

UNIVERSITY OF NEVADA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DEPARTMENT OF Meteorology

RECORD OF INVESTIGATIONS

PROJECT No. 1

May 14, 1914.

Subject : Forecasting Frost from Summit of Mountains.

(See explanation of work in detail on sheets following)

Approved June, 1906, 191..... Dr. J. E. Stubbs....., Director
(Date) (Signature)

Conducted by S. P. Fergusson
J. E. Church..... Reporting to J. E. Church
(Chief of Division)

Location of work Mt. Rose, Nevada, Fallon, Nevada, Truckee, Cal., and central
office, Reno, Nevada.

Funds used : Adams

Date suggested : March, 1905..... By whom Prof. A. G. Meadie, U. S.
24 Weather Bureau

Date begun : As a volunteer project, June, 1905
As station project, June, 1906.

Date concluded : In progress

OUTLINE OF THE INVESTIGATION.—On a succeeding page give the following items :

- I. Reasons for the investigation.
- II. Points to be investigated. Specific question to be answered.
- III. Plan of organizing work, or methods of procedure. (Samples of record blanks may be useful to show methods.)
- IV. Literature. Give list of existing publications or leading references to subject.

PROGRESS REPORT.—Forward to the Director's office from time to time, copy in duplicate, since last forwarded, of all pages which have been completed.

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DEPARTMENT OF meteorology
PROJECT No. 1 Pg. 1

I. Reasons for the Investigation :

The purpose of this investigation was to ascertain what relation, if any, exists between meteorological phenomena occurring on the summits of mountains and in nearby lowlands, and to determine the value of simultaneous records at different levels in forecasting frost or other conditions of concern to agriculture.

It is well known that the movements of the air at considerable heights are much more rapid than at the earth's surface; and instances have been recorded of changes of condition occurring earlier at high level than at low level stations. During the past forty years attempts have been made to forecast from mountain stations on Pike's Peak, Mount Washington, Ben Nevis, and other places, but without noteworthy success. Recently a study, conducted on Mount Royal, by McLeod and Barnes of McGill University, has indicated that well-marked changes of condition may be forecasted from records at the upper stations, and this being partly confirmed by records of maximum and minimum temperatures on Mt. Rose, a study of conditions on Mt. Rose was begun as a project of the Adams fund by Dr. J. E. Church, Jr. It was expected that the comparative uniformity of meteorological conditions in this region would make the work less difficult than it has proved to be at other places where decisive results are lacking.

II. Points to be investigated, and
III. Plan of organizing work

Beginning with 1905, continuous records of pressure and temperature were obtained on Mt. Rose by means of a barograph and a thermograph of the well known Richard patterns. In 1910 these instruments were replaced by a meteorograph recording five elements and operating for a period of six weeks with one winding of the clock. Instruments similar to this but recording for a period of seven days only were also installed at Truckee and Fallon in order to secure records at two low level points on the west and east sides of Mt. Rose. These instruments were designed for this work and built by the writer while at Blue Hill Observatory. In August, 1910, the writer became a member of the Station Staff and was given charge of the instruments employed in the work and authorized to make analyses of the records obtained.

Much difficulty has been encountered in obtaining satisfactory records on Mt. Rose, and because of the severity of conditions there it will be impossible to secure continuous records of the

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velocity and duration of the wind during the winter months until observers can be on duty continuously. During the period from May until October the record of these elements is fairly complete since 1910, and the records of temperature, pressure, and humidity are reasonably complete for the entire time. The meteorograph has been improved until the recording mechanism are weather-proof and the original clock replaced by one capable of running 80 days with one winding.

The analysis of the data now being gathered was begun according to the following plan: (1) a careful comparison of simultaneous records from Truckee, Mt. Rose, and Fallon, was made to detect the most obvious coincidences or differences. (2) The instances where a change of phase or condition occurs are to be studied separately in their relation to other meteorological elements in order to determine the causes of the change. (3) the relation of changes of condition to the normal diurnal and annual periods of the principal elements will probably be the final stage of the investigation. The diurnal and annual periods are being computed for four months of the year (one for each season) from readings of the records made every two hours of temperature, pressure, humidity, and when possible, of the direction and velocity of the wind.

Most of the work of studying the records has been accomplished during the years 1912 and 1913, and it is expected that material for at least a preliminary bulletin will be ready within a few months. Heretofore it has been necessary to spend much time designing, constructing and repairing apparatus for this and other projects, and the study of records has been much delayed. It is expected that much more time will be available hereafter, since, at present, the projects are tolerably well equipped with instruments.

Reports of the state of this project can be found in the Annual Reports of the Station since 1906, and in special reports of which those made at the request of Director True and others, on June 24, 1912, October 17 and 25, 1912. May 26 and 27, and June 9, 1913. A report or inventory of the property controlled by this Department was filed, July 1, 1912.

IV. LITERATURE:

The Mount Rose Weather Observatory 1907-1908. Bulletin 67 of the Experiment Station, 1909.

Progress of Mt. Rose Observatory- Science, Dec. 6, 1912.
Also articles in current periodicals, such as Science, Scientific American, etc.

Of particular importance are four papers by McLeod and Barnes on the "Transactions of the Royal Society of Canada, on the work done at Mount Royal; also important information relating to mountain meteorology may be found in the Zeitschrift, 1869 to date,

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Annals of the Sonnblick Vereins, and Annals of the Ben Nevis Observatory.

S. P. Fergusson.

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DEPARTMENT OF Meteorology
PROJECT No. 2

Subject: The Influence of Mountains and Forests upon the Conservation of
Snow.

Approved Summer, 1907, 191..... Dr. J. E. Stubbs, Director
(Date) (Signature)

Conducted by J. E. Church Reporting to J. E. Church
(Chief of Division)

Location of work : Mount Rose and Basin of Lake Tahoe, on California- Nevada
State Line.

Funds used : Adams Fund, supplemented since 1911 by appropriation from
State Fund for Support of Experiment Station.

Date suggested : 1906 By whom Dr. J. E. Church
through discovery of snow domes
Date begun : 1907 on exposed slope late in spring.

Date concluded : In progress

OUTLINE OF THE INVESTIGATION.—On a succeeding page give the following items :

- I. Reasons for the investigation.
- II. Points to be investigated. Specific question to be answered.
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PROJECT No. 2 PG. 1

I. Reason for Investigation.

The reason for the investigation is to provide data on the relative efficiency of mountains and forests in conserving snow with the view of ultimately improving the watersheds in the semi-arid region to increase the storage of snow.

II. Points to be Investigated.

The points to be investigated are:

- (a) How to measure the snowfall, the moisture content of the snow, the action of heat within the snow, the evaporation of snow, and the run-off.
- (b) The efficiency of the open and various types of forest-covering in gathering and sheltering snow, and the exact reason for the efficiency or deficiency of each.
- (c) How to determine before the melting begins the moisture available for the coming season's crops.

III. Methods of Procedure.

- (a) Perfecting suitable instruments for the work and transportation facilities and housing for observers.
- (b) Sampling snow by means of snow sampler and weigher to determine exact water content; making temperature determinations in snow, by means of recording thermometers and thermometers sealed in glass tubes and placed in position by means of the sampler; use of evaporation pans and spring balance to determine rate of evaporation under various conditions of protection and exposure; determining the run-off or melting by subtracting the evaporation from the loss of moisture in the snow-field; and the comparison of various types of timber and sloped, and elevations from the view-point of the conservation of snow.

- IV. Literature (Where not otherwise specified by J. E. Church, Jr.)
- Bulletin No. 67, (June 1908): The Mount Rose Weather Observatory; Daily Independent, Elko, July 16, 1908: The Ruby Mountains; Sci. Amer. Supp. LXXIV, 1914, (Sept. 7, 1912): The Conservation of Snow, Its Dependence upon Mountains and Forests. Bulletin, Internat. Irrig. Congress I 6 (Dec. 1912) Same subject; Engineering and Contracting XXXIX 6 (Feb. 5, 1913: Reprint; " " " XL 16 (Oct. 15, 1913): The Relative Efficiency of Talus Slopes in Conserving Snow for Irrigation.

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Science N. S. XXXVI 936 (Dec. 6, 1912): The Progress of Mount Rose Observatory;
 Meteorologische Zeitschrift XXX 1 (Jan, 1913): Das Verhältniss des Waldes und des Gebirges zur Erhaltung des Schnees;
 Science Conspectus III 5 (April, 1913): The Relation of Snow to Irrigation and Forestry, by S. P. Fergusson;
 Quarterly Journal of the Royal Met. Society XL 169 (Jan, 1914): Recent studies of snow in the United States.
 Engineering Record (accepted for publication):
 1. Snow Survey of the Tahoe Basin, a Study in the rapid Survey^{ing} of Large Areas of snow at High Elevations.

2. The Retarding Effect of Various Types of Forests on the Sudden Melting of Snow. *Eng. Rec. 69:24 pp. 74.*

Nevada State Journal and Reno Evening Gazette: Occasional bulletins containing Snow Surveys and Forecasts of Water.

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Report of Progress, May 14, 1914.

1. A snow sampler and weigher has been perfected so that snow to the depth of 20 feet can be quickly and easily sampled. The entire apparatus has now been made sufficiently light to be carried and operated by one man; however, two are preferable.

Two snow samplers of the Mount Rose type have been made for the U. S. Weather Bureau, and one, ruled to centimeters, and made in several short sections is nearing completion for the Gletscher-Kommission, Switzerland.

2. Evaporation pans for the study of the evaporation of snow in trees and in snowfields have been made and have been fitted with hoods to keep out precipitation during storms.

3. Copious data have been obtained on (a) the conserving power of pine and fir forests of varying densities as compared with each other and with unforested areas and the characteristics of the ideal forest have been determined; (b) and on the relative efficiency of talus slopes and timber line forests in-

4. The rate of evaporation of snow under various conditions of exposure and protection is being determined for an entire season.

5. (a) The relative density of snow under high mountain and valley conditions have been determined; (b) and the altitude of maximum snowfall locally is being finally established.

6. The influence of both air and soil upon the temperatures in snow has been investigated and data procured; however, this investigation is now only fully under way.

7. Methods of making practical seasonal surveys of drainage basins have been devised. For three seasons a survey of the Lake Tahoe Basin has been made in two weeks by two men working together, and in each case the forecast of the level of the Lake for the coming season was within one-tenth of one foot of the level actually attained, assuming that the dam was not opened. The forecast was therefore, within 3% of accuracy.

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PROJECT No. 2 PG. 4

Report of Progress
May 14, 1914.

Plans for the Coming Year.

1. To study tamarack and mountain hemlock forests with reference to conservation.
2. To continue study of evaporation.
3. To inaugurate a study of various mountain slopes and their influence upon the conservation of snow.

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DEPARTMENT OF Meteorology
PROJECT No. 3

Subject : Temperature Survey of the Agricultural Lands of Nevada,
and Experiments in Orchard Heating.

Approved Spring, 1911 Dr. J. E. Stubbs, Director
(Date) (Signature)

Conducted by J. E. Church Reporting to J. E. Church
S. P. Fergusson (Chief of Division)

Location of work : At present in Truckee Meadows and Carson Sink; but the
instruments will be moved after observations covering three (3)
years to other basins in the State.

Funds used : State Funds for Support of Experiment Station

Date suggested : 1910 By whom J. E. Church

Date begun : April, 1911

Date concluded : In progress

OUTLINE OF THE INVESTIGATION.—On a succeeding page give the following items :

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PROJECT No. 3 Pg. 1I. Reason for Investigation.

The reason for this investigation is to determine the adaptability of the various sections of the State for the growing of fruit.

II. Points to be Investigated.

The point to be investigated is the frequency of frost, during the season of blossoming and the setting of fruit, and the diminution of this frequency with elevation above the valley floor. Also the expense of orchard heating season after season in Nevada.

III. Method of Procedure

The method of procedure is as follows: The location of a series of stations at various elevations in each basin and the value of each for temperature zones and the value of each for fruit. These stations consist of a thermometer shelter, a small Richard thermograph, and a Green's thermometer by means of which to check the accuracy of the thermograph. The instruments are set and protected mainly by voluntary observers. A record covering three consecutive years is obtained at each station.

Literature. IV.

Bulletin No. 79, January, 1912; The Avoidance and Prevention of Frost in the Fruit Belts of Nevada, by J. E. Church, Jr., and S. P. Fergusson.

Farm and Fireside, Saturday, March 14, 1914: Keeping the Frost away from the Fruit, by J. E. Church, Jr.

Popular Mechanics, Feb. 1913: Trailing the Frost Belt Through Nevada Snows, (little not our own).

title

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PROJECT No. 3 PG. 2

Progress Report, May 14, 1914.

The survey of the Truckee Meadows is nearing completion.

Two years' data have been tabulated and verify the statements made in Bulletin No. 79.

Experiments in orchard heating are being continued at Church's orchard without expense to the Department. The results plainly indicate that orchards in the average fruit belts of Nevada can be protected at moderate cost. Indeed, the present year all fruit except the earliest has escaped unharmed despite the fact that the buds were started one month early by unusually fair weather in the month of March. It appears that temperatures of 28 degrees to 31 degrees F will not work commercial injury to unheated orchards.

The publication of the survey so far as completed is being postponed until bulletins on Projects I and II have been published.

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