1944, agricultural extension agent Reuben Albaugh wrote to officials at the University Farm, in Davis, requesting that Hastings be made available to ranchers from nearby Salinas who were concerned that the area had received insufficient precipitation during the winter rainy season to sustain their cattle through the long, dry summer. According to Albaugh, the reservation had "not been grazed for four or five years"—in other words, since its establishment—"and it has excellent feed on it. Since we are very short of feed in this area, it seems to me if it wouldn't upset their

FIGURE 8.5
The Boyd Deep Canyon Desert Research Center was the first major reserve acquisition of the postwar era. Reprinted with permission of Mark Fisher, Boyd Deep Canyon Desert Research Center.

experimental work too much it should be used for the grazing of cattle." This request, which represented the interests of big agriculture, the state's largest industry, during wartime rationing, wound through the university bureaucracy, reaching all the way to the office of president Robert Sproul. Hastings director Jean Linsdale and museum chief Alden Miller, sensing that Grinnell's vision was in jeopardy, fended off the request with two arguments: first, it was not a particularly dry year for central California, which meant that there should be adequate forage elsewhere; and second, the reservation's scientific value depended on consistent monitoring and management, including banning cattle.[21]

Grinnell's vision, forged in the 1930s and 1940s, remains a touchstone for the Natural Reserve System. Reserve directors still prohibit resource extraction and commodity production, except in cases where such activities are part of approved scientific studies. Researchers still come from around the world to use the reserves, seek extended periods of undistracted outdoor work, and see themselves as going "back to nature," even as they are aware that the sites they study have long histories of human use and ecological change. Work at the Natural Reserve System, in areas such as watershed conservation and exotic weed management, sometimes overlaps with parallel projects at the agricultural experiment stations. Yet the Natural Reserve System has retained its distinctive

identity as a site for environmental science research and teaching in fields such as ecology, zoology, botany, geology, geophysics, and evolutionary biology.

In other ways, however, the Natural Reserve System has outgrown Grinnell's vision. The most obvious of these is that he seems to have viewed Hastings as an end unto itself. There is no evidence that he contemplated additional sites, much less the vast system of reserves that exists today. He might have taken this conceptual leap had he not died suddenly, of a heart attack, just days before the university gave its final approval for the Hastings acquisition. After Grinnell's death, it took a quarter century to begin expanding the university's collection of natural reserves.

The path toward a bigger system began in 1958, when Wilbur Mayhew, a young faculty member in zoology at the University of California, Riverside, began working with state senator and university regent Philip Boyd to create a reserve at Deep Canyon in the Coachella Valley near Palm Springs. Mayhew's original vision was for a forty-acre site on the canyon floor, but within a year Boyd came back with a different idea: he would purchase and donate some six thousand acres—an area four times the size of Hastings, which spanned from near sea level to 8,700 feet in elevation and encompassed a spectacular desert and mountain landscape (Figure 8.5).[22]

Nothing quite like this had been proposed before, and faculty and administrators on the Riverside campus did not know how to respond. Sensing their tepid mood, Mayhew turned to the Office of the President in Oakland. He argued that postwar suburban development was gobbling up the state's wildlands at an unprecedented rate. Scientists needed secure sites to conduct their work, but agencies like the National Park Service, which were focused more on accommodating visitors than facilitating research, were unreliable partners. He also argued that the state's natural diversity demanded that its flagship public university take the extraordinary step of acquiring more than one reserve. Boyd and Mayhew eventually received the support of university president Clark Kerr. Kerr's wife was a well-known Bay Area conservationist, and he seems to have had a soft spot for the old-fashioned natural history that he thought the reserves represented.[23]

By the time that Mayhew and Boyd closed the Deep Canyon deal, other efforts were underway. The University of California, Los Angeles (UCLA), herpetologist Ray Cowles and his star student, Kenneth Norris, were hatching a plan to dramatically expand the nature reserves of the University of California system. Over the next several years, they circulated a series of proposals that argued that such a multisite reserve system would advance Kerr's landmark Master Plan for Higher Education in California, published in 1960.[24] They also used emissaries on the inside, including Kerr's friend and Berkeley professor A. Starker Leopold, the son of the famous conservationist Aldo Leopold, to court the president's further support. In 1965 and 1966, Norris set out on a statewide tour to assess potential sites for future reserves, leading to the creation of an Acquisition Priorities Plan.[25] The university began acquiring new sites; in 1970, it renamed its collection of environmental science field stations the Natural Reserve System.[26]

