Title: "A Microclimatic Profile from the Snake River Canyon to the St. Joe Mountains", by Prof. Richard L. Day, Chief Investigator

The physical facilities of this study include thermographs and hygrothermographs, principally the latter, plus maximum and minimum thermometers, placed in specially constructed instrument shelters at eighteen sites (besides the station at the College of Mines Building, University of Idaho, Moscow) through a distance of about 65 miles between Uniontown, Washington, in the Snake River Canyon, and Freezeout Mountain, about ten miles east of Clarkia, Idaho. Recording rain and snow gauges are now in place at five of these sites and simple measuring gauges at six others. Two of the stations, those on Bald Mountain (5330 feet) and Freezeout Mountain (about 5950 feet) are operated in summer only. There is some prospect that arrangements can be made with J. Martin Rosa, Resident Hydraulic Engineer with the Agricultural Engineering Department, who is engaged in a snow-pack study, for servicing the station on Bald Mountain monthly during the coming winter. The recording rain and snow gauge on Moscow Mountain (Palouse Range) is already being serviced throughout the winter by workers associated with Prof. Alan C. Robertson of the Agricultural Engineering Department, who is developing instruments for remotely measuring water content of the snow pack.

Basic temperature, relative humidity, and precipitation data are summarized monthly and annually in the manner shown on the attached sample data sheets. Distribution of this material is made regularly to about fifty interested Federal government offices, University personnel, and individuals.

Much of the chief investigator's time during the past year has been utilized in the initial compilation of data, and in the servicing, cleaning, adjusting, and calibrating of instruments, tasks which must be performed continuously. As a result of certain instrumental and other difficulties, the record has been interrupted from time to time at a number of stations, and at no time has it yet been possible to secure simultaneous records at all eighteen stations.

Many of the instruments used in this investigation have been purchased by the chief investigator and he has financed all clock repairs on these instruments. The latter has been done to reduce the time hygrothermographs are out of service due to malfunctioning clocks from weeks or months to a few days. A few of the instruments were purchased by the College of Mines, University of Idaho, but most of their funds have been devoted to building up the University weather station. A tabulation is made on a separate page listing instruments purchased from each source of funds.

Records, principally of precipitation, maintained at additional sites by the U. S. Soil Conservation Service, Weather Bureau, and Messrs. Rosa and Robertson are being utilized in this study.

Preliminary Findings

Whereas the precise location of a U. S. Weather Bureau cooperative station is usually dictated by where a voluntary observer can be found, it has been possible to follow the opposite approach in the present study. The desired sites for stations have been identified and then permission has been sought from the landowners to place our instruments at these locations. In every case we have been able to locate the station at the desired site, for the landowners have been most helpful and interested in our project.

Considerable experimentation was carried on prior to settling upon the final distribution of stations. As a result, it is felt that we have been able to develop an especially significant station pattern, and that we are therefore securing an unusually complete and accurate picture of the variations existing in local climates along the profile. Actually, five of the eighteen stations have been placed somewhat out of the direct line between Wawawai and Freezeout Mountain for the purpose of determining how representative our selection of stations is for a larger area.

Wawawai, Washington, is downstream from Lewiston, Idaho, being about 30 miles northwest, and almost 100 feet lower in altitude. Wawawai's precipitation is, however, considerably greater than at Lewiston, averaging about 19 inches a year compared with Lewiston's 13¾ and Moscow's 22½. Wawawai temperatures average two to three degrees warmer than downtown Lewiston in winter, mostly because of the considerably warmer winter nights. By contrast, summer temperatures average about the same at the two locations, although summer day maxima average two degrees lower and the summer night minima average two degrees higher at Wawawai than in downtown Lewiston. In winter, Wawawai is warmer and wetter than any place either upstream or downstream along the Snake River. Snowfall is less than at any other locality east of the Cascade Mountains, the long term average being only six inches for the entire winter season.

In summer, the nighttime minima at elevation 1300 feet in Wawawai Canyon (a small tributary canyon to the main Snake River Canyon), 5 miles southeast and more than 800 feet above Wawawai on the Snake River, average higher than any other station along the profile. This 1500-foot elevation marks the average top of the nocturnal inversion in the canyon complex. On individual nights, minima may be as much as 12° warmer than at river level, but the mean difference is about 3°. However, daytime maxima average about 5° cooler at the higher elevation. In winter, the nocturnal temperature inversions are much less frequent and of smaller magnitude.

The ridge or rim overlooking the Snake River Canyon at elevation 2500 feet above Wawawai apparently experiences very little more precipitation than the canyon bottom, over 1800 feet below. Difficulties have been experienced in securing a satisfactory precipitation record so far at the exposed rim location, but it is expected that this problem can be overcome in the near future. Summer night minimum temperatures average only about two degrees lower on the rim than at the bottom of the Snake River Canyon and some nights are warmer. Daytime maxima average nearly ten degrees cooler on the rim.

