

A. Project Summary

Sagehen Creek Field Station has a 50-year history of research in field biology, forestry, fisheries, and wildlife. The station is situated just east of the crest of the Sierra Nevada mountains, roughly 13 km north of Truckee, California, and has operated since 1951 under a Special Use Permit from the USDA Forest Service. Sagehen has been used extensively for research in field biology and aquatic ecology, resulting in over 75 Ph.D. and M.S. theses and 340 publications. Sagehen now serves as the hub for a larger field station network, the Central Sierra Field Research Stations (CSFRS). This network comprises Sagehen Creek Field Station, the Central Sierra Snow Laboratory, Onion Creek Experimental Forest, the Chickering American River Reserve, and the North Fork Reserve. Together these field stations encompass roughly 8,000 ha of high-altitude montane forests, including one of the largest tracts of intact old-growth remaining in the central Sierra Nevada.

Intellectual merit

Sagehen has operated for decades without a comprehensive plan. Three recent developments -- the emergence of new research focus areas, the formation of the CSFRS network, and a restructuring of Berkeley's administrative oversight for Sagehen -- have led to a long-range planning effort for research, management, and facilities at Sagehen. This planning effort is led by the Sagehen Program Planning Advisory Group, a joint university/agency/community initiative that brings together individuals from three universities, six agencies (federal, state, and local), and several nonprofit organizations and community groups.

To aid in the development of the long-range plan, we propose to conduct two planning workshops at Sagehen. One workshop would be devoted to a broad-ranging evaluation of the draft long-range plan. The second workshop would be focused on designing a plan for managing the forest fire risk in the Sagehen watershed, a critical issue that must be addressed for the station to remain viable in the long term. We seek funds to bring in outside experts to share their expertise with the Planning Advisory Group. The summary documents that emerge from these workshops will be critical in the development of the final long-range plan.

Broader impacts

Sagehen Creek Field Station and the surrounding Sagehen watershed are used regularly for educational programs by several universities and the local K-12 school district, and are also used for training programs by several government agencies and local non-profit organizations. Preserving and enhancing these educational functions of Sagehen are important components of the long-range planning efforts now underway. A bill recently introduced by Senator Barbara Boxer proposes to add Sagehen Creek to the National Wild and Scenic Rivers system. Developing a long-range management plan for the field station and the surrounding watershed will help in preserving the natural values of this unique and valuable riparian ecosystem.

The proposed planning workshops would supply the Planning Advisory Group and the Berkeley campus with independent expert assessments of the field station, its facilities, and its research and education resources at a critical point in its history. The workshops would evaluate Sagehen's facilities by assessing their suitability to support research and teaching in several broad areas, including fire risk management and fire ecology, habitat restoration and native species reintroduction, and watershed hydrology and biogeochemistry. These workshops offer an excellent opportunity to incorporate the best available information into a long-range plan for Sagehen Creek Field Station.