Most of Norris's recommended acquisitions never made it into the Natural Reserve System. But some—including Stunt Ranch in Los Angeles, James San Jacinto Mountains Reserve in Riverside, and Coal Oil Point Reserve in Santa Barbara—did,

and many more that he did not initially identify joined the system in the decades that followed. Norris's plan laid out a bold agenda. He envisioned reserves with different levels of access and facilities, in a system that would include representative samples of the state's natural diversity. The reserves would serve as microcosms of their surrounding regions. This was an unusually forward-thinking model at a time before the emergence of modern conservation planning, when nongovernmental organizations, such as the Nature Conservancy, were just beginning to lay out their own visions for regionally organized representative systems of natural reserves.

The present collection of reserves reflects Norris's original plan, as well as changing priorities and opportunistic acquisitions. It also reflects the changing structure and direction of the university itself. An example of an opportunistic acquisition came in 1997, when the University of California, Santa Barbara, acquired the nearly six-thousand-acre Sedgwick Reserve in the Santa Ynez Valley. As one of several reserves located in a hardwood rangeland landscape, carpeted with grass and dotted with oaks, Sedgwick was not a unique addition to the Natural Reserve System. Yet it offered such potential for teaching and research that when the chance arose, the faculty and staff fought hard to obtain the site. An example of a reserve that reflects the changing structure and direction of the university is the White Mountain Research Center. Operated as an independent facility for high-altitude research beginning in 1950, White Mountain joined the Natural Reserve System in 2012 as an extension of the UCLA Institute of the Environment and Sustainability.

These acquisitions took several forms, and the current Natural Reserve System includes units with at least three different kinds of ownership arrangements. The university owns some reserves outright. Most of these, such as the Sedgwick Reserve, were donated or purchased with the aid of supporting funds from third parties, such as land trusts. Some reserves are administered through use agreements with the landowners of the site or surrounding area, usually a government agency or nongovernmental organization. In recent years, the National Park Service has emerged as an especially enthusiastic partner. The university now administers three reserves within or immediately adjacent to National Park Service units—Yosemite Field Station, Santa Cruz Island Reserve on the Channel Islands, and the Sweeney Granite Mountains Desert Research Center surrounded by the Mojave National Preserve. Future stations are planned for Point Reyes National Seashore and Lassen Volcanic National Park. Other sites, such as the Sierra Nevada Aquatic Research Laboratory (part of Valentine Eastern Sierra Reserves), occupy sites that the university leases. These ownership arrangements create opportunities and challenges, and shape the form and function of reserves as university-run landscapes.

Field Stations as Places

What is it like to visit these reserves? What kinds of places are they, and how are they managed? University of California reserves are located throughout the state, and each reserve is affiliated with one of the university's general campuses (Figure 8.6).

FIGURE 8.6

As of 2017, the University of California Natural Reserve System included thirty-nine sites covering 750,000 acres. Reprinted with permission from the University of California Natural Reserve System.

Some reserves may also be tied to special campus units, such as the Museum of Vertebrate Zoology in Berkeley or the Institute of the Environment and Sustainability in Los Angeles. The Natural Reserve System itself is based at the Office of the President of the University of California, in Oakland, which provides administrative and legal support and helps coordinate system-wide initiatives.

The Natural Reserve System represents a variety of sites and situations, but most reserves fall into three broad categories: annexes, outposts, and wildlands. Reserves in each of these categories differ in terms of their levels of access, the types of activities they support, and their day-to-day management, all of which influence their physical appearance and their footprint on the landscape.[27]

The first kind of reserve, annexes, are extensions of their home campuses. Annex reserves may be on, adjacent to, or near their home campuses. Since annex reserves are easy to access, they host numerous classes and engage in diverse conservation and outreach programs. They may have hiking trails, beach access points, or wildlife viewing areas, and they often contain signage or other interpretive infrastructure. They usually do not offer much in the way of on-site facilities, such as lodging, libraries, or laboratory spaces, since these are available nearby. Annex reserves often serve as important open spaces for their local communities, but their main challenges also come from managing this public access.

Scripps Coastal Reserve, an annex reserve in La Jolla next to the University of California, San Diego, hosts hundreds of thousands of visitors annually. Both a terrestrial and a marine reserve, its 850 acres abut the Pacific Ocean. The key management challenges at the Scripps Coastal Reserve are allowing access while promoting public safety in the presence of unstable seaside cliffs, and preserving the integrity of this fragile landscape while facilitating coastal and marine research. The reserve includes "the knoll," a mesa with interpretive trails and sweeping views; a shoreline zone with limited public access; and an ocean zone designated as a State Marine Conservation Area. The various interests and institutions involved make this a hybrid space of negotiated access, shared governance, overlapping jurisdictions, and sometimes contested claims.

A similar situation exists at Coal Oil Point Reserve, a popular site for surfers, bird-watchers, and dog walkers about a mile west of the University of California, Santa Barbara. A controversy erupted at the Coal Oil Point Reserve in the early 2000s, when the reserve director imposed restrictions on public access to protect the snowy plover, a federally listed threatened bird species that nests on the site's coastal dunes.[28] Some local residents felt that they were being excluded from an area that they had long enjoyed. The reserve director responded by reaching out to the affected parties and launching a docent-led education and outreach program (Figure 8.7). The reserve will also see major changes in the years ahead. In 2012–13, the university acquired a golf course just upstream of the reserve. A portion of this property is being redeveloped as university housing, with the remainder being redesigned to serve as a wetland similar to the one that existed there before the golf course's construction decades ago.

The second kind of natural reserve, outposts, are located far from their home campuses. Outpost reserves may offer limited public access, usually by appointment or scheduled events. Their facilities vary, but the most popular outpost reserves are largely self-contained due to their remoteness; therefore, they possess some of the best facilities of the Natural Reserve System. Outpost reserves sometimes border private lands, but many also share boundaries with public lands administered by the National Park Service, U.S. Forest Service, or other government agencies.

The Valentine Eastern Sierra Reserves, for example, is 370 miles by car from its home campus in Santa Barbara. It includes two sites. The first, Valentine Camp, a 156-acre site surrounded by the ski town of Mammoth Lakes, was once a retreat for wealthy Angelenos. Its rustic cabins are available for lodging during the summer; its access road is often closed due to snow from November to May. Located in a shady

FIGURE 8.7
A view of Coal Oil Point Reserve during cleanup efforts following the May 2015 Refugio oil spill. Photograph by George Foulsham.

valley, the camp contains lush wetlands and dense conifer forests. The university maintains the core area of the reserve for researcher housing and youth science education programs, including summer camps. The rest of the camp is carefully managed for forest conservation. The second site is the Sierra Nevada Aquatic Research Laboratory (SNARL). Located ten miles east of Valentine Camp, SNARL is surrounded by high desert sagebrush vegetation and is open year-round. Originally founded in the 1930s as a U.S. Fish and Wildlife Service field station, SNARL joined the Natural Reserve System in 1973. SNARL straddles Convict Creek, which drains one of the Eastern Sierra's most geologically complex watersheds and makes it an ideal site for water-related research in this often-parched state. SNARL possesses a unique diversion system capable of sending water from Convict Creek into nine fifty-meter-long artificial channels, which researchers can manipulate to study stream hydrology and aquatic biology (Figure 8.8). It also houses extensive lodging and office spaces, wet and dry labs, a radioisotope lab, controlled-environment chambers, vertebrate research facilities, a 120-seat state-of-the-art classroom and events center, and a historic church building. The property is owned by the Los Angeles Department of Water and Power, which leases it to the university.

The Sweeney Granite Mountains Desert Research Center, located in the remote eastern Mojave Desert between Los Angeles and Las Vegas, is another example of an outpost reserve. It contains a rich ecosystem—including woodland, mixed shrubland,

FIGURE 8.8
The Sierra Nevada Aquatic Research Laboratory contains outstanding research facilities, including a unique network of experimental streams. Photograph by Emily Peffer Zefferman.

and towering granite monoliths—arrayed along a three-thousand-foot elevation gradient. Acquired as a reserve in 1978, the nine-thousand-acre site soon became one of the most popular destinations for teaching and research in the Mojave Desert.[29] The California Desert Protection Act of 1994 transferred 1.4 million acres of land around the research center from the Bureau of Land Management to the National Park Service, and renamed this remarkable area the Mojave National Preserve. This led to important administrative changes, including the removal of any remaining cattle in this long-grazed area. The site houses a library, laboratory, and conference facilities, a researcher cabin, and two campgrounds. In 2016, the Sweeney Granite Mountains Desert Research Center hosted more than 170 active research projects.

The third kind of reserve, wildlands, tend to be located far from population centers and may function as satellites of larger but geographically separate reserves. Wildland reserves have limited public access and few facilities. Some are managed as wilderness areas and thus prohibit new roads, built structures, and most motorized or mechanized transportation. These reserves tend to attract relatively few visitors, but they may contribute to other natural resource management goals, such as wildlife and water conservation or fire protection.

Oasis de los Osos, a 160-acre reserve north of Palm Springs, is part of the larger James San Jacinto Mountains Reserve, an outpost site affiliated with the University of California, Riverside. Although these two reserves appear close on a map, they are around thirty-seven miles apart by road. Visible only to those with permission to enter, Oasis de los Osos has no facilities or infrastructure save for a locked entrance gate. Yet this gate hides a rare gem. Inside lies a magnificent desert oasis with fan palms, a perennial creek, and a waterfall. The Nature Conservancy donated the site to the University of California in 1987 as part of an effort to protect it from development.

The Chickering American River Reserve is a wildland site much like the Oasis de los Osos, although it exists in a very different setting. Located just a few miles from Donner Pass, on the windward slopes of the Sierra Nevada west of Lake Tahoe, its 16,875 acres vary from six to eight thousand feet in elevation. The Chickering American River Reserve is part of a consortium of reserves known as the Central Sierra Field Research Stations, which are affiliated with the University of California, Berkeley, and coordinated through the Sagehen Creek Field Station in Truckee. It does not contain any facilities, and access is restricted from November through May, depending on snow conditions. Despite the obvious attractions of its flora and fauna, its remote location and lack of research support facilities mean that it is rarely used for research compared to other, more bustling sites.

The Role of Field Stations in a Wider World

Field stations are not islands; they shape and are shaped by diverse processes and events, including ecological, cultural, political, and institutional changes. Reserves also shape the world around them through research, teaching, and outreach, which can include conservation work and even broader political engagement.

The Natural Reserve System hosts an enormous variety of research, mostly in the environmental sciences, resulting in hundreds of peer-reviewed publications each year. Most research at the reserves is the work of individuals or small teams of scientists focused on specific questions in particular places. Currently, however, several major collaborative and interdisciplinary initiatives are bringing together diverse groups to tackle problems of common interest. The California Phenology Project is using more than one hundred sites at eight reserves to study biological cycles and to examine how they may be shifting due to climate or other environmental changes. The Partnership for Interdisciplinary Studies of Coastal Oceans encompasses a number of related projects that seek to increase our understanding of marine ecosystems along the West Coast of the United States. The Institute for the Study of Ecological and Evolutionary Climate Impacts, launched in 2015, is using twenty-four reserves to study the effects of climate change in California.[30]

Teaching on the reserves takes many forms. It includes university courses as well as classes offered by other institutions around the world. Most courses are in the natural sciences, but these vary greatly, from half-day field trips to identify local flora during the spring bloom, to geophysical expeditions exploring remote desert landscapes in

FIGURE 8.9
Students from the University of California, Santa Cruz, visit the eastern Mojave Desert and Sweeney Granite Mountains Desert Research Center in 1984. Photograph by Stephen R. Gliessman.

the summer. The Natural Reserve System also sponsors a quarter-long field course on California ecology and conservation, which draws students from around the university system. Courses in the social sciences and humanities are relatively rare, with archaeology and art among the most common offerings. Students that participate in field trips to the reserves often remember these as among their most rewarding college experiences. Reserves also host lab group retreats, conferences, and workshops for students, faculty, and staff (Figures 8.9 and 8.10).

Outreach activities vary widely among the reserves. Wildland reserves tend to host little outreach, while annex reserves hum with visits by local elementary and high schools, adult education programs, and docent-led tour groups. The reserves serve other important functions in their communities, as the directors of both outpost and annex reserves participate in local planning processes, comment on environmental impact reports for nearby projects, and contribute expert advice on local conservation issues. These issues vary from managing public access, to shaping county land-use plans, to working with local, state, and federal agencies on water and wildlife conservation initiatives, to fostering research meant to inform policy and management of other California landscapes.[31]

Despite all of this productive work, today's field stations embody at least three important contradictions. First, field stations are meant to represent their surrounding ecosystems and, thus, they enable the production of generalizable knowledge.[32] But

FIGURE 8.10
Students from the University of California, Santa Barbara, visit the Sierra Nevada Aquatic Research Laboratory in 2015. Photograph by Brian Tyrrell, from the personal collection of Peter Alagona.

every site is, to some extent, unique in its history and geography. Moreover, once a university creates a field station, the policies and management practices there change. Ecologically, the site begins to diverge from nearby areas with different land-use practices, making it a poorer proxy, over time, for the larger landscape. In the case of Hastings, for example, the removal of cattle enabled an experiment in ecological restoration. Yet the Hastings Natural History Reservation of today is quite different from other nearby ranches, where cattle continue to graze.

Second, continuing controversies about access to the reserves illustrate the paradox of operating what are essentially public lands in a mostly private manner. The first reserves were established in part because public lands proved unreliable for long-term research due to shifting policies and priorities. Today's reserves still struggle with balancing their missions and identities; they are state-run lands that must restrict public access to enable research that is supposed to benefit the public. Most site users accept that this presents difficult choices, and that reserve directors must sometimes navigate challenging political problems. Overall, however, the Natural Reserve System has had only modest success explaining its purpose and value to the citizens of California, few of whom even know that it exists.

Third, most of the scholars that use the reserves are natural scientists who value them as sites for contemporary research. They know that the reserves have long human and ecological histories. Some field stations have spent considerable effort building

archives that document these histories, provide a knowledge base for the site, and serve as a foundation for future research. With a few exceptions—and despite the advice of key figures such as Joseph Grinnell, who advocated for these sites as archives—most reserves have done a poor job collecting historical and other supporting materials that can provide a long-term context. Several projects that attempt to remedy this problem are currently underway, but they have received only modest support and many historic collections have been degraded or lost. Building archives in retrospect, for field stations that may have been operating for decades without coherent archival conservation plans, presents a major challenge.

Some of these problems stem from the fact that the Natural Reserve System, like the University of California and public research universities more generally, is spread thin. Running so many different kinds of reserves, in so many different places, has costs as well as benefits. Some reserves offer little in the way of resources or opportunities, and others that could be world-class field stations remain underdeveloped and underused. Each home campus manages its reserves differently. Some have not only reserve directors but also professional staff on campus, faculty liaisons for each site, interdisciplinary advisory boards, and networks of donors and volunteers. But others have little, if any, organizational structure.

The funding situation for the reserves is also mixed. Operational support from the university never abounded, so cutbacks since the Great Recession mostly missed the reserve system. Reductions in National Science Foundation funding probably delayed or derailed some projects, but this is difficult to quantify. The past decade, in fact, was a period of progress at many reserves. In 2006, California voters passed Proposition 84, which allocated up to $25 million in matching grants for reserve projects that "improve management of natural lands and preservation of wildlife resources."[33] This windfall has enabled some reserves to upgrade their facilities, from buildings to roads. The downside is that funding is now more unevenly distributed among the reserves than ever before, leaving some to thrive and others to languish.

This brings us to the greatest challenges facing university-run environmental science field stations. In the past, many field stations operated as private clubs for the few faculty and students fortunate enough to have the keys. To thrive in the twenty-first century, field stations will need to cultivate a larger and more diverse constituency, including not only local supporters but also a broader range of scholarly disciplines and perspectives that can bring greater intellectual diversity and institutional support. Finally, many field stations were created to represent a particular place, region, or kind of landscape. Today, however, questions about global change dominate the environmental sciences. A 2014 National Research Council report entitled "Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century" made the problem clear. Field stations need to find better ways to work together to become more than just the sum of their parts; they need to develop the collaborations, networking capacities, and infrastructures to paint a bigger picture and to help us better understand the intricate connections of a complex, dynamic, and changing planet.

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