Union Creek Flat, a shallow valley averaging only about 300 feet deep on the plateau about five miles northeast of the rim of the Snake River Canyon, experiences a much stronger nocturnal temperature inversion than does the deep canyon on clear nights. Sometimes the temperature is as much as 20° lower on summer nights on Union Creek Flat than on the rim. The average differential is about ten degrees. Daytime maxima are approximately the same at both places.

As one moves farther eastward across the Palouse plateau, nights become still colder, although very little elevation is gained. A valley flat only two hundred feet higher but 35 miles east-northeast of Union Creek Flat, specifically Dry Creek (also designated "Subalpine Fir Meadow) halfway between Troy and Deary, Idaho, averages five to ten degrees colder than Union Creek Flat. Simultaneous records at the two locations have not yet been kept long enough to ascertain the exact difference. Daytime maxima average about the same at the two places.

Warmest location on the Palouse plateau on summer nights is a ridge at elevation 3150 feet, four miles north and nearly 600 feet above Moscow, Idaho. At times the minima are higher here than at the inversion level in the Snake River Canyon, although they average about four degrees cooler in summer. For example, on July 31, 1965, the minimum temperature on this ridge was 78°, warmest night of the entire summer in the Pacific Northwest, and 34° warmer than on the flat adjacent to the Palouse River just east of Potlatch, Idaho, ten miles northeast of the ridge in question, at elevation 2510 feet. The average difference between these two locations appears to be about 12° in summer.

Precipitation increases at an accelerated rate up the valley of the Palouse River from Potlatch to Bald Mountain. The pattern along the profile for the month of August 1965 was as follows: Wawawai, 0.66 inch; Wawawai Ridge (rim of Snake River Canyon 4 miles southeast), 0.75 inch; Univ. of Idaho, Moscow, 1.06

inches; Potlatch valley flat, 2.28 inches; Harvard valley flat, 2.66 inches; 1 mile south of giant white pines, 2.84 inches; Emida Ridge (North-South Ski Bowl), 3.00 inches; and Bald Mountain, 5.15 inches.

For the July 1965 - June 1966 year, precipitation gained only one-half inch in the twenty miles between Wawawai and Moscow (13.51 to 13.98 inches), but 7½ inches, from 16½ to 24 inches, between the station near Potlatch and a point 7½ miles northeast near the giant white pines, but still three miles from Bald Mountain where no record could be kept during the winter months. Elevation at the giant pines is also 2500 feet lower than the summit of Bald Mountain.

In the valleys northeast of Harvard, Idaho, and east of the station at Dry Creek halfway between Troy and Deary, Idaho, nighttime valley flat minimum temperatures show no further decline during the summer, but do show an additional decrease of up to five degrees in monthly averages during the winter. Key station in this case is 2½ miles north of Bovill, Idaho, and another is sometimes operated near the giant white pines six miles north of Harvard, Idaho.

Diurnal temperature and relative humidity curves on the ridge four miles north of Moscow (elev. 3150 feet) and on the summit of Bald Mountain (5330 feet) often show significant departures from those at most other stations during the summer months. The normal diurnal temperature curve is characterized by a steady decline throughout the night to a minimum at sunrise. However, on the ridge north of Moscow during clear, calm summer weather, the temperature may cease to drop about an hour after sunset and then remain steady for most of the night, until an abrupt dip of perhaps eight or ten degrees occurs around sunrise. The relative humidity remains very low throughout most of the night, instead of steadily increasing as is normal at most stations. In fact, the relative humidity sometimes declines to a slightly lower level at about midnight than during the afternoon hours. On occasion, late evening relative humidities may be near 20% on this ridge while simultaneously approaching 100%, often with low fog, in the valleys

east of Harvard and Troy.

On Bald Mountain, during calm, clear weather, the temperature decline frequently ceases altogether shortly after sunset, and the temperature remains perfectly steady until sunrise. The sudden dip observed at sunrise on the ridge north of Moscow is not recorded on Bald Mountain. Relative humidities on the mountain show either very little variation from day to night under such circumstances, or otherwise highly irregular variations, with abrupt decreases or increases at almost any time of day or night. Sometimes the minima on Bald Mountain are actually higher than at Wawawai in the Snake River Canyon at these times. Records have been only started in July 1966 on Freeseout Mountain. Results there are awaited with great interest.

INSTRUMENTS USED ALONG PROFILE

1. Water Resources Research Institute Funds:

Four (4) recording rain and snow gauges

Two (2) standard eight-inch gauges

Five (5) hygrothermographs

Five (5) shelters for hygrothermographs

Two (2) maximum and minimum thermometers

Four (4) platforms for recording rain and snow gauges

Two (2) evaporation recorders

Two (2) sling psychrometers

One (1) hand anemometer

2. Personal Purchases - R. L. Day, Chief Investigator:

Eight (8) hygrothermographs

Two (2) thermographs

Fifteen (15) maximum and minimum thermometers

Twelve (12) instrument shelters

Six (6) four-inch plastic rain gauges

Two (2) sling psychrometers

3. University of Idaho (College of Mines) Funds:
(Note: most of these instruments were purchased for the University weather station)

One (1) recording rain and snow gauge

Two (2) standard eight-inch gauges

One (1) hygrothermograph

Two (2) thermographs

One (1) hygrograph

One (1) standard cotton region Weather Bureau type instrument shelter

One (1) maximum thermometer and one (1) minimum thermometer

3. University of Idaho (College of Mines) Funds - Cont.:

One (1) four-foot evaporation pan, with hook gauge and stilling well

One (1) electric psychrometer

One (1) Aerovane wind direction and velocity recording system

One (1) microbarograph

One (1) pyrehelicmeter

One (1) mercurial barometer

RESEARCH TECHNICAL COMPLETION REPORT
PROJECT ~~A-010-IDA~~
A-012-IDA

A Microclimatic Profile Between the Snake River Canyon and Clearwater Mountains, Idaho

PROJECT INVESTIGATOR - Dr. Richard L. Day
Associate Professor of Geography
College of Mines
University of Idaho
Moscow, Idaho

PERIOD OF INVESTIGATION - July 1965 to July 1968

The work upon which this report is based was supported in part by funds provided by the United States Department of Interior, Office of Water Resources Research as authorized under the Water Resources Research Act of 1964.

Water Resources Research Institute
University of Idaho
July 1968

ABSTRACT

Temperature and relative humidity records have been kept at a maximum of 18 sites, and precipitation records at 8 sites, along a 75-mile profile between Wawawai, Washington, elevation 675 feet in the Snake River Canyon, and Crater Peak, elevation 6400 feet in the Clearwater Mountains, Idaho. Most distinctive microclimatic feature is the extreme development of nocturnal temperature inversions during summer and early autumn. Mean inversions between non-contiguous hilltops and bottomlands may reach 20 to 30 degrees. Greatest recorded on a specific day has been 42 degrees. Mean temperatures, length of frost-free season, nocturnal relative humidities, natural vegetation, and land use are all strongly influenced by these inversions. None of the six official Weather Bureau stations in the vicinity of the profile is located to show these inversions. Diurnal temperature and relative humidity patterns differ greatly at individual sites along the profile and are analyzed and compared. Precipitation normally varies by a factor of at least 3½ along the profile, but may reach several times this value during individual months. Maximum snow depths range from none at Wawawai to 14 feet at Lost Lake near Crater Peak during specific snow seasons.

WR-GEOGRAPHY EXPENDITURES

January 1, 1967 - March 31, 1967

Dr. Richard L. Day

Capitol Outlay:			
Allocation	-	$300.00	
Previous Balance	-	259.47	
Expenditures	-	220.50	
Balance	-		$38.97
Other Expense:			
Allocation	-	220.00	
Expenditures	-	208.00	
Balance	-		12.00
Irregular Help:			
Allocation	-	$600.00	
Previous Balance	-	380.50	
Expenditures	-	88.76	
Balance	-		291.74
Travel:			
Allocation	-	800.00	
Previous Balance	-	514.54	
Expenditures	-	132.86	
Balance	-		$381.68

WR - GEOGRAPHY (HH-2) QUARTERLY REPORT

"A MICROCLIMATIC PROFILE BETWEEN THE SNAKE RIVER CANYON AND CLEARWATER MOUNTAINS, IDAHO"

by Prof. Richard L. Day
College of Mines
Univ. of Idaho

A condensed program of observations was continued at five key stations for precipitation, and eight basic stations for temperature and humidity during the January - March 1968 period, using instruments equipped with 14-day and 31-day clockworks at five more distant locations, and 7-day clockworks at three close-in stations. No travel expense was charged to the Project budget, and only four hours of irregular help was used for observation purposes during the quarter, in order to hold our expenditures within the bounds of our budget allocations.

Work is underway on a paper reporting on research in this project to be given at the annual meeting of the Association of Pacific Coast Geographers at Western Washington State University at Bellingham in mid-June. These findings also will be incorporated in a final report to be submitted at the termination of the project this summer.

WR - GEOGRAPHY (10)

EXPENDITURES AS OF APRIL 12, 1968
(SINCE JULY 1, 1967)

Capital Outlay

Expenditures	0 *

Other Expense

Allocation	$300.00
Expenditures	40.04
Balance -	$259.96

Travel

Allocation	$550.00
Expenditures	521.20
Balance	$ 28.80

Irregular Help

Allocation	$779.68
Expenditures	526.91
Balance	$252.77

526.91
1.27
7'391

* $66.00 rain-snow gage item listed on Jan. 12, 1968 report never went through Purchasing Office. Hence expenditure never made.

WR-GEOGRAPHY (10)

EXPENDITURES AS OF JULY 1, 1968

Capital Outlay:

None during the 1967-68 year.

Other Expenses:

Allocation	$300.00	
Expenditures	169.54	(includes requisition for $127.50 for negatives and prints, job not yet done)
Balance	130.46	

Travel:

Allocation	$550.00	
Expenditures	622.05	
Deficit	72.05	

Irregular Help:

Allocation	$779.68	
Expenditures	770.46	
Balance	9.22	

Net overall balance: $67.63

FIRST QUARTER REPORT, 1967-68, ON WR-GEOGRAPHY RESEARCH PROJECT NO. M-2 (HH)

"A MICROCLIMATIC PROFILE FROM THE SNAKE RIVER CANYON TO THE CLEARWATER MOUNTAINS"

BY PROF. RICHARD L. DAY - COLLEGE OF MINES - UNIVERSITY OF IDAHO - MOSCOW.

Observations of temperature, relative humidity, and precipitation were extended east to Jug Lookout, about 25 air line miles east of Clarkia, Idaho, and 85 miles northeast of Wawawai, Washington (southwesternmost point in the profile) during the summer months. A detailed investigation of the microclimates within the higher mountains was carried on, as hygrothermographs were placed in a variety of exposures, including ridge crests, depressions, air drainage channels, ~~on~~ the shores of a cirque lake, and ~~on~~ north and south slopes. The high mountains could not be penetrated until late July because of winter snowdrifts blocking the access road until that time. Snow and mud again made it necessary to terminate all observations in the area by mid-October. Observations ~~on~~ along the remaining portion of the profile (from Bovill and Bald Mountain southwest to Wawawai) were continued in the usual manner throughout the period.

The greatest temperature inversions since the project was initiated were recorded during August, the hottest, driest month in many years. Magnitude of these inversions was as great as 40° at times. A related phenomenon of particular interest was the extremely low noctural relative humidities on the mountaintops and ridges during much of August. At times the relative humidity was actually lower at night than during the day in such locations.

A good start was made on the drafting of final maps by our draftsman, Mr. Clifford Wood, during August and early September. It appears that this work will require most of the academic year, through June 1968, because of the limited amount of time either Mr. Wood or any other potential draftsman has for this work while classes are in progress.

The present (second) quarter will be the last in which a full program of observations is carried on. It will be necessary to terminate the Bald Mountain observations by the end of October because indications are that the access road will become impassable due to mud and perhaps snow by or soon after that time. Other observations, between the Snake River Canyon and Emida Ridge and Bovill, will be continued until the end of December. Thereafter lack of travel and irregular help funds, plus the need to spend all available time on data analysis and writing, will make it necessary to discontinue most field observations. As much work as possible will be done on maps for the final report on the project, including papers being prepared for submission to professional journals, during the coming months. The usual monthly summary of observations will continued to be prepared as long as ~~the latter~~ these are made.

W. R. Engineering, E-12

STUDIES ON METHODS OF SOIL WATER DETERMINATION

1. Introduction

This project is directed toward the ultimate goal of developing a reliable method of soil water determination. In addition to the actual percentage of water in a given soil, possible methods of obtaining information on the state of the ground water and its flow conditions are being examined.

Two graduate students are working out theses for M.S. degrees in electrical engineering. On this project the one, Mr. Gene Hite is the recipiant of a budgeted stipend; the other, Mr. Harasprasad Shastry, a student from India, derives some support in the form of Irregular Help funding. Mr. Roger Lackey, a senior in electrical engineering is supported by a work-study grant.

2. Progress 7/1/67 to 9/30/60

a. Thermal conductivity and infrared reflectance-- Mr. Gene Hite.

A rather extensive quantity of data has been accumulated on the behavior of a thermal conductivity probe and trends are being carefully examined. These have been sufficiently promising to justify the construction of a prototype instrument. In this, heat is supplied to the soil surrounding a brass heat conductor while is in turn coupled thermally to a thermistor. Heat is obtained by means of a 4-watt electrical unit for a ten-minute period. The temperature behavior seen by the thermistor is strongly a function of the soil's water content.

Data has been accumulated over an ambient temperature range of -20°F to 78°F using sand with a water content ranging from dry to 22% water. A large freezer unit was modified to contain the

prototype soil probe and soil sample for the lower temperatures. Data taking has been facilitated by a degree of automation, whereby heating and cooling curves are presented on a strip chart recorder. It has thus been possible to accumulate data at continuous intervals, day and night.

An interesting possibility of recognizing water in the form of ice presents itself when noting the shape of the heating curve as the latent heat of fusion is added.

