United States Department of the Interior
National Park Service

National Register of Historic Places Registration Form

This form is for use in nominating or requesting determination for individual properties and districts. See instruction in *How to Complete the National Register of Historic Places Registration Form* (National Register Bulletin 16A). Complete each item by marking ``x'' in the appropriate box or by entering the information requested. If an item does not apply to the property being documented, enter ``N/A'' for ``not applicable.'' For functions, architectural classification, materials and areas of significance, enter only categories and subcategories from the instructions. Place additional entries and narrative items on continuation sheets (NPS Form 10-900a). Use a typewriter, word processor, or computer, to complete all items.

1. Name of Property

historic name Willard, Beatrice, Alpine Tundra Research Plots

other names/site number Rock Cut Research Plot; 5LR10540; Forest Canyon Research Plot' 5LR11754

2. Location

street & number Rocky Mountain National Park (ROMO) [N/A] not for publication

city or town Estes Park [X] vicinity

state Colorado code CO county Larimer code 069 zip code 80517

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act, as amended, I hereby certify that this [X] nomination [ ] request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property [X] meets [ ] does not meet the National Register criteria. I recommend that this property be considered significant [ ] nationally [ ] statewide [ ] locally. ([ ] See continuation sheet for additional comments.)

Signature of certifying official/Title Date

State or Federal agency and bureau

In my opinion, the property [ ] meets [ ] does not meet the National Register criteria.
([ ] See continuation sheet for additional comments.)

State Historic Preservation Officer
Signