

1999 WMRS ANNUAL REPORT

The 1999 annual report for the White Mountain Research Station (WMRS) MRU covers fiscal year 1998/99. However as in previous reports, data related to station use is reported for the 1999 calendar year, which correlates more closely with the main research season from June through September at the station. The report is organized according to the January 8, 1998 General Campus ORU Policies and Procedures. According to the 1982 UC Policy on ORU and MRU reports, it is being submitted to the Chair of the Advisory Committee the President (*via* the Provost and Senior Vice-President for Academic Affairs) and the Vice Chancellor for Research with copies to the Chancellor.

1. SUMMARY OF MAJOR ACTIVITIES IN 1999

a. Research and educational “use” of a field station is one of the most valuable measures of its success. WMRS tracks the total number of users, the total number of “user nights” (requiring room and or board) and “user days” (*e.g.* classroom use for teaching or a conference), and the institutions and disciplines represented by the users for the *calendar year*. The calendar year corresponds more closely to the research season, which peaks between April and October and straddles the fiscal year.

- In 1999, there were 8832 user nights (all sites), representing 79 institutions. Use by UC faculty and students remained constant in absolute terms and growth was in non-UC use.
- The campus most represented at WMRS is UCSD.
- Earth and Biological Sciences are equally represented with 46% and 43% respectively. The majority of Earth Science users are non-UC and the majority of Biological Science users are UC.
- Use of Crooked Creek doubled from 1998 to comprise 24% of total use but The Owens Valley Laboratory still receives the most use (66%).
- Researchers comprise 29% of the user nights and educational programs comprise 59% similar to 1998.
- Publications resulted from WMRS in 1999.

b. WMRS Research Programs. WMRS scientists submitted 12 proposals in 1999 and 5 were funded. Funded proposals included:

1. **Comparative Demography of Selected Mountain Sheep Populations in High Mountains and the Mojave Desert of California**, California Department of Fish and Game grant (\$583,041 for 2000-2002), J. Wehausen, PI and R. Ramey, Co-PI). J. Wehausen is in the third decade of long-term research on comparative demography of mountain sheep populations in the Sierra Nevada, White Mountains, and eastern Mojave Desert of California. This work focuses on demography at three levels: (1) actual patterns of dynamics of population sizes; (2) the relative importance of variation in adult survivorship vs. recruitment in these dynamics; and (3) the factors underlying variation in adult survivorship and recruitment, including predation, diseases, weather, age structure, pregnancy rates, and

population density. This research tests basic theoretical models of ungulate population dynamics that serve as the foundation for wildlife conservation approaches.

2. **"CRB-Context-Dependent Constraints of Sagebrush-Herb Dynamics"**, NSF (\$145,370, Eric Berlow, PI) Like many other areas of the western United States, large montane meadows in the eastern Sierra Nevada of California have changed dramatically in their vegetative cover since the introduction of livestock grazing earlier this century. The most obvious changes include large scale expansion of sagebrush, reduction in cover of herbaceous species, and an apparent aridification of these habitats. Currently there is great interest in restoring these meadows to a condition where herbaceous species are dominant, yet little is known about the processes governing the interaction of sagebrush and herbaceous species in these sites, or about the role of temporal and spatial heterogeneity in influencing species interactions and vegetation change. The large montane meadows of the Golden Tout Wilderness in the southern Sierra Nevada are an ideal system to explore what regulates context-dependency in the dynamics of sagebrush-herb interactions because: 1)several large cattle enclosures exist in four different meadows within the regions, 2)variability in the patterns of shrub expansion and herb recovery occurs over relatively small scales that are experimentally tractable, 3)a series of at least 15 geologically similar meadow exist within this large plateau, and 4)meadow restoration plans are in their initial stages of development and ecological information and a conceptual framework for understanding constraints on restoration are badly needed. These meadows exhibit patterns of terracing where gravelly terraces greater than one meter above the water table are dominated by xeric stands of sagebrush with few herbs. Below these lie mesic terraces where a mosaic of sagebrush patches and herbaceous meadow species are intermixed across constant water table depth. While constraints to restoration at the scale of an entire meadow likely depend on water table depth, within the mesic terrace, both physical and biological processes may determine existing patterns. Using a combination of experimental and observational studies, this research addresses the following questions: 1)Within the mesic terraces, where patches of shrubs and herbs vary across constant water table depth, what factors control vegetation patterns and dynamics? 2)If restoration efforts increase water availability in xeric terraces, will other processes characteristic of mesic terraces inhibit the recovery of herbaceous species? 3)How do the patterns of meadow terracing vary within and among meadows and over time? We will focus on testing hypotheses about the role of current vegetation in inhibiting establishment of species that could otherwise exist in these patches and the roles of spatial variation in soils and temporal variation in water availability in determining the outcome of species interactions. This potential variability in sagebrush-herb interactions is typical of the challenges faced by many restoration efforts in systems. Thus, not only will the proposed research contribute a solid ecological framework to current restoration plans for this particular system, but it also will help address the more widespread problem of tailoring general ecological theory to site-specific management issues.
3. **"Forest Health Monitoring"**, USFS (\$66,620, S. Szewczak, PI). The Forest Health Monitoring Program (FHM) is an interagency/university research team charged with assessing the condition and trends of the nation's forest resources. The program is comprehensive in scale, using a nationwide, intensive assessment grid including thousands of plots and covering every forested ecosystem in the country. FHM currently works in 31 states (including California) and is slated by Congress for expansion into all remaining states

over the next five years. The program includes such indicators as lichen communities, foliar damage, ozone, soils, and crown mensuration/transparency, and involves a collaboration of approximately 20 research institutions and several agencies. Funding provided support for Peter Nietlich and Linda Hasselbach (NPS) and a variety of subcontracting field staff

4. **Graduate Course Modules and Research Proposal Workshops at the WMRS Eastern Sierra Institute;** UCOP grant (\$29,598 per year, 1998-2001, F.L. Powell and C.O. Qualset (Genetics Resource Conservation Program), co-PI's). This was a competitive renewal of our MRU grant for the "Eastern Sierra Institute at WMRS" in 1997 (\$68,325, F.L. Powell, PI). These competitive funds were awarded at the end of 1998 but we did not start Eastern Sierra Institute (ESI) programs until spring and summer 1999 with three activities. The **UC Summer Symposium in Conservation Biology and Ecological Restoration in Montane, Riparian and Upland Habitats in the Owens Valley** are described under educational activities below. We also ran a **Research Proposal Workshop** to develop an intercampus and interdisciplinary program to study "**Adaptation and Acclimatization to Hypoxia**" at WMRS on June 10, 1999. This workshop was a follow-up to an NSF sponsored symposium organized by WMRS at the 1999 Society for Integrative and Comparative Biology meetings in 1999, titled "Phenotypic and Genotypic Strategies to Chronic Hypoxia". Participants included 7 faculty from 4 UC campuses, one faculty each from the University of Washington, Fordham University and Case Western Reserve, and one UC graduate student. A scientific theme was identified for pursuit of external funding, namely determining mechanisms of genotypic and phenotypic responses to chronic hypoxia with human and animal studies. WMRS will provide a central focal point for these studies through its physical resources (e.g. high altitude laboratories, computer support for on-line preparation of collaborative grants) and administrative support (e.g. contract and grant preparation).
5. **Undergraduate Summer Internship in Natural Resource Monitoring and Research,** Eastern Sierra Institute for Collaborative Education, H.C. and Frances N. Berger Foundation, National Fish and Wildlife Foundation, US Forest Service, U.S. Geological Survey, Inyo County Water Department, and Bureau of Land Management (\$77,732, S. Szewczak, PI). Funding to provide support for field supervisors, advanced interns, staff, supplies, transportation, and equipment.

c. WMRS Educational Programs:

1. **UC Intercampus Supercourse in Environmental Biology.** In the Spring of 1999, 15 students from UCI, UCSD, UCSB, and UCD enrolled in the WMRS Environmental Biology Supercourse and were in residence at WMRS for the 10 week quarter taking a full course load and completing independent research projects
<http://www.wmrs.edu/supercourse/1998yearbook/paperindex.htm>
Faculty teaching in the Supercourse were from UCI, UCSD, California State University Fullerton, and the Claremont Colleges as well as local and government and scientific agencies. Prof. Peter Bowler (UCI) was the resident course coordinator and completed several research projects (for posters at national meetings or publications in preparation) with some students as part of their independent research.
2. The first **UC Summer Symposium in Conservation Biology** for graduate students was held August 1-6, 1999 at the Crooked Creek facilities. Forty people participated in the symposium, including graduate students from every UC campus except UCSF, and fourteen

faculty from UC, other Universities (Hawaii) and government agencies (US Forest Service, US Geological Survey). The evaluations collected from participants indicates it was very successful and the most common benefit (96%) was meeting other UC students, faculty or staff who may be valuable contacts in future research or conservation activities. The faculty all agreed it was a very valuable experience too. The symposium will be evaluated at the next meeting of the *Ad hoc* Committee for a University of California Intercampus activity in Conservation Biology. If the Committee agrees, plans for sustainable funding for this activity will be pursued. Details about the program and evaluation are provided in the letter with attachments from Deborah Rogers to the *Ad hoc* Committee.

3. **Ecological Restoration in Montane, Riparian and Upland Habitats in the Owens Valley** was held Aug 7-8, 1999. This was the prototype for advanced courses we plan to hold before and after longer courses or symposia at ESI. The idea is to attract graduate students, post-graduates and professionals for advanced training in technical aspects related to the theme of the ESI in a given year.
4. **The WMRS Undergraduate Internship Program.** There were 19 undergraduate and 11 high school participants in the 1999 program between June 28 and August 20. Universities and High Schools represented include UCI, UCLA, UCSB, UCD, UCB, UCSC, Swarthmore, CSU, Humboldt, U. Nevada-Reno, Brown University as well as Lone Pine, Independence, and Bishop High Schools. Interns used the GIS, Manis, Botany and native plant propagation labs. Detailed descriptions of all projects can be seen at www.wmrs.edu/interns.

The Interns completed 12 projects:

- **Sensitive Plant Monitoring** (USFS),
- **Macroinvertebrate Monitoring** (UC Santa Barbara),
- **Stream Condition Inventories** (USFS),
- **Bristlecone Pine Interpretation** (USFS),
- **Noxious Weed Monitoring** (BLM, USFS, DWP, Inyo County Water Department),
- **Eastern Sierra Riparian Bird Survey** (Point Reyes Bird Observatory, USFS, BLM),
- **Stream Condition Inventory** (USFS),
- **Yosemite Toad Survey** (USFS),
- **Physiological research on rodents** (UC Riverside, WMRS),
- **Research on Sagebrush Invasion** (WMRS, UC Berkeley),
- **Goshawk Monitoring** (USFS),
- **Archeological Inventory of the Eastern Escarpment of the Sierra Nevada** (USFS)

Advanced Student Internships were increased to 11 in summer 1999 to evaluate the effects of an increased number of research projects on the program. We found that the summer-long research projects could be effectively integrated into the internship program.

- **Investigation of Processes Involved in the Distribution Patterns in Sage Brush and Herbs in Sierra Nevada Meadows** (D'Antonio/Berlow, UC Berkeley/WMRS),
- **Establishment of Biological Water Quality Monitoring Criteria for the Eastern Sierra Nevada and Lahontan Basin** (Herbst/Sada, UCSB, WMRS),
- **Investigation of Ventilatory Acclimatization in Reptiles and Mammals** (Szewczak, Hammond, Powell; WMRS/UCRiverside, UCSD),

- **Examination of the Adaptive Significance of Genetic Variation in Natural Populations of Montane Leaf Beetles** (Rank/Dalhoff; Sonoma State/Santa Clara College),
- **Determination of a Reference Genealogy for CA Big Horn Sheep Populations and Identification of Breeding Individuals** (Wehausen, WMRS),
- **Restoration of Native Grass Seed Zones** (USFS, BLM),
- **Bristlecone Pine Forest Naturalist Internship** (USFS),
- **Landscape Evolution of the central Death Valley region** (USGS),
- **Inyo National Forest Stream Inventory/Monitoring Program** (USFS),
- **The Owens Basin Collaborative Weed Outreach and Control Project** (BLM, USFS, DWP, ICWD, Inyo CO Ag Office),
- **Range Monitoring** (USFS)

d. WMRS Outreach Programs

1. **1999 WMRS Public Lecture Series.** The WMRS lecture Series is a quarter-long series of public lectures at the Owens Valley Facility that was started in 1982. Since that time, the annual series has attracted thousands of attendees, who come to hear about the scientific work by researchers in the region. In addition to an evening lecture, the speakers generally stay at the Station to interact with WMRS students, faculty, and local agency scientists. In 1999, we attempted to incorporate visiting faculty from the Environmental Biology Supercourse into the lecture series. We also invited some local citizens to dinner with speakers at the station before the lectures.
 - The 1999 lectures included:
 - "Are DNA Markers for Me? Four Fireside Stories", Tony Long, University of California Irvine. April 8, 1999.
 - "Ecological Approaches and Products from Restoration of Costal Sage Scrub", Peter Bowler, University of California Irvine. April 15, 1999.
 - "Effects of Key Alien Species on Native Hawaiian Forests", Stephen Weller, University of California Irvine. April 22, 1999.
 - "Oxygen Enrichment of Room Air to Improve Human Performance and Well Being at High Altitude", John West, University of California San Diego. April 29, 1999.
 - "Chaos, Fractals, and You", Joe Szewczak, University of California White Mountain Research Station. May 6, 1999
 - "Terrestrial Ecosystems and Global Environmental Chang: How Forest Help Control the Concentration of Carbon Dioxide in the Atmosphere", Michael Golden, University of California Irvine. May 13, 1999.
2. **The Eastern Sierra Geological Society (ESGS) Academic Lecture Series.** Clem Nelson (Emeritus Professor, UCLA), working with a group of local geologists in Bishop, developed a new academic geological organization known as the Eastern Sierra Geological Society (ESGS). Throughout 1999, they have held a series of academic talks and field trips. Further information is available from the ESGS membership coordinator, Paul Hancock (pack@QNET.COM) . In addition to their academic talks, ESGS will be organizing several public lectures in geology for the Winter and Fall to further support WMRS outreach into the local community. The 1999 ESGS lectures and field trips included:

- "Analysis of the Big Bend Segment of the San Andreas Fault Zone" Robert Paschall, Valuation Geologist. May 24, 1999.
 - "Structural Geology of a Portion of the White Mountains" (field trip with discussion), Tim Welch, Consulting Geologist and Clem Nelson, UCLA, WMRS. June 26, 27, 1999.
 - "Summary of Long Valley Caldera Studies" Roy Bailey and Dave Hill, USGS. July 26, 1999.
 - "Remote Sensing and Geobotanical Research in the Central White-Inyo Range", Gary Ernst, Stanford University. August 9, 1999.
 - "The Independence Dike Swarm" Allen Glazner, University of North Carolina. September 27, 1999.
 - "Plateaus and Platitudes, Pleistocene Relicts in the Death Valley Landscape" (field trip with discussion), Angela Jayko, USGS, WMRS. October 23-24, 1999.
 - "Contemporary Volcanic CO₂ Degassing at Mammoth Mountain, California: Methods in Quantifying Temporal Variability and Unanswered Questions", John Rogie, Penn State, USGS. November 8, 1999.
- 3. The Eastern Sierra Education Forum.** The Education Forum was originally developed in 1994 by Elizabeth Phillips, then office manager at WMRS and Susan Szewczak, current Academic Coordinator to provide a link between the academic and research community of WMRS and the local k-12 educational community. The original mission statement adopted in 1994 states that "The Education Forum, facilitated by University of California, White Mountain Research Station, brings together teachers, post-secondary faculty, administrators, parents, governmental agency personnel and other interested individual in an effort to pool and share resources, facilities and expertise. By fostering communication and support, the Education Forum seeks to build consortiums which empower all potential participants, in order to develop creative and cost-effective ways to meet the wide variety of needs of the students in the rural communities of the Eastern Sierra."

In 1999, the Ed Forum has begun to explore how to connect the vast resources of the Eastern Sierra into a nationally recognized outdoor science education program. WMRS has been facilitating collaboration with other UC organizations, including the UC, Office of the President MESA and MSTAR programs as well as UC Merced and its flagship research unit, the Sierra Nevada Research Institute. The goal is to share resources and experience in the development of K-12 outdoor science education programs that can link students from both the east and west sides of the Sierra Nevada to the wonder of these mountains as they improve their understanding of math, science, and technology. For 1999, the Ed Forum has been developing a pilot Scientist-in-the-Classroom/Students-in-the-Field Program. This program will draw on the needs of the local k-12 educational districts, research resources of WMRS, and volunteer support groups in the Bishop Paiute Tribe, the Senior Center, and the Friends of WMRS.

Participating organizations in the Ed Forum are Bishop Elementary, Bishop High School, Big Pine, Independence, and Round Valley School Districts, Inyo County Office of Education, UC WMRS, Cal Tech Owens Valley Radio Observatory, Cerro Coso Community College, Bishop Paiute Tribe, Inyo-Mono Senior Association, Inyo County Library, Inyo County

Head Start Program, US Forest Service, Bureau and Land Management, California Department of Fish and Game, Friends of White Mountain Research Station.

4. **Friends of White Mountain Research Station.** In 1999, Friends of White Mountain was officially recognized as a Campus Support Group at UCSD. The purposes of this organization are 1) to help the station enhance its community outreach activities and 2) provide support to WMRS rural community education needs programs. Activities include annual open house, lecture series, adult-education workshops, teacher training, K-12 activities, and other interpretive activities for general public. To implement this purpose, participants in Friends will help with such activities as sale of WMRS merchandise (T-shirts, Mugs, hats, books, and posters), library staffing, and fund raising.

d. WMRS Laboratory Activity:

1. **Manis Laboratory.** The Manis Laboratory is being upgraded for modern molecular biology. This is part of a laboratory modernization program for which we are seeking NSF support. Equipment upgrades include a -70°C freezer for storing samples, dry ice maker, DNA thermocycler for PCR, a variable speed microcentrifuge, ultraviolet sterilizer, vortex mixer, and micropipettors. Much of this equipment was made possible by Dr. John Wehausen's contract with California Department of fish and game to study the genetics of the Sierra Bighorn Sheep. This equipment has also been critical for research by Profs. Elizabeth Dalhoff (Santa Clara College) and Nathan Rank (CSU Humboldt). Their current studies build on data collected on predator-prey interactions between willow beetles and host plants with chemical defenses by Dr. John Smiley (UCSC) at WMRS in the 1980s. The data are showing molecular mechanisms of evolution to drought in the late 1980s and subsequent recovery that isolated different populations of the willow beetles in the eastern Sierra Nevadas.
2. **Geographical Information System/ Computer Labs.** The GIS Laboratory at WMRS is rapidly expanding with activities that support research and educational objectives of the users, maintenance of the WMRS web site and National Geospatial Clearinghouse node for the Eastern Sierra, and management of the WMRS data. Research and educational activities include:
 - Providing technical support for researchers, interns, and students (use of computer network, GIS, GPS, digital camera, and related software)
 - Consulting with users about available data sets relevant to particular research questions
 - Creation of GIS coverage for researchers: (Jeff Lee (UCSB) , Marilyn Meyers (UCB) Nathan Rank (CSUH), Allen Glazner (U North Carolina), Jennifer Bryson(xx), Anne Halford (BLM), Angela Jayko (USGS and WMRS)
 - Developing an ArcView demonstration on economic GIS models with Richard Bernkopf (USGS and Stanford U) for the UC Summer Conservation Biology Symposium
 - Programming weather stations distributed on altitude transect over White Mountains (Michael Richter, U. Erlangen, Germany)
 - Developing new WMRS web sites with USGS guidance and advanced intern support on Death Valley Geology, Trilobites of the White Mountains and USGS Dust Studies in Owens Valley for monitoring aerosols.
 - 1 journal article in Madrono and 4 Posters at national GIS and geological society meetings.

3. **Deepest Valley Native Plant Propagation Center.** On-going research included the Eastern Sierra Native Seed Zone Project in cooperation with the University of California WMRS, Eastern Sierra Institute for Collaborative Education, Bureau of Land Management and the Inyo National Forest (S. Szewczak, PI). The main goals of this project are to determine the amount of ecotypic variation in native perennial bunch grass species through in and ex situ common garden experiments, electrophoresis analyses and biotic site characterization to facilitate the development of seed collection zones for on-going and future revegetation projects.

In 1999, there were also over 50 different species of eastern Sierra native plants grown at the Deepest Valley Cooperative Native Plant Propagation Center. Some of these were uncommon, and not known to have been grown "in captivity" before. The Bristlecone Chapter of the California Native Plant Society grew approximately 1200 plants for their successful native plant sale. 2000 willow and cottonwood cuttings were grown for the Inyo National Forest for revegetation of the Division Creek fire. 200 *Lupinus padre-crowleyii* were also grown for the Inyo National Forest for a revegetation project on the Coyote plateau. 200 *Atriplex canescens* cuttings were propagated for the Bureau of Land Management Bishop (BLM) Field Office for a revegetation project in the Fish Slough area.

4. **Botany Laboratory.** The Forest Health Monitoring Program (FHM) moved into this laboratory in 1999. This program is an interagency/university research team charged with assessing the condition and trends of the nation's forest resources. The WMRS team is organized by Dr. Susan Szewczak and includes two researchers, Peter Nietlich and Linda Hasselbach (NPS). The program uses a nationwide, intensive assessment grid including thousands of plots and covering every forested ecosystem in the country. FHM currently works in 31 states and is slated by Congress for expansion into all remaining states over the next five years. The program includes indicators of forest health such as lichen communities, foliar damage, ozone, soils, and crown mensuration/transparency, and involves a collaboration of approximately 20 research institutions and several agencies. Epiphytic lichen communities have been chosen as a core indicator of the program because they directly address such key assessment questions as air quality trends, effects of air quality on biodiversity, long-term climate change, and sustainability of timber production

2. ADVISORY COMMITTEE MEMBERS

Prof. Bickler assumed the chair of the Advisory Committee following Prof. Sally Holbrook (UCSB) who rotated off the committee. New campus representatives included Prof. Reichman replacing Prof. Holbrook, Prof. Droser replacing Prof. Mark Chappell (UCR) and Prof. Kohn replacing Prof. Ted Case (UCSD).

- Phillip E. Bickler, Department of Anesthesiology, UC San Francisco, Committee Chair
- Diane Campbell, Department of Ecology and Evol. Biology, UC Irvine
- Mary Droser, Department of Biology, UC Riverside
- Martin L. Cody, Department of Biology, UC Los Angeles
- Gary Ernst, Member-at-large, Dept. Geological & Environmental. Science, Stanford University

- Joshua Kohn, Department of Biology, UC San Diego
- Mathias Kondolf, Department of Environmental Planning, UC Berkeley
- Carol McClain, Multicampus Research Planning & Programs, UC Office of the President
- James McClain, Geology, UC Davis
- Kenneth A. Nagy, Organismic Biology, Ecology and Evolution, UC Los Angeles
- Edwin P. (Phil) Pister, Member-at-large, Calif. Dept. of Fish and Game Emeritus
- Powell, Frank L., WMRS/Medicine, UC San Diego
- O. J. Reichman, NCEAS/Dept. of Ecology, Evolution & Marine Biology
- John Smiley, Division of Natural Sciences, UC Santa Cruz and Landells Hill Big Creek Reserve
- Steven J. Wickler, Member at large, Dept. of Animal & Veterinary Science, Cal Poly Pomona.

3. ACTIVE WMRS FACULTY MEMBERS

a. U.C. Faculty. In 1998/99, four faculty from four UC campuses are receiving WMRS support:

1. Peter A. Bowler, Assoc. Adj. Prof. of Ecology & Evolutionary Biology, Course Coordinator for 1999 Environmental Biology Supercourse.
2. Kimberly A. Hammond, Asst. Prof. of Biology, UCR - WMRS Assistant Research Scientist.
3. Scott A. Hodges, Asst. Prof. of Ecology, Evolution and Marine Biology, UCSB - WMRS Assistant Research Scientist.
4. Frank L. Powell, Prof. of Medicine, UCSD - WMRS Director.

b. U.C. Professional Researchers:

In 1999, five professional researchers were based at the station:

1. Eric L. Berlow, Ph.D. – WMRS Assistant Research Scientist
2. Joseph M. Szewczak, Ph.D. - Assistant Research Physiologist, Dept. of Medicine, UCSD
3. Susan M. Szewczak, Ph.D. - WMRS Academic Coordinator
4. Rob R. Ramey, Ph.D. – WMRS? Assistant Project Scientist
5. John D. Wehausen, Ph.D. - WMRS Associate Research Scientist

Appointments for two more WMRS researchers are pending external funding for their salaries:

1. Angela Jayko, Ph.D. - Associate Research Scientist, pending NSF/ITR funding 1/1/01.
2. William Riley, Ph.D. – Assistant Research Scientist, pending NSF funding 7/1/00.

4. GRADUATE STUDENTS AND POSTDOCTORAL RESEARCHERS

a. Postdoctoral trainees were not officially supported by WMRS, although several trainees worked with UC and non-UC researchers using the facilities.

b. WMRS graduate student Fellowships. Graduate student research proposals were reviewed by the Advisory Committee. In 1999, sixteen awards were made for a total of \$21,229 including carry forward from 1998. \$8,689 was given as a cash award for travel and \$12,540 was given as credit vouchers for room and board at the station. The awards were:

- Alstad, Karrin, \$2,000 (Northern Arizona University): “Cellulose isotopic indicators of historical water-use by riparian species following an altered hydrologic regime”, (Stephen Hart, Ph.D., Advisor).
- Bacon, Steven, \$630 (Humboldt State University): “Paleoseismic Owens Valley Fault”, (John Longshore, Ph.D., Advisor).
- Barash, Ilona, \$1,990 (UC, San Diego): “The effects of oxygen enrichment on objective measurements of sleep quality after rapid ascent to high altitude”, (John West, M.D., Ph.D., Advisor).
- DiSalvo, Angela, \$2,000 (Northern Arizona University): “Effects of stream flow diversion on riparian community structure and productivity in Bishop Creek, Inyo County, CA”, (Stephen Hart, Ph.D., Advisor).
- Floyd, Chris, \$645 (UC, Davis): “Marmots on mountain tops: using genetic markers to test a biogeographics paradigm”, (Dirk Van Vuren, Ph.D., Advisor).
- Gaines, Robert, \$925 (UC, Riverside): “Where Burgess Shale faunas burrowed away?”, (Mary Droser, Ph.D., Advisor).
- Kleier, Catherine, \$1,360 (UC, Los Angeles): “Determination of cushion plant Morphology”, (Philip Rundel, Ph.D., Advisor).
- McFadzean, Peter, \$1,500 (University of Edinburgh): “The mechanics of fault linkage in extensional settings”, (Patience Cowie, Ph.D., Advisor).
- Saltikov, Chad, \$925 (Irvine): “The prevalence and distribution of *arsA*, *arsB*, and *arsC* of the *E. coli* *ars* operon in bacteria originating from arsenic enriched water”, (Betty Olson, Ph.D., Advisor).
- Smeltzer, Matthew W., \$1,200 (UC Berkeley): “Fluvial geomorphology and river ecosystem restoration planning”, (G.M. Kondolf, Ph.D., Advisor).
- Stallman, Elizabeth, \$2,000 (University of Michigan): “The effects of female-female competition on female reproductive success in yellow-bellied marmots”, (Warren Holmes, Ph.D., Advisor).
- Van de Ven, Christopher, \$1,200 (Stanford University): “The White-Inyo Mountain, Eastern California: Influence of bedrock and altitude on soil development and botanical cover”, (W.G. Ernst, Ph.D., Advisor).

- Vines, John A., \$1,584 (VA Polytech): “The development of stretching lineations and strain path within the Santa Rita shear system, east-central California”, (Richard D. Law, Advisor).
- Webster, Mark, \$1,400 (UC, Riverside): “Paleobiologic aspects of olenelloid trilobites from the lower cambrian pre-bistolia zonule of the White Inyo Mtns and western Great Basin”, (Nigel Hughes, Ph.D., Advisor).
- Wenner, Jennifer, \$1,060 (Boston University): “The role of high-silica granites in the Sierra Nevada as end members in a mixing process that generates average continental crust”, (Drew S. Coleman, Ph.D., Advisor).
- Yturralde, Kasey, \$1,339 (Sonoma State University): “mate choice in a montane leaf beetle *Chrysomela aeneicollis*”, (Nathan Rank, Ph.D., Advisor).

c. Graduate Students Involved in the Unit’s work.

- Anne Rankin (Dept. of Ecology and Evolutionary Biology, UCI) was the Teaching Assistant for the WMRS Supercourse in Environmental Biology.
- Natahlie Garcia (University of Paris Ph.D. Candidate) was hosted by WMRS to work in Prof. Frank Powell’s laboratory at UCSD and at WMRS. She was supported by funding from France, the American Alpine Club and the Wilderness Medical Society.

5. STUDENT AND FACULTY PARTICIPATION FROM OTHER CAMPUSES OR UNIVERSITIES

In 1999, the total number of “user nights” at all sites by non-UC institutions increased to 5,308 (from 3,612 in 1998) representing 80 institutions. The number of UC user nights decreased some (3,524 in 1999 vs. 3,992 in 1998) although 1998 was the largest number of UC user nights that WMRS has ever hosted, growing from 1,150 in 1995.

User nights by institution

	1995	1996	1997	1998	1999
UC	24%	25%	47%	52%	40%
non-UC	76%	75%	53%	48%	60%

There were 25 field classes, field trips, and workshops from non-UC institutions compared to 9 from UCD, UCLA, UCR and UCSD and 5 extension classes from UCB, UCR, and UCSC.

6. NUMBERS AND FTE OF ACADEMIC RESEARCH PERSONNEL, TECHNICAL STAFF AND ADMINISTRATIVE PERSONNEL¹

		FTE
Director		
Powell, Frank	Director	0.50
Asst. Res. Sci. 11-mos²		
Bowler, Peter	Supercourse Coord.	0.33
Hammond, Kim	Res. Scientist	0.33
Hodges, Scott	Res. Scientist	0.33
Academic Subtotal (Sub 00)		1.50
Campus Office Staff		
Fager, Barbara	Admin. Specialist	1.00
Jamous, Cecilia ³	Admin. Asst. II	0.53
Campus Subtotal (Sub 01)		1.53
Station Staff		
Hetzler, Scott	Lead Groundskeeper	1.00
Masters, Richard	Auto. Mechanic Senior	0.75
Patrick, Cecil	Principal Cook	1.00
Shinn, Donna	Admin. Asst. III	1.00
Trydahl, David	Sr. Super. of PPS	1.00
Station Subtotal (Sub 01)		4.75
Total FTE		7.78

¹ Casual employees; office help, seasonal cooks carpenters, building maintenance workers, laborers are essential for support during heavy research use in the summer season.

² The Assistant Research Scientist (1) FTE is an unfilled position used for rotating support of UC faculty to seed long-term research programs at WMRS.

³ The Executive Assistant to the Director had an upward reclassification to an Admin. Asst. II, effective 7/1/99.

7. PUBLICATIONS

Research at WMRS resulted in 50 publications in 1999 including 1 Ph.D. and 1 M.S. thesis based on research at the Station. The full list of WMRS-related publications is being organized in a searchable database that will be available on our web site.

1. Berlow, E.L., S.A. Navarrete, C.J. Briggs, M.E. Power, and B.A. Menge. 1999. Quantifying variation in the strengths of species interactions. *Ecology* 80(20):2206-2224.
2. Berlow, E.L. and C.M. d'Antonio. 1999. Factors controlling sagebrush establishment in montane meadows after cessation of livestock grazing. (presented at the Ecological Society of America 1999 Annual Meeting, spokane, WA.) *Bulletin of the Ecological Society of America*, v.79.
3. Boyce, W.M., R.R. Ramey II, T.C. Rodwell, E.S. Rubin, R.S. Singer. 1999. Population subdivision among desert bighorn sheep (*Ovis canadensis*) ewes revealed by mitochondrial DNA analysis. *Molecular Ecology*, 8: 99-106.
4. Brown, L.B. and M.R. Dwinell. 1999. Chronic hypoxia does not change in situ lung static mechanics in rats. *FASEB J.* 13:164.3, A166.
5. Buchholz, J., K. Edwards-Teunissen, and S.P. Duckles. Impact of development and chronic hypoxia on NE release from adrenergic nerves in sheep arteries. *Am. J. Physiol.* 276:R799-R808, 1999.
6. Burwell, Trevor A. 1999. Environmental history of the lower montane Pinyon (*Pinus monophylla*) treeline. Eastern California U. of Wisconsin-Madison. Ph. D. Thesis.
7. Coleman, D.S., J.M. Wenner, and A.F. Glazner. 1999 (invited). The role of hydrous mafic magmas in the generation of the Sierra Nevada batholith and their interaction with high-silica magmas: *Geological Society of America Abstracts with Programs*. v.31, no. 2, p. 68.
8. Ducsay, C.A. Hypoxia, effect on reproduction. *Encycl. Reprod.* 2:769-775, 1999.
9. Elmore, A.J., J.F. Mustard, S.J. Manning, and D.B. Lobell, In Press. Quantifying Vegetation Change in Semi-Arid Environments: Precision and Accuracy of Spectral Mixture Analysis and the Normalized Difference Vegetation Index. *Remote Sensing of Environment*.
10. Farmer, G. L., A. F. Glazner, and C. R. Manley. 1999. Late Cenozoic volcanism and tectonic evolution of the southern Sierra Nevada: *Geological Society of America Abstracts with Programs*. v. 31, p. A481.
11. Fulton, M. and S.A. Hodges. 1999. Floral isolation between *Aquilegia formosa* and *A. pubescens*. *Proceedings of the Royal Society of London, Series b.* 266: 2247-2252.
12. Garcia, N., S.R. Hopkins, and F.L. Powell. 1999. Effects of intermittent vs. continuous hypoxia on the isocapnic hypoxic ventilatory response in man. *Am. J. Crit. Care and Resp. Med.* 159; S44.
13. Garcia, N., S.R. Hopkins, and F.L. Powell. In Press. Effects of intermittent hypoxia on the isocapnic hypoxic ventilatory response and erythropoiesis in normal humans. *Respir. Physiol.*
14. Garcia, N., S.R. Hopkins and F.L. Powell. In Press. Intermittent versus continuous hypoxia: effects on ventilation and erythropoiesis in man. *Wilderness Env. Med.*

15. Gerard, A.B., M.K. McElroy, M.J. Taylor, I. Grant, F.L. Powell, S. Holverda, N. Sentse and J.B. West. In Press. 6% oxygen enrichment of room air at simulated 5000m altitude improves neuropsychologic function. *High Alt. Med and Bio*.
16. Glazner, Allen F., John M. Bartley, and Brian S. Carl, 1999. Oblique opening and noncoaxial emplacement of the Jurassic Independence dike swarm, California: *Journal of Structural Geology* 21, 1275-1283.
17. Greene, Holly M. and Steven J. Wickler, , March 2000. Acute Altitude Exposure (3800 Meters) and Metabolic Capacity in the Middle Gluteal Muscle of Equids: *The Journal of Equine Veterinary Science*. Vol. 20, No.3.
18. Greene, H. M., S. J. Wickler, T. P. Anderson, E. A. Cogger, C. C. Lewis, A. Wyle. 1999. High-altitude effects on respiratory gases, acid-base balance and pulmonary artery pressures in equids. *Equine Exercise Physiology* 5, *Equine vet. J. Suppl.* 30: 71-76.
19. Hershler, R. and D.W. Sada. In Press. Biogeography of Great Basin freshwater snails of the genus *Pyrgulopsis*. In Press, *Smithsonian Contributions to Earth Science*.
20. Hu, X-Q, S. Yang, W.J. Pearce, L.D. Longo, and L. Zhang. Effect of chronic hypoxia on alpha-1 adrenoreceptor-mediated inositol 1,4,5-trisphosphate signaling in ovine uterine artery. *J. Pharmacol. Exper, Therap.* 288:977-983, 1999.
21. Huey, K.A, and F.L., Powell. In Press. Time-dependent changes in dopamine D2-receptor mRNA in the arterial chemoreflex pathway with chronic hypoxia. *Molec. Brain Res.*
22. Jayko, A.S., and D.W. Pritchett. 1999. Regional 1:100,000 mapping of Quaternary units from SPOT images and 30-m DEM's, in Slate, J. L. editor, *Proceedings of Conference on Status of Geologic Research and Mapping in Death Valley National Park, Las Vegas, Nevada, April 9-11, 1999*: U.S. Geological Survey Open-File Report 99-153, p. 106.
23. Jayko, A.S., M. Essington, B. Heise, H.E. Johnson, P.W. Mc Grath, D.W. Pritchett, G. Saucedo, R. Thompson, and D. Wagner. 1999. Status of geologic mapping in Death Valley National Park , in Slate, J. L. editor, *Proceedings of Conference on Status of Geologic Research and Mapping in Death Valley National Park, Las Vegas, Nevada, April 9-11, 1999*: U.S. Geological Survey Open-File Report 99-153, p. 5.
24. Jayko, A.S., and D.W. Pritchett. 1999. Estimate Of Late Quaternary Denudation Rate, Death Valley Area, Eastern California: *EOS American Geophysical Union*, v. 80 p. 443.
25. Kaiser, F.G., M. Ranney, T. Hartig, and P.A. Bowler. 1999. Ecological Behavior, Environmental Attitude, and Feelings of Responsibility for the Environment. *European Psychologist*, 4 (2): 59-74.
26. Lewis, A.M., O. Mathieu-Costello, P.J. McMillan, and R.D. Gilbert. Quantitative electron microscopic study of the hypoxic fetal sheep heart. *The Anatomical Record* 256:381-399, 1999.
27. Lewis, A.M., O. Mathieu-Costello, P.J. McMillan, and R.D. Gilbert. Effects of long-term, high-altitude hypoxia on the capillarity of the ovine fetal heart. *Am. J. Physiol.* 277:H756-H762, 1998.
28. Long, W. Y. Zhao, L Zhang, and L.D. Longo. 1999. Role of Ca²⁺ channels in NE-induced increase in [Ca²⁺]_i and tension in fetal and adult cerebral arteries. *Am.J. Physiol.* 277 (Regulatory Integrative Comp. Physiol. 46): R286-R294.

29. Menge, Bruce A., Eric L. Berlow, Carol A. Blanchette, Sergio A. Navarrete and Sylvia B. Yamada, 1994. The Keystone Species Concept: Variation in Interaction Strength in a Rocky Intertidal Habitat: Ecological Monographs, pp.249-286.
30. Millar, C. I. And W.B. Woolfenden. 1999. The role of climate change in interpreting historical variability, Ecological Applications 9(4): 1207-1216.
31. Millar, C. I. And W.B. Woolfenden. 1999. Sierra Nevada Forests: Where did they come from? Where are they going? What does it mean? Trans. 64th No. Am. Wildl. and Resour. Conf. 206-236.
32. Mathieu-Costello, O., P.J. Agey and J.M. Szewczak. In Press. Capillary-to-fiber structure in pectoralis muscle of the microchiropteran bat, *Eptesicus fuscus*, acclimated to altitude. Am. J. Physiol.
33. Morgan, S.S., 1999, Barcroft structural break, White Mountains, CA: Insight into the emplacement of the Sierra Nevada Batholith, Geological Society of America Abstracts with Program, A-235.
34. Nice, C.C. and A.M. Shapiro., 1999. Molecular and morphological divergence in the butterfly genus *Lycaeides* (Lepidoptera: Lycaenidae) in North America: evidence of recent speciation. J. Evol. Biol. 12: 936-950, 1999.
35. Seeliger, Curt. 1999. Dark Septate Endophyte and Vesicular Arbuscular Mycorrhizal Infections in *Carex* Occurring in Chiatovitch Canyon, White Mountains Range, Nevada and California. Cal. State Univ., Humboldt, M.A. Thesis.
36. Pearce, W.J., S.P. Duckles, and J. Buchholz. Effects of maturation on adrenergic neurotransmission in ovine cerebral arteries. *Am. J. Physiol.* 277:R931-R937, 1999.
37. Powell, F.L., K.A. Huey and M.R. Dwinell. In Press. Central nervous system mechanisms of ventilatory acclimatization to hypoxia. *Respir. Physiol.*
38. Sada, D.W. In Press. Natural history of native fishes east of the Sierra Nevada, California. Chapter 7, In, G. Smith (editor), Natural History of the Eastern Sierra Nevada, California. University of California Press.
39. Sada, D.W. and G.L. Vinyard. In Press. Anthropogenic changes in historical biogeography of Great Basin aquatic biota. In Press, Smithsonian Contributions to Earth Science.
40. Szewczak, J.M., 1999, Hypoxic hypometabolism and thermal conductance. *FASEB Journal*, 13:A495.
41. Szewczak, J.M. and F.L. Powell. 1999. Arterial blood gas and acid-base state in C57 mice during normoxia and hypoxia. *Am.J.Crit. Care and Resp. Med.*, 159: A842.
42. Stallman, E.L. and W.G. Holme. In Preparation. Selective foraging and food distribution of alpine yellow-bellied marmots (*Marmota flaviventris*). *Journal of Mammalogy* .
43. Wenner, J.M. and D.S. Coleman. 1999. Limits on the water content of basaltic magmas involved in magma mixing: Geological Society of America Abstracts with Programs, v. 31, no. 7.
44. Van de Ven, C., W.G. Ernst, and R.J.P. Lyon. In Press. Early mineralogical results from AVIRIS data over the White-Inyo Mountains: Jet Propulsion Laboratory AVIRIS Earth Sci. Applications Workshop, Feb. 8-11, 1999.

45. Vines, J. 1999, Emplacement of the Santa Rita Flat pluton and kinematic analysis of cross cutting shear zones, eastern California. Virginia Polytechnic Institute and State University. MS Thesis.
46. Wehausen, J.D., and R.R. Ramey II. 2000. Cranial morphometric and evolutionary relationships in the northern range of *Ovis canadensis*. *Journal of Mammalogy* 81:145-161.
47. Wenner, J.M. and D.S. Coleman. 1999. A mathematical mixing model using hydrous high-alumina arc basaltic magmas: Geological Society of America Abstracts with Programs, v. 31, no. 2.
48. West, J.B. 1999. Commuting to high altitude. *Adv. Exp. Med. Biol.* 474:57-64.
49. West, J.B. 1999. Recent advances in human physiology at extreme altitude *Adv. Exp. Med. Biol.* 474: 287-296, 1999.
50. Xiao, D., Y. Liu, W.J. Pearce, and L. Zhang. Endothelial nitric oxide release in isolated perfused ovine uterine arteries: effect of pregnancy. *Eur. J. Pharmacol.* 367:223-230, 1999.

8. INCOME

The table below shows the WMRS budget for fiscal year 1998/99. Not included are the federal and state contracts and grants awarded to individual investigators using WMRS. The 1999 annual total for these awards was \$5.74. This includes \$459,609 to UC faculty and \$1.49M to non-UC faculty for research directly involving WMRS (*i.e.* the work would be impossible without the Station).