The infrared reflectance technique was suggested as a result of work done at the Snake River Water Resources Laboratory at Kimberly, Idaho, in connection with the development of instrumentation to observe the water content of leaves. Selective absorption of water occurs at a wavelength of about 1.9 microns. Preliminary study and procurement is in progress.

b. Electrokinetic Phenomena--Mr. R. Lackey

The streaming potential existing when water flows through a porous media has been variously considered. The hope for practical utilization of this phenomenon is still remote, however, owing to the complexity and the many variables.

c. Nuclear Magnetic Resonance--Mr. H. Shastry

Resonance has been observed using very simple apparatus. Initial experiments have pointed out the need for more sensitive detection and a greater degree of homogeniety within the magnetic field. Work is in progress on these items.

3. Plans for Future Work

For the thermal conductivity approach, existing data will be analyzed. Further data will be collected on clay and loam type soils, and the detection of freezing will be further exploited.

The IR work should be well underway and the NMR experiments should be near completion.

The "streaming potential" work is in need of new ideas.

4. Statement of Budget Status--9/30/67 (E-12)

a. Irregular Help

Budget	$ 300.00
Expenditures	.00
Balance	$ 300.00

b. Other Expense

Budget	$ 260.00
Expenditures	69.43
Encumbrances	157.72
Unencumbered Balance	$ 32.85

c. Capital Outlay

Budget	$ 400.00
Expenditures	50.00
Encumbrances	.00
Unencumbered Balance	$ 350.00

Submitted 30 September 1967

J. I. Hagen, Assoc. Prof. Research
Electrical Engineering

Summary of Expenditures July 1, 1967 - September 30, 1967

WR-Geography (71-10) (A-012-IDA)

Capitol Outlay:

Allocation - None

Other Expense:

Allocation -	$300.00
Expenditures -	None

Travel:

Allocation -	$550.00
Expenditures -	360.10
Balance -	$189.90

Irregular Help:

Allocation -	$779.68
Expenditures -	393.66
Balance -	$386.02

OWRR Quarterly Progress Report

July 1, 1967 - October 1, 1967

Project: Food Habits of Mayflies in the Aquatic Environment.

Personnel: Dr. M. A. Brusven, Leader; B. R. Gilpin, Research Fellow.

Quarterly Progress:

Twenty-seven stations have been established on the St. Maries River to study the distribution, food habits and ecology of mayflies. Stations have been selected to depict the numerous habitats in the drainage ranging from head-water riffle areas to lower slack waters. Mayfly naiads were collected from stations in July and August. Water chemistry analysis was made in July. Detailed habitat descriptions have been made for headwater stations relative to stream width, bottom type, marginal stream cover, etc. Algae collections and identification were made in July and August and will serve as a basis for later food habit studies.

Work Proposed for Next Quarter:

Identification of mayflies will be initiated. Techniques for gut analysis will be investigated, i.e., dissection, staining, slide preparation, etc. Population samples of key riffle areas will be made in October to reflect seasonal changes and population turnover of mayflies.

Summary of Expenditures:

Travel: $36.20

Other Expense: $70.53

Capital Outlay: None

Irregular Help: None

Respectfully submitted,

Merlyn Brusven

Merlyn A. Brusven

WR-GEOGRAPHY (10)

EXPENDITURES AS OF JULY 1, 1968

Capital Outlay:

None during the 1967-68 year.

Other Expenses:

Allocation	$300.00	
Expenditures	169.54	(includes requisition for $127.50 for negatives and prints, job not yet done)
Balance	130.46	

Travel:

Allocation	$550.00	
Expenditures	622.05	
Deficit	72.05	

Irregular Help:

Allocation	$779.68	
Expenditures	770.46	
Balance	9.22	

Net overall balance: $67.63

WR-GEOGRAPHY (10)

EXPENDITURES AS OF JAN. 12, 1968

Capital Outlay:

Expenditures -	$66.00

Other Expense:

Allocation	$300.00
Expenditures -	26.20
Balance -	$273.80

Travel:

Allocation -	$550.00
Expenditures -	521.20
Balance -	$ 28.80

Irregular Help:

Allocation -	$779.68
Expenditures -	520.91
	$258.77

GROWING SEASON - LENGTH OF PERIOD BETWEEN LAST AND FIRST FREEZING TEMPERATURES
1964 AND 1965

Station	1964 Last 32°	1964 First 32°	1964 Growing Season (Days)	1965 Last 32°	1965 First 32°	1965 Growing Season (Days)
Wawawai, Washington (Snake River Canyon)	-	-	-	Mar. 26	Sept. 17	175
Wawawai Canyon (3 mi. SE of Wawawai)	-	-	-	(Mar. 27) (33 May 6)	Nov. 25 (33 Sept. 17)	242 (133)
Wawawai Ridge	-	-	-	May 6	Sept. 16	132
Union Creek Flat	-	-	-	May 18 (33 June 7)	Aug. 30	103
Moscow, Univ. of Ida.	May 25	Oct. 3	130	May 7	Sept. 17	132
Viola Hill	May 5 (33 May 25)	Nov. 8 (34 Oct. 27)	186	May 6	Sept. 16	132
Potlatch Val. Flat	-	-	-	July 19	Aug. 30	50
Harvard Val. Flat	June 28	Aug. 15	48	July 19	Aug. 30 (33 Aug. 14)	50
Emida Ridge	May 25	Sept. 18	115	May 18	Sept. 16	120
Bald Mountain Lookout	-	Aug. 19	-	June 30	Aug. 29	61
Bovill (2½ mi. N.)	-	-	-	July 19	Aug. 14	25
Subalpine Fir Meadow	June 29	Aug. 10	42	July 19	Aug. 14e	25e
Hilltop near Subalpine Fir Mead.	May 23	Oct. 3	132	-	-	-
Genesee Flat	June 29	Aug. 15	47	June 28	Aug. 30	63
Genesee Hill	May 23	Oct. 27	166	-	-	-
Lewiston Airport	April 19	Nov. 15 (33 Oct. 18)	209	April 7 (34 May 18)	Sept. 17	151
Lewiston Downtown	April 19	Oct. 22 (33 Oct. 4)	185	April 7 (33 May 18)	Sept. 17	151

REPORT ON PROGRESS AND FINDINGS DURING FISCAL YEAR [illegible], N.S.F. [illegible]

"A MICROCLIMATIC [illegible]" FILE COPY

by Prof. Richard L. Day - College of Mines - University of Idaho - Moscow.

Part I. - Activities

During the past year observations of temperature and humidity were continued at 15 stations and precipitation at nine stations in the zone of microclimatic study between the bottom of the Snake River Canyon at Wawawai, Washington, and the Clearwater Mountains of Idaho. During the period between mid-July and mid-October, records were kept at an additional remote station, Crescent Mountain (elev. c. 6,000 feet), which is inaccessible by land during about nine months of the year.

A number of instrumental problems were encountered during the year, including an unusual number of clock failures, and great difficulty in obtaining usable records from the recording rain and snow gauge and hygrothermograph on Bald Mountain when the site could be visited only once a month during the period from November to June. The project leader is cooperating with Marvin Rosa of the Agricultural Research Service, U. S. Dept. of Agriculture, who arranged to have his assistant, Mr. Vern Thompson, visit the summit of Bald Mountain on a snowmobile once a month during the winter and spring months. Unfortunately, precipitation catches in the recording gauge were deficient by about 36% in spite of all precautions, but the water content of the snowcover in the vicinity was used to correct the record insofar as possible. Also, much difficulty was encountered with the functioning of the 31-day clockwork of the hygrothermograph being used on the mountain. As a result, very few temperature and humidity records could be obtained.

Some difficulties arose with certain other precipitation gauges in matters of exposure and interference of various kinds, the most serious being the multiple shooting of the recording gauge at Wawawai, and problems involved in finding a suitable exposure for the gauge on the canyon rim above Wawawai. The recording gauge at Wawawai was about 15% deficient in its precipitation catch throughout the winter in spite of all precautions. Corrections were made to the record on the basis of measurements made with the standard stick gauge placed adjacent to the recording gauge.

A number of problems were encountered with the operation of the humidity elements in several of the hygrothermographs, and two of the instruments had to be returned to the manufacturer.

Excellent precipitation records were obtained throughout 1966 near the summit of Moscow Mountain (the Palouse Range) northeast of Moscow, through the cooperation of Prof. Alan Robertson of the Department of Agricultural Engineering, University of Idaho, who arranged weekly visits by his assistants to the gauge. During 1967, however, regular visits have not been possible, and there have been major interruptions in the record.

Although the winter was the mildest of record, with the temperatures averaging 5°F above normal during the December-February period, snowfall accumulations at higher elevations (above 5,000 feet) on the mountains were much above normal, especially during the latter part of the season. Consequently, the station on Freeseout Mountain could not be re-established until July 16, 1967, because of snowdrifts blocking the road until that time. At the end of July, after the road east of Freeseout finally opened, this station was moved 11 miles farther east to Jugs Lookout (elev. c. 6,500 feet), near South Butte Mtn. Another station was established to provide check observations of mountaintop conditions on Crater Mtn. (elev. c. 6400 feet), three miles east of Freeseout. Consequently, during August and September 1967, the microclimatic profile will extend a total distance of 85 air line miles along a west-southwest to east-northeast orientation between Wawawai, Wash., and the vicinity of South Butte Mtn., Idaho. By comparison, air line distance between Wawawai and Bald Mountain is about 30 miles.

Part II. - Summary of Findings

A. - Precipitation and Snow Depths

Precipitation along the profile between Wawawai, Washington (elev. 675 feet), and the summit of Bald Mountain (elev. 5330 feet) varied from approximately 20 inches at Wawawai to at least 48 inches on Bald Mountain during the year between July 1, 1966 and June 30, 1967. These figures involve estimates because of instrumental problems that were encountered at both of these extreme locations. Totals at intermediate stations were as follows: 28.58 inches at the College of Mines Building, Univ. of Idaho, Moscow (elev. 2610 feet); 26.87 inches 1½ miles northeast of Harvard, Idaho (elev. 2590 feet); 31.79 inches one mile south of the Giant White Pines (elev. 2880 feet); and 37.91 inches on Emida Ridge near the North-South Ski Bowl (elev. 3700 feet).

Maximum depths of the snow pack were approximately as follows: 90 inches in late April on Bald Mountain; 42 inches on March 19 on Emida Ridge; 10 inches several times in January one mile south of the Giant White Pines; 7 inches 1½ miles northeast of Harvard on March 29; 6 inches at Potlatch on March 29; 5 inches at Moscow on March 29; 8 inches on the canyon rim above Wawawai on March 29; and a trace at Wawawai. At Purdue Creek 2½ miles north of Bovill, the greatest depth was 18 inches on March 11.

Precipitation records were made on Freezeout Mountain for nearly three and one-half months, and were running considerably heavier than on Bald Mountain. In October, accumulations were nearly twice as great on Freezeout as the first cyclones of the approaching winter season were experienced. U. S. Soil Conservation Service snow surveys reported snow pack depth, and water content of same, twice as great at Lost Lake, six miles northeast of Freezeout Mtn., as on Bald Mtn., by April. Elevation of Lost Lake is the same as Freezeout Mtn., 6,000 feet. Snow pack measured 169 inches at Lost Lake on April 1st, compared with 85 inches on Bald Mountain. Water content measured 67.4 inches on this date at Lost Lake, compared with 33 inches on Bald Mountain.

B. - Temperature

Temperature lapse rate at the time of the afternoon maximum temperature averages about 4.3° per 1000 feet between Wawawai (elev. 675 feet) and the summit of Bald Mountain (5330 feet). This lapse rate holds quite uniformly, both throughout the profile, and through the various seasons of the year. On clear days, the lapse rate may average closer to 5° per thousand feet, for on such occasions there is typically a temperature difference of 21° or 22° through the 4650 feet difference in altitude. On days when the mountain is in clouds, but the sun shines at Wawawai, differences as great as 28° and, rarely, 30°, may be recorded. On Freeseout Mountain, 26 miles east of, and 760 feet higher than Bald Mountain, the maximum temperature averaged only 1.3° lower than on Bald Mtn. between July 17 and August 13, but this difference increased to 4.6° during the first fifteen days of October. On the warmest days in October, maximum temperatures were as much as eight to ten degrees lower on Freeseout Mountain.

The night temperature pattern is much more complex, particularly during the dry summer and early fall months (July through September), when temperature inversions attain their greatest development. Average differences in minima between Wawawai and Bald Mountain is reduced to about 10°F during some months in this period, as compared with an average difference of about 20° between the maximum temperatures at the same time of year. Occasionally night minima are actually two to four degrees higher on Bald Mountain than at Wawawai. At these times inversions in the magnitude of 25° to 35°F may be experienced between the summit of Bald Mountain (and even lesser heights such as Viola Hill, 3150 feet, north of Moscow) and the surrounding valley flats. For example, on July 12 and 16, 1967, and August 24, 1966, the patterns of minimum temperature shown in Table 1 were observed. Average differences in minimum temperatures between high and low sites over the period of a month sometimes reach the magnitude of 15° to 20° as is also shown in the table. For comparative purposes, the average daytime maxima for the month of August 1966 and the maximum temperature on a single day, August 24, 1966, also are included in this table.

Table 1. Selected Temperature Patterns Along Microclimatic Profile Between Wawawai, Washington, and Bald Mountain, Idaho. °F

Station	Minimum July 12, 1967	Minimum July 10, 1967	Minimum Aug. 24, 1966	Average Minimum Aug. '66	Average Maximum Aug. '66	Maximum Aug. 24, 1966
Wawawai, bottom of Snake River Canyon (elev. 675 feet)	64	64	67	60	90	110
Slope above Wawawai (elev. 1500 feet)	72	67	77	62	85	105
Canyon Rim above Wawawai (elev. 2500 feet)	71	66	72	60	82	101
Union Creek Flat behind Canyon Rim (elev. 2436 feet)	50	48	52	46	82	99
Univ. of Idaho - Moscow (elev. 2610 feet)	61	57	68	52	81	101
Viola Hill (Ridgetop 3 miles north of Moscow - elev. 3150 feet)	78	69	74	59	80	97
Valley flat 1½ miles NE of Harvard (elev. 2590 feet)	46	41	39	39	82	101
Emida Ridge near N-S Ski Bowl (11 miles N of Harvard - elev. 3700 feet)	64	65	63	54	77	96
Bald Mountain Lookout (11 miles NE of Harvard - elev. 5530 feet)	68	68	67	50	70	88
Purdue Creek Flat (2⅝ miles north of Bovill and 15 miles SE of Bald Mtn - elev. 2880 feet)	45	38	34	36	81	100

It will be noted that the minimum temperatures on the valley flats drop off more rapidly as one moves farther east and northeast across the plateau and into the mountains than would be expected solely on the basis of the modest gains in altitude. For example, the average minimum during August 1966 at Union Creek Flat, Wash., elev. 2436 feet, was 46°, while that on the flat near Harvard, Idaho, only 150 feet higher and 30 miles northeast, was 7° lower, or 39°. On the other hand the average daytime maxima show no such decline.

Related to the minimum temperature patterns discussed above is a great variation in the length of the frost-free season along the microclimatic profile. In 1966, the frost-free period varied from 202 days in the Snake River Canyon around Wawawai to only 20 days on the valley flats from the vicinity of Moscow, eastward. In Moscow itself, and on the hilltops in the surrounding Palouse, the frost-free season was in the vicinity of either 166 or 134 days, depending upon whether 32° is taken as indicating a significant frost, or 33° or 34° (which usually would indicate frost conditions on the ground beneath the standard thermometer shelter on calm, clear nights). Bald mountain's frost-free period was 91 days.

Another feature of considerable interest is the great difference in the diurnal temperature ranges between high and low sites. Average diurnal range on the valley flats in the hilly and mountainous country east and northeast of Moscow is greatest, reaching 45° during the warmest and driest summer months, such as August 1966. The greatest range yet recorded for a particular day was 66° (between 100° and 34°) at Purdue Flat, north of Bovill, on August 24, 1966. By contrast, the average diurnal temperature range on the summit of Bald Mountain was only 26° during the same month of August 1966 (and even on this specific day of August 24, 1966), and on Viola Hill north of Moscow 21°. At Moscow itself, the average range was 28½°, about normal for the month.

C. - Relative Humidities - During July, minimum daily relative humidities average between 20 and 25% in the bottom of the Snake River Canyon, sometimes dropping as low as 10%. On the Palouse Hills and in the mountain valleys 1500 to 2000 feet higher in elevation, they average nearly 10% higher, or a little over 30%. On the mountaintops another 2500 to 3500 feet higher still, there is a further increase of about the same magnitude, bringing the average to about 40%. During the year's most humid months of December and January, the altitudinal increase is from around 60% in the canyons to between 70 and 75% on the plateau, and to probably close to 95% on the mountaintops which are in the clouds and subject to heavy fine accumulation for days at a time. Thus, during the daytime there is a steady increase in relative humidity with altitude, an increase which is especially pronounced during the winter months.

The nocturnal pattern of relative humidity is, however, much more complex, particularly during the warmer half of the year between April and October, when frequent pronounced temperature inversions and subsiding air currents occur. At all seasons of the year, even in the driest part of the summer, the relative humidity reaches close to 100% in the valleys during most nights. In winter, readings reach 95 to 100% on most nights everywhere except in the canyons where they average about 5% lower.

During the summer months, maximum daily relative humidities average about 60% on the ridges and hills of the Palouse and 70% on the mountaintops. The diurnal pattern becomes increasingly irregular with altitude, however, at this season. On Viola Hill (3150 feet), about 575 feet above Moscow, a secondary minimum often occurs in the relative humidity during the late evening or early morning hours. Sometimes the relative humidity during these nocturnal hours drops even lower than during the afternoon. On such occasions, a pronounced rise usually follows late at night and the diurnal maximum is reached at the normal sunrise hour. The drop in relative

humidity in the late evening is accompanied by a leveling off, and sometimes a slight rise, in temperature. In many cases, however, the temperature rise is not in proportion to the drop in relative humidity.

On the summits of Bald and Freemont Mountains, the relative humidity pattern sometimes becomes extremely irregular, with drops and rises occurring almost at random throughout the 24-hour period. The normal diurnal curve may become virtually indistinguishable. Occasionally, a reversal of the normal diurnal curve occurs with the relative humidity reaching a minimum at about sunrise, then rising to higher levels as the day advances, at least until mid-day. At these times, the diurnal temperature curve is still in evidence, but the temperature may remain virtually constant from sunset to sunrise, after dropping abruptly 10° or 15° shortly before sunset. Occasionally, a slight rise in temperature occurs during the night on Bald Mountain, and a more abrupt rise of five or six degrees at around midnight on Freemont Mountain. This pattern is, of course, in pronounced contrast to the steady decline in temperature (and rise in relative humidity) which continues throughout the night in most localities, although often at a diminishing rate as the night progresses.