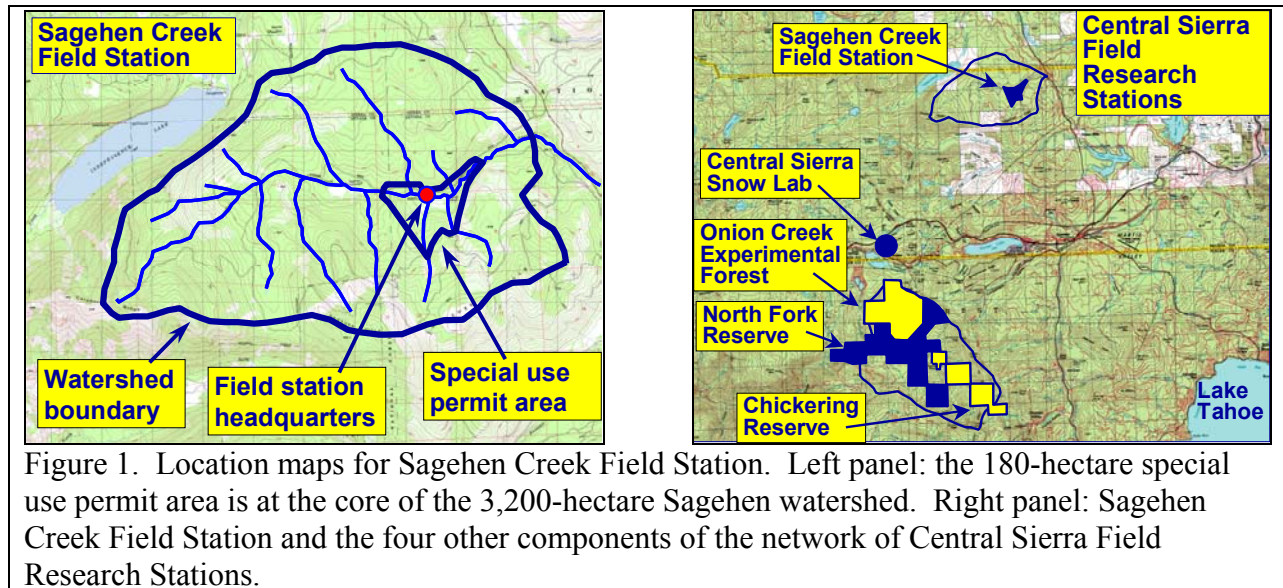
Project Description

A. Description of the Facility

1) Location and Background

Sagehen Creek Field Station is situated just east of the crest of the Sierra Nevada mountains, roughly 13 km north of Truckee, California, at an altitude of 2,000 m. It has provided facilities for research and education in biology, fisheries, forestry, hydrology, entomology and wildlife since 1951. Sagehen also serves as the hub for a larger field station network, the Central Sierra Field Research Stations (CSFRS). This network comprises Sagehen Creek Field Station, the Central Sierra Snow Laboratory, Onion Creek Experimental Forest, the Chickering American River Reserve, and the North Fork Reserve (see Figure 1, below). Together these field stations encompass roughly 8,000 hectares of high-altitude montane forests.

Sagehen Creek Field Station is located within the 3,200 hectare Sagehen Creek watershed in the Tahoe National Forest; the field station itself comprises approximately 180 hectares and 2.4 km of stream channel in the center of the watershed (see Figure 1, below). UC Berkeley has operated these lands under a Special Use Permit with the Tahoe National Forest since 1951. In addition, the entire Sagehen Creek watershed is managed for research purposes under the current Tahoe Forest Plan, as the primary component of multiple-use management of the basin. UC Berkeley and the Tahoe National Forest are currently developing a long-term cooperative management agreement for the Sagehen watershed and surrounding lands.



The climate at Sagehen encompasses severe contrasts. Summers are typically dry with daytime high temperatures averaging around 25 °C, but summer nighttime temperatures routinely drop below 0 °C. Winters are snowy with daytime high temperatures averaging around

5 °C; snow cover typically lasts from November to April or May, and winter access requires traveling by skis, snowshoes, or snowmobiles.

The lands surrounding the field station include several fens, wet and dry meadows, willow thickets, lodgepole pine stands, mixed forests of ponderosa pine, Jeffrey pine and white fir, and scattered stands of aspens. Strong contrasts in groundwater permeability have created sharp boundaries between habitats at Sagehen (for example, dry sagebrush meadows and permanent wet meadows coexist within 10's of meters of one another), providing valuable settings for comparative ecological research.

Sagehen was established in 1951 as part of a program in teaching and research on freshwater fisheries and wildlife funded by the state of California through the University of California, Berkeley. The station's location along Sagehen Creek was chosen because of its suitability for research on trout and other research problems of interest to the Berkeley faculty. Unique research facilities were constructed, including a fish observation building with an 8m underwater window, allowing ongoing monitoring of fish behavior.

Although initially fisheries work was stressed, from the outset Sagehen was intended to serve a broad spectrum of ecological research interests. The station has particularly encouraged long-term studies and monitoring. For the first several years, the station served primarily as a research base for UC Berkeley staff and students, but since then it has been used by faculty, staff scientists and students from many universities, government agencies, non-profit institutions and K-12 schools. In recent years Sagehen has attracted researchers from New York, Colorado, and Texas in addition to California and Nevada.

On-site courses have been offered since 1954 and continue to the present. The use of the facility for classes is an important aspect of the station, serving to motivate younger students to pursue careers in science.

2) Administration

Sagehen Creek Field Station (Sagehen) is administered by the Berkeley's Vice Chancellor for Research, the Berkeley Natural History Museums (BNHM) and the California Biodiversity Center (CBC), an organized research unit of the University of California at Berkeley. The BNHM, a consortium of campus natural history museums, is also responsible for the administration of several biological field stations controlled by the campus. The BNHM endeavors to support field research by capturing, storing, and disseminating field data via computerized database systems, and by linking research activities at Berkeley's field stations with museum-based research activities. The Resident Station Manager at Sagehen is Jeff Brown (full-time employee), the Resident Assistant Manager is Faerthen Felix (40% appointment) and the Faculty Director is Professor Jim Kirchner. Professor Kirchner also serves as director of the broader network of Central Sierra Field Research Stations.

3) Research Areas and Habitats

Sagehen is located on the east slope of the Sierra Nevada Mountains at an elevation of approximately 2000m. It part of (and is surrounded by) the Tahoe National Forest. The special use permit area includes fens, meadows that range from dry grasses and annual plants to wet, Carex-dominated areas, open areas of sagebrush, and a large area that was burned in 1960 and is currently dominated by large stands of tobacco brush and greenleaf manzanita with young lodgepole and Jeffrey pines. Along Sagehen Creek, lodgepole pines dominate. The balance of the area is mixed coniferous forest consisting primarily of lodgepole pine, Jeffrey pine, ponderosa pine and white fir.

The surrounding Sagehen watershed encompasses tracts of areas of uncut red and white fir, areas of logged red fir and small groves of aspen. On Carpenter Ridge (the headwaters of Sagehen Creek at the Sierra crest) are stands of mountain hemlock; beneath the cirque of the ridge is a small lake and vernal pool. Some areas within the basin that have been heavily grazed by sheep, where large stands of woolly mule's ear (*Wyethia mollis*) occur in near-monoculture. Within close driving distance are many small lakes and several large water bodies (including Lake Tahoe and Pyramid Lake).

Fish populations in Sagehen Creek have been studied extensively. The most important species in the creek are brown, rainbow and brook trout, Tahoe sucker and Piute sculpin. The underwater window has allowed extensive observation of fish behavior.

Perhaps the most important attribute of the Sagehen basin is its 50-year record of research and monitoring covering nearly all species of vertebrates, many aquatic invertebrates, fire succession and vegetation, stream flow, water quality and weather data. Much of this information is available on Sagehen's website or via its GIS system.

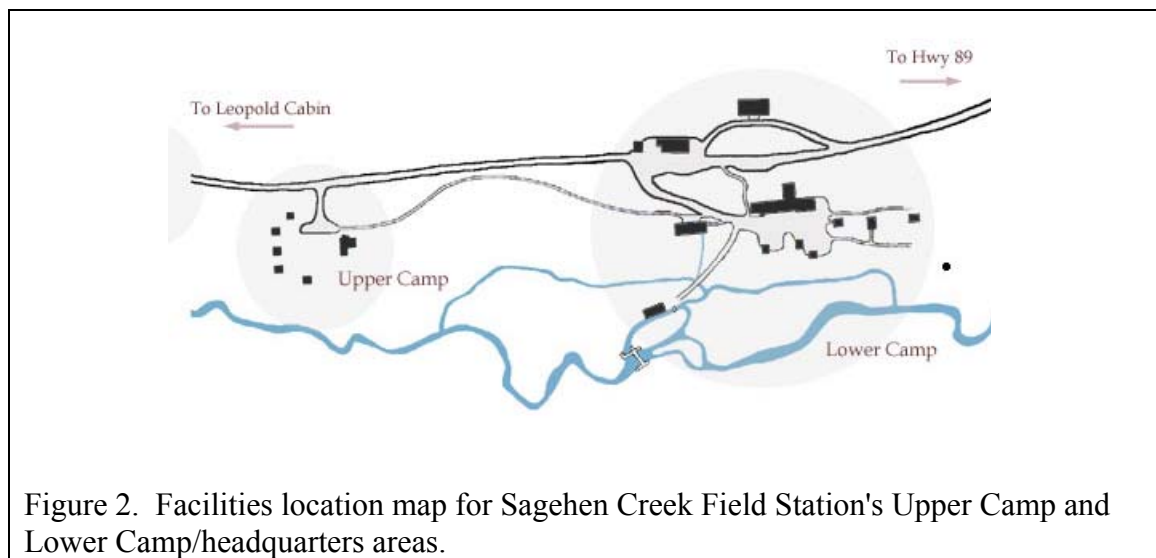
4) Physical Facilities

Sagehen administers 180 ha and 2.4 km of Sagehen Creek within the Tahoe National Forest under a Special Use Permit. The site has 22 buildings (Figure 2). Negotiations with the USDA Forest Service for the expansion of the research area to include the entire 3,200-hectar Sagehen Basin are now underway, and will be formalized through a long-range Cooperative Management Agreement.

Sagehen's facilities are divided into two main groups: *the Lower camp/headquarters complex* and *Upper Camp* of researcher cabins, with several outlying buildings including the *Leopold cabin* and the highway garage. Most of Sagehen's facilities are 40-50 years old, and are in need of renovation or replacement.

Sagehen can house a maximum of 40 people in heated, winterized cabins (most are heated with wood stoves). One large, unheated laboratory/classroom building with two separate spaces is available for teaching or research in the summer months and a small, heated wet lab is available year round. There are three kitchen spaces and one dining hall where researchers and visitors may prepare their meals. A small library/conference room has good selection of local

and regional field guides, Sagehen-based theses and reprints of scientific publications. The University of Nevada, Reno library is only 70km away, and provides extensive access to journals and books (as well as inter-library loan services from Stanford and Berkeley).



The station has a network of computers and peripheral devices, connected via a local LAN with satellite internet access. Sagehen anticipates expanding its networking capabilities by installing a dual-band wireless network that would service the Lower and Upper camp areas. Sagehen has also been selected as a test location for distributed environmental sensing, as part of the NSF-funded Center for Embedded Network Sensing (CENS). Sagehen's role in CENS is still in the design process.

The station has a current website (<http://socrates.berkeley.edu/~sagehen>) with an online application/reservation system, online data source links, an online bibliography, and species lists for amphibians, mammals, birds, bony fishes and reptiles. There is also extensive station information available on the website.