INCOME	1998/99
1. Fed/State contracts & grants (includes carry forward FY97/98)	\$92,876
2a. Recharge income	\$172,605
2b. Gifts and endowments	\$9,193
3a. UC appropriation	\$720,499
3b. UC grants	\$2,200
TOTAL	\$997,373

9. EXPENDITURES

Expenditure directly related to research includes 1. Academic Personnel (listed in section 3. Active WMRS Faculty), 2. Graduate Student Fellowships, and expenses under 7. Operations and Supplies covered by Income through Federal/State contracts and grants (see 1. on Income table above). Administrative and physical plant expenses account for the rest of the expenditures. This includes 3. Station Staff and 4. Campus Staff (shown on Table 6. above) plus temporary office help and seasonal cooks, carpenters, building maintenance workers and laborers who are essential during heavy research use in the summer season. 5. Benefits are lumped for all personnel. 6. Other support costs are grouped Campus supplies, equipment, and travel costs and 7. Station operations and supplies: this includes “fixed expenses” for running four separate operations for utilities, facility improvements, vehicle maintenance, insurance, land leases, in addition to station office expenses. 7. Operations and Supplies includes “variable” expenses related to station use, such as food, linens, non-inventoried equipment, physical plant and.

b. EXPENDITURES	
1. Academic pers. (sub 0)	\$162,338
2. Grad. Fellows/TAs	19,020
3. Station Staff (sub 1 & 2)	342,910
4. Campus Staff (sub 1 & 2)	53,269
5. Benefits (sub 6)	115,417
6. Campus Supplies, Equipment & Travel	12,953
7. Station Supplies, Equipment & Travel	326,437
TOTAL	\$1,032,344

This budget left a deficit of \$34,971 that was covered by improvement funds obtained previously for developing the Crooked Creek facilities. The deficit was less than that projected for 1998/99 to finish the Crooked Creek improvements but the improvements were not completed. A new budget analysis indicates that the improvements cannot be completed within the original budget and raises questions about the ability to sustain routine maintenance on all of the facilities at “build out”. Hence, we are re-evaluating the degree and nature of the improvements at Crooked Creek that are necessary to support on-going programs and their fiscal soundness. It is imperative that we do not deplete our \$100,000 contingency, which is essential for the safe and continuous operation of WMRS facilities, given the remote and hostile nature of the high altitude mountain environment.

10. SPACE

No new space was added in 1999. Progress was made on improving the Manis laboratory, finishing more of the buildings at Crooked Creek and relocating portions of the library in Owens Valley Laboratory.

The WMRS office at UCSD (11.1 m²) is provided by the Dept. of Medicine in the Medical Teaching Facility. The Station’s main facilities are located near Bishop, CA on land leased from the Los Angeles Dept. of Water and Power, or used under a special use permit from the U.S. Forest Service. The Station consists of 4 facilities located over a 3,100 m (>10,000 foot) vertical transect from the floor of the Owens Valley to the summit of White Mountain.

Owens Valley Facility (1,235 m): Owens Valley facility consists of a 230 m² office-kitchen-dining building and 2 classrooms (80 and 87 m²). A 116 m² machine/vehicle shop is housed in what was once a helicopter hanger. Three dormitories and 7 trailers provide the bulk of the living quarters and bathroom facilities (393 m²) for approximately 60 persons. One long-term research residence suitable for a family is also on site. Camping areas are available in overflow times (May-September). Open storage and storage units account for another 269 m² of space. Kitchen facilities for large groups are separated from a small kitchen set aside for individual users of the Station. **The Manis Laboratory** is divided into two rooms and has an attached animal facility (22 m²). The main room currently has 11 m of wet bench space, propane gas and vacuum, plumbing for compressed gases, microscopes, dissecting microscopes, chemical reagents, balances, glassware, spectrophotometer, and drying ovens. In addition this part of the Manis Laboratory has been equipped with new equipment for molecular biology as described above. The other room in the Manis laboratory (19 m²) is currently occupied by Dr. Joe Szewczak as a *respiratory physiology lab*. This includes respiratory physiology equipment to measure ventilation, metabolism, and blood gases in small animals; physiological recorders and computers for A-D data collection and analysis. **The GIS Laboratory** consists of 5 client PC GIS workstations, a high-end Internet/GIS server, and 2 internet linked Macintosh computers, laser printers, a color scanner, digitizer, and plotter. Software packages allow for complete GIS capability to provide GIS maps and query capabilities through a USGS/SDI clearinghouse web site. Remote Sensing Applications are supported by Erdas Imagine software. **The Herbarium and Biological Library** are housed in a the *Botany Lab* (37 m²). Over 1,200 more specimens are contained in the Bishop herbarium. **The Geology Library and Trilobite Collection** are housing in the *Geology Lab/Office trailer* (37 m²). The total library holdings include approximately 800 scientific books and another 700 scientific research articles. **Deepest Valley Native Plant Propagation Center** is a

collaborative project with the University of California, Bureau of Land Management, US Forest Service and the Los Angeles Department of Water and Power includes a greenhouse and shadehouse for native seed propagation. This facility allows researchers to germinate and propagate native plant under controlled conditions.

Crooked Creek Facility (3,094 m altitude): The renovated Crooked Creek facility consists of housing for approximately 60 researchers and students in the two-story Clarence A. Hall Jr., Lodge and four smaller cabins under construction. When complete, each cabin has two rooms two bathrooms and can sleep 8 people. Two cabins have kitchenettes, and are suitable for use by long-term researchers with families. The bedroom in one cabin room is being set for meetings instead of sleeping. The Lodge consists of a dormitory and an adjoining common facility that has a kitchen, dining and assembly room, large meeting room and housing for staff and several researchers. Partially covered outdoor patio/decking provides an additional 279 m² of space. The existing original structures (kitchen, dining, two bedrooms, and two baths) were converted into a new research laboratory (121 m²) separated into three rooms for research, teaching and animal housing. Furthermore, researchers have access to a fully equipped shop (90 m²). Fully automated weather data acquisition equipment is located at this facility. Foundations are in place and logs have already been purchased for the construction of two more cabins when there is sufficient user demand.

Barcroft Facility (3,801 m altitude): The Barcroft facility consists of main laboratory building (Nello Pace Laboratory) is a two story Quonset hut (1300 m²) that contains living quarters (for approximately 50 researchers), kitchen, shop, dining area, storage area, an office and three laboratories and includes a room in which the oxygen environment can be controlled to simulate altitudes from 3,000-5,500 m. Other buildings include a remodeled animal building (44 m²), a separate laboratory (36 m²), and two cement block/Quonset buildings (total of 62 m²) used for storage and garages. Fully automated weather data acquisition equipment is located at this facility also.

Summit Facility (4343 m altitude): This 42 m² laboratory consists of living quarters for four and a small laboratory area. The living quarters are stocked and maintained at all times. It is supplied by the Barcroft Facility, 8 km to the south and powered by generators or solar power as necessary.