Expanding research activity at Sagehen and in the surrounding network of Central Sierra Field Research Stations has meant that staff and facilities are stretched thin. Over the past 5-10 years, Sagehen has averaged roughly 950 user days per year, but calendar year 2001 recorded over 1500 user days, and calendar year 2002 recorded over 3,400 user days. The long-range plan will need to evaluate the impact of rising use on Sagehen's facilities and infrastructure. Ongoing fiscal challenges within the California State budget will make it difficult for the state government, including the University of California, to provide substantial facilities improvement funds for the foreseeable future.

The risk of catastrophic forest fires within the Sagehen watershed is high, and rising year by year. Very high fuel loads have resulted from a combination of decades of fire suppression, regrowth of crowded even-aged stands following logging in the early 1900's, and bark beetle infestations that have left extensive dead and downed lodgepole pine. The development of a fire management plan will be a critical component of the long-term strategic plan for Sagehen. The

draft plan that is currently under development envisions an adaptive management approach, in which the ecological effects of different management approaches, such as thinning and prescribed burning, will be intensively monitored. We expect that fire management activities at Sagehen will generate many research opportunities relating to fire ecology, management and post-fire restoration.

Sagehen has a fully automated weather station that records temperature, humidity, atmospheric pressure, wind speed, wind direction, solar radiation and ground soil moisture. This information is collected and archived at the Western Region Climate Center and is available online. Working in conjunction with the Desert Research Institute (DRI), three additional weather stations are being installed progressively up the basin towards the upper ridgeline. There is also a SNOTEL site on the ridgeline, further adding to Sagehen's archive of weather data. Sagehen is also a US EPA National Atmospheric Deposition Program monitoring site. This nationwide program samples and analyzes the chemistry of precipitation and dry deposition.

Sagehen Creek is a benchmark stream within the USGS benchmark hydrologic network. Stream water samples are collected on a regular basis and analyzed by the USGS. This data is archived and data is available online. A USGS stream gauging station has been in operation at Sagehen since the early 1950's. Real-time satellite transmission will begin this spring with the installation of satellite uplink equipment.

5) Goals

The goals of Sagehen Creek Field Station are:

- a) To contribute to scientific understanding of the ecological effects of fire risk management activities in montane forest ecosystems.
- b) To test approaches to restoring and enhancing the ecological functioning of second-growth montane Western forests.
- c) To contribute to scientific understanding of the social and ecological effects of expanding residential development adjacent to Sierra Nevada wildlands, including the cumulative impacts of intensive recreational use of wildlands.
- d) To contribute to scientific understanding of the interconnections between hydrological, geochemical, and ecological processes in snowmelt-dominated watersheds.
- e) To continue to improve the ability to conduct field research and teaching in general, and to expand the range and types of studies conducted.
- f) To capture, store, and disseminate field data through the use of automated environmental sensors, computerized database systems and the world wide web.
- g) To enhance and expand K-12 outreach programs in field biology.
- h) To develop and implement a public outreach program, to provide information on ongoing research, educational programs and relevant scientific results from research at Sagehen.

B. Description, Justification and Benefits of Proposed Project

Although Sagehen Creek Field Station has operated successfully for decades without a long-term plan, several recent developments have made the need for long-term planning particularly evident. First, research and teaching at Sagehen has shifted away from the emphasis on fisheries and wildlife themes that characterized the early decades at the Field Station. Second, Sagehen has recently emerged from a turbulent and uncertain period, and now has new on-site managers, a new Berkeley faculty director, and a new administrative home in the office of Berkeley's Vice Chancellor for Research. Third, use of Sagehen for research and teaching has increased dramatically in recent years, with user-days in 2002 totaling over three times the previous average for busy years. The intensity of current use is putting an increasing strain on the station's limited facilities. Fourth, although the Berkeley campus has made a long-term commitment to managing and supporting the station, California's well-known fiscal difficulties have highlighted the desirability of collaborative management arrangement for Sagehen, in which the station would be supported by several universities and overseen by a board of directors from the participating institutions. A long-range plan is a necessary first step in developing a collaborative management structure for Sagehen. Fifth, rising fuel loads in the Sagehen watershed over the past several decades have led to an extreme risk of catastrophic wildfire. A long-range plan for managing this risk is urgently needed.

As part of this long-range planning process, Sagehen's Faculty Director (Jim Kirchner) and Resident Manager (Jeff Brown) have assembled a Planning Advisory Group of individuals and organizations interested in the future of the station (see Table 1). The Planning Advisory Group includes representatives from three universities (UC-Berkeley, UC-Davis, and the University of Nevada, Reno), six government agencies (the U.S. Forest Service, the California Resources Agency, the Nevada County Board of Supervisors, the Lahontan Regional Water Quality Control Board, the Truckee Town Council, and the Truckee School District), and several non-profit organizations (including The Nature Conservancy, the Tahoe/Truckee Community Foundation, and the Truckee River Watershed Council). The diversity of constituencies represented in the Planning Advisory Group indicates the broad scope of interest in Sagehen and its future; it also makes this planning exercise an unusual experiment in participatory, collaborative planning and management.

In order to plan the future of Sagehen Creek Field Station in a careful and informed manner, and to ensure the success of the field station's research initiatives, we propose to conduct two planning workshops at Sagehen. The first workshop would be devoted to a broad-ranging evaluation of the draft long-range plan. The purpose of this workshop is to supply the Planning Advisory Group with expert assessments of the station's facilities and research initiatives during this critical time in its history. Outside experts would evaluate Sagehen's facilities and infrastructure and by assessing whether or not they are adequate to support its research goals in the target areas identified above, namely (1) fire ecology and fire risk management, (2) restoration and enhancement of ecological functioning in second-growth montane Western forests, (3) social and ecological effects of development near wildlands, and (4) and interconnections between hydrological, geochemical, and ecological processes in snowmelt dominated watersheds. The outside experts we would invite to this workshop would be directors

Table 1. Sagehen Program Planning Advisory Group: Membership as of February 2003

University of California, Berkeley	
Beth Burnside	Vice Chancellor for Research (ex officio)
Jim Kirchner	Professor and Director, Sagehen Creek Field Station
Jeff Brown	Station Manager, Sagehen Creek Field Station
Mary Power	Professor and Director, California Biodiversity Center
John Battles	Professor of Forest Ecology
Laurie Goldman	Director of Planning and Analysis, Office of VC-Research
University of California, Davis	
Susan Harrison	Professor and Director, UC-Davis Natural Reserve System
University of Nevada, Reno	
Scott Tyler	Professor and Director, Hydrology Graduate Program
Dale Johnson	Professor
Doug Boyle	Associate Research Professor, Desert Research Institute
US Forest Service	
Steve Eubanks	Forest Supervisor, Tahoe National Forest
Joanne Roubique	District Ranger, Truckee Ranger District
Peter Stine	Program Manager, Pacific Southwest Research Station
California Resources Agency	
Greg Greenwood	Deputy Asst. Secretary/Science Advisor
Nevada County Board of Supervisors	
Barbara Green	County Supervisor
Lahontan Regional Water Quality Control Board	
Cadie Olsen	Hydrologist
Truckee Town Council	
Don McCormack	Former Town Councilman
Truckee School District	
Pat Gemma	Superintendent
The Nature Conservancy	
Jim Gaither	Sierra Nevada Program Director
Tahoe/Truckee Community Foundation	
Lisa Dobey	Executive Director
Truckee River Watershed Council	
Lisa Wallace	Executive Director
Jim Plehn	Member
Sarah Trebilcock	Member
Integrated Environmental Restoration, Inc.	
Michael Hogan	Principal
Soderquist Consulting	
Charles Soderquist	Principal
Jones & Stokes	
Edward Beedy	Science Coordinator

or principal scientists from several leading field research stations, including HJ Andrews Experimental Forest, the Rocky Mountain Biological Laboratory, Flathead Lake Biological Station, and the University of Colorado's Mountain Research Station. Berkeley participants would include, among others: Jim Kirchner (Professor of Earth and Planetary Science and faculty director of Sagehen), Jeff Brown (Sagehen resident manager), John Battles (Professor of Forestry), Mary Power (Professor of Integrative Biology), and Mark Stromberg (manager of the Hastings Reserve and Chair of the Data Management/Networking Committee of the Organization of Biological Field Stations (OBFS)).

The second workshop will be focused on fire ecology and fire risk management, which will be both a major management issue and a major research focus at Sagehen in the next several years. The Sagehen watershed, like many forests in the Sierra Nevada and throughout the west, has very high fuel loads and a correspondingly high risk of catastrophic wildfire. Much of the Sagehen basin was logged a century ago, and many tracts have regrown as crowded, even-aged stands. Standing and downed dead timber have accumulated to very high densities in many parts of the Sagehen basin as a result of decades of fire suppression, just as they have over millions of acres of the Sierra Nevada. The fire risk in the Sagehen basin must be addressed, and the Planning Advisory Group is currently exploring alternatives for doing so. The objective of this effort is to not only reduce the fire risk in the Sagehen basin itself, but also to create research opportunities for intensively studying the ecological consequences of alternative risk management strategies. An integrated research plan would explore the effects of thinning and prescribed burning, not only on forest stand structure, but also on understory vegetation, invertebrate communities, below-ground fungal and microbial communities, decomposition processes, nutrient cycling rates, water and solute fluxes in streams, and net uptake or sequestration of carbon. Through such an integrated research program, it is hoped that research at Sagehen can contribute to scientific management of fire risk in forests across much of the Sierra Nevada and the West. In the second workshop, experts will assess the Sagehen watershed and alternative management strategies for it, and aid in outlining a science plan for studying the ecology of fire risk management at Sagehen. The outside experts we will invite to this workshop are specialists in fire ecology and fire management, such as James Agee (University of Washington), Phil Omi (Colorado State University), John Covington (Arizona State University), Mark Finney (US Forest Service Fire Science Laboratory, Missoula, Montana), and Carl Skinner (US Forest Service Pacific Southwest Research Station, Redding, CA). Berkeley participants in this workshop would include, among others: Jim Kirchner (Professor of Earth and Planetary Science and faculty director of Sagehen), Jeff Brown (Sagehen resident manager), Scott Stephens (Professor of Forestry and specialist in fire ecology), John Battles (Professor of Forestry), Keith Gilliss (Professor of Forestry), Bob Heald (Director of UC Blodgett Forest).

We expect that many members of the Planning Advisory Group will attend both workshops. For each workshop, offered over the course of two days, a series of presentations would be given by researchers with current or recent experience at Sagehen. Interspersed with these presentations by researchers, the outside experts would be asked to outline their research efforts, and to describe how facilities at similar research stations have enhanced or hindered their research efforts in the past.

Each workshop would consist of at least five presentations, each 20 minutes in length. Presentations would alternate with discussion periods and tours of the facilities and the Sagehen watershed. In addition to supplying insight into the kinds of research conducted at Sagehen and other similar facilities, the goals, directions, and administrative structure of Sagehen would be reviewed during the workshop. Discussion periods would have designated facilitators from the Berkeley campus Group, and tours of the facilities and surrounding habitats would be offered so that experts would have the opportunity to assess the fit between the station's assets and the research directions outlined in the presentations.

In addition to supplying a series of expert assessments to be used in the long-range planning process, one of the major benefits of this project will be the generation of written documents to be used as tools in the refinement of the strategic plan. These workshops offer an excellent opportunity to pause and evaluate the impact of Sagehen's new research initiatives, and to plan any future equipment purchases, facility renovations, or research initiatives with the best available information. We believe that these workshops will be critically important in supporting the long-range planning effort, and in further developing the research potential of Sagehen Creek Field Station.

C. Research and Training Use of Sagehen During Past Five Years

1) Research

Over the past five years, Sagehen Creek Field Station has facilitated research on a wide range of topics, including: groundwater hydrology and geochemistry (Laura Rademacher and Jordan Clark, UC Santa Barbara), nitrogen cycling in alpine ecosystems (Tracy Benning and Amy Merrill, UC-Berkeley), snow hydrology and streamflow modeling (Doug Boyle and Scott Tyler, University of Nevada-Reno), effects of large woody debris in streams (Neil Berg and Anne Carlson, US Forest Service), interactions between groundwater levels and meadow plant communities (Barbara Allen-Diaz and Jennifer Kluse, UC-Berkeley), interspecific competition in meadow communities (Neil Hausmann, UC-Berkeley), interactions between native and non-native grasses (Jennifer Kluse, UC-Berkeley), egg coloration and camouflage (David Westmoreland, US Air Force Academy), and ecology of aphids (Erik Nelson, UC-Davis and Don Miller, Trinity University), monkeyflowers (Bret Elder, UC Santa Cruz), willow flycatchers (Linnea Hall, Helen Bombay, Denise Taylor and Mike Morrison, CSU-Sacramento), crayfish ecology (Theo Light, UC-Davis), and trout (Elizabeth Campbell, UC-Davis).

Major research activities at Sagehen in 2001 and 2002 included the following:

UC-Berkeley	Forest fire research	76 user-days
UC-Berkeley	Native/non-native grasses	64 user-days
UC-Berkeley	Interspecific competition in meadow plants	14 user-days
UC-Berkeley/USGS	Stream and deposition sampling	148 user-days
UC-Davis	Wasp ecology research	52 user-days
UC-Santa Cruz	Monkeyflower ecology	124 user-days
Calif. State Univ.-Sacramento	Willow flycatcher behavior study	240 user-days
UNR/Desert Research Institute	Groundwater and streamflow modeling	120 user-days
US Air Force Academy	Egg coloration study	180 user-days
The Nature Conservancy	Central Sierra bird surveys	430 user-days
US Forest Service	Willow flycatcher surveys	702 user-days
US Forest Service	Amphibian surveys	137 user-days
US Forest Service	Level 6 stream survey	60 user-days
US Forest Service	Stream survey	21 user-days
California Fish and Wildlife	Fish surveys	76 user-days

2) Instructional activities

Sagehen currently accommodates undergraduate courses from UC Davis in Entomology, Botany, and Nature and Culture. Graduate courses at UC Berkeley, San Francisco State University, University of Nevada, Reno, and Sierra Nevada College all conduct field trips to Sagehen. Space limitations usually restrict overnight instructional use of the field station to no more than 25 students.

Major instructional activities at Sagehen in 2001 and 2002 included the following:

UC-Berkeley	Biology field trip	16 user-days
UC-Berkeley	Graduate retreat	20 user-days
UC-Berkeley	Mycology field trip	40 user-days
UC-Davis	Stream ecology class	45 user-days
UC-Davis	Field entomology class	525 user-days
UC-Davis	Population biology class retreat	54 user-days
UC-Davis	Sierra ecosystems orientation	158 user-days
UC-Davis	Nature and culture class	152 user-days
UC-Davis	Stream ecology field trip	54 user-days
UC-Davis	Graduate ecology course	76 user-days
University of Nevada-Reno	Hydrology field trip	40 user-days
University of Nevada-Reno	Hydrology field trip	60 user-days
San Francisco State University	Biology field trip	54 user-days
San Francisco State University	Ornithology field trip	42 user-days
Sierra Nevada College	Biology field trip	12 user-days
California Fish and Wildlife	Bird survey crew training	35 user-days
US Forest Service	Stream survey training	45 user-days

3) Outreach

Within the last five years, Sagehen has continued its long-standing sponsorship of environmental education programs for elementary and high school students in the surrounding community of Truckee and Lake Tahoe, with coordination from the station managers (Jeff Brown and Faerthen Felix). The field station is open to tours by the public, if guides are available to supervise them. The field station's meeting spaces are also used to host a variety of meetings and symposia for government agencies, non-profit organizations, and university and college extension programs.

Major outreach activities at Sagehen in 2001 and 2002 included the following:

Truckee Elementary School	Field day	35 user-days
Prosser Charter School	Class field trip	20 user-days
The Nature Conservancy	Field trip	24 user-days
Lawrence Hall of Science	Summer High School program	340 user-days
Truckee River Watershed Council	Truckee River TMDL workshop	52 user-days
UC Natural Reserve System	2002 Manager's annual meeting	220 user-days
UC Berkeley	Sagehen planning meeting	80 user-days
Truckee River Watershed Council	Stream surveys	47 user-days

D. Summary of Most Significant Research and Training Accomplishments in Past Five Years

In her dissertation research at the fish observation facility at Sagehen, Elizabeth Campbell studied how habitat choices by trout are affected by changes in flow and the presence of potential predators. Her results showed that both habitat use and feeding rates were strongly affected by flow regime, the presence of predators, the aggressiveness of individual fish, and time of day. Her results challenge the prevailing models that are used to recommend instream flow rates in regulated streams (Campbell, 1998).

In her dissertation research based at Sagehen, Amy Merrill studied structural and floristic variation in riparian zones of the Lake Tahoe basin, and showed that different ecosystem types had different rates of nitrogen dynamics, and different responses to experimental additions of nitrogen. Her results show that classifying riparian zones into ecosystem types may be useful in predicting landscape-scale patterns of riparian zone nitrogen dynamics, and for predicting the water-quality effects of atmospheric nitrogen deposition (Merrill, 2001).

The willow flycatcher is a Neotropical migratory species that has been extirpated from most of its range in California. Masters theses by Helen Bombay and James Cain studied the ecology of willow flycatchers in and around the Sagehen basin. Results from this work show that willow flycatchers require meadows with elevated water tables and low disturbance levels (Bombay, 1999). Reproductive success was demonstrated to be highest in shrubs far from the forest margin. The major cause of reproductive failure was nest predation. This work shows that

recovery of the willow flycatcher in the Central Sierra Nevada could be enhanced through habitat restoration efforts, including active flooding of portions of meadows to restrict meadow access by nest predators that live in the forest margin (Cain, 2001).

Competition for resources between native and introduced species has been hypothesized as a controlling factor behind the success or failure of biological invasions. In her master's thesis, Jennifer Kluse examined the competitive interaction between a native grass (*Deschampsia cespitosa*) and an invasive non-native grass (*Poa pratensis*) in meadows at Sagehen as well as in greenhouse competition experiments. Her work shows that these two species have different tolerance for wetter vs drier conditions, and therefore occupy different hydrologic niches, allowing coexistence. Meadow hydrology therefore needs to be considered as a primary factor in conserving habitat for endemic meadow flora such as *Deschampsia*, as *Poa* can more easily invade drier sites.

For her dissertation research, Laura Rademacher studied the hydrology and geochemistry of several springs in the Sagehen Basin. Using chlorofluorocarbon and tritium/³He dating methods, she showed that groundwaters discharged from different springs ranged in age from less than five years to nearly 40 years. The older spring waters had higher concentrations of rock-derived weathering products, enabling a direct calculation of chemical weathering rates (Rademacher et al., 2001). Stable isotope ratios in older groundwaters (ca. 1960) are lower than in younger groundwaters (ca. 1990). The difference in isotope ratios is too large to be explained by the measured increase in average air temperatures over the same period (1.3 °C), implying that changes in atmospheric circulation patterns are responsible for some of the observed isotopic shift. This work demonstrates that isotope ratios in groundwaters can be used to study changes in climate and atmospheric circulation over decadal time scales (Rademacher et al., 2002).

The major training accomplishments at Sagehen over the past five years include the completion of five Ph.D. theses and three M.S. theses. In the past two years alone, over 350 university students have participated in courses and seminars at Sagehen; in addition, over 50 have acquired experience as research assistants on projects at Sagehen. Roughly 200 K-12 students have received their first exposure to field science at Sagehen in the last two years alone.

E. Results from Prior NSF Support

Sagehen Creek Field Station has not received support from the NSF FSML program in the past five years.

F. Selected Bibliography Attributable to Facility in Past Five Years

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Kluse, J. 2002. Abiotic Gradients and Grazing Effects on the Interactions of Dominant Meadow Grasses, *Deschampsia cespitosa*, a Native, and *Poa pratensis* spp. *pratensis*, a Non-native, Masters Thesis, University of California, Berkeley.

Rademacher, L.K., Clark, J.F., Hudson, G.B., Erman, D.C., and Erman, N.A., 2001. Chemical evolution of shallow groundwater as recorded by springs, Sagehen basin; Nevada County, California, *Chemical Geology*, 179(1-4): 37-51.

Merrill, A. 2001. Variation in the Structure & Nitrogen Dynamics of Mountain Riparian Zones, Ph.D. Thesis, University of California, Berkeley.

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G. Summary of Station Policies with respect to Data Collection and Management

Sagehen is planning to integrate its data collection and management into the national framework recently articulated by the Organization of Biological Field Stations (OBFS). This framework involves establishing an Internet-based network for data sharing and archiving among Biological Field Stations, and involves 160 OBFS member stations, Long Term Ecological Research (LTER) sites, the National Center for Ecological Analysis and Synthesis (NCEAS) and the San Diego Supercomputing Center (SDSC). Protocols and standards for data management

and sharing through the development of an OBFS network were proposed in order to answer questions about the condition of strategic natural resources nationwide, and to contribute to the development of more informed land use and environmental policies (Stanford and McKee 2000). Among other things, the framework allows for the sharing of metadata, and provides a mechanism for both housing and sharing individual data files among researchers, a specific goal at Sagehen. Dr. Mark Stromberg, Chair of the OBFS data Management/Network Committee, and a UC Berkeley employee as Reserve Manager of the Hastings field station, has been closely involved in developing OBFS standards.

As part of the planning process, the database, software, and hardware needs of units associated with the Berkeley Natural History Museums, including field stations such as the Sagehen Creek Field Station, were recently assessed (Luby 2001). Luby's analysis, which was adopted by the consortium, found that significant and immediate data needs existed at all units, especially at the field stations. In order to fulfill the research and educational missions of the individual units, as well as to develop a common shared data structure (a major goal of the BNHM consortium), the report recommended that these data needs be met as soon as possible. First steps have been taken and the BNHM system now has web-based search links to identify which specimens within the museums were collected at the various BNHM field stations.

Berkeley has assigned a permanent programmer/analyst position to the BNHM consortium in order to coordinate efforts to compile metadata at Sagehen and the other field stations, and to integrate the stations into the OBFS framework. This programmer also works at integrating field station metadata with the common shared database system that has been developed for the BNHM consortium, and provides expertise with web-database interfaces and GIS. Furthermore, it was recommended that a Computer Resource Specialist position be created to support general computing and hardware issues across BNHM units.

Integration of data collected at Sagehen into the OBFS system is designed to update the informal policy which has been in place for the last several years. In the past few years, researchers have been encouraged to share data with one and other on relevant projects and to supply copies of data files to the Station Manager. The recent appointment of an Assistant Manager at Sagehen was specifically designed to provide the station with much needed on-site computing support. This position has already improved the web presence of the station and has begun to lay the groundwork for incorporating "shoe box data" (data archives currently found in a diverse array of paper-based formats) into a web-accessible system. Additional staffing is needed at Sagehen to assist with data organization and entry. Together with networked desktops located at the field station, and advice from experts assembled for workshops, further upgrading of computer facilities would facilitate Sagehen's integration into the OBFS framework.

H. Fee Schedule

We do not anticipate any changes to the current fee structure. The current structure is (overnight rates, per person per night):

	Students	UC Faculty	Non-UC Faculty	Others
Camping	\$3	\$5	\$7.50	\$10
Cabins	\$5	\$7.50	\$10	\$12.50
Apartment	\$10	\$10	\$12.50	\$15
Johnson cabin	\$12.50	\$12.50	\$15	\$20

Day use fees are determined on a case-by-case basis; Long-term arrangements have negotiable rates. Use of the station Local Area Network (LAN) and internet access are available to visitors, as well as use of the station computers located in the Library, as part of the nightly use fee. Satellite internet service is accessed through the LAN. Photocopies and use of station printers are charged at \$.10 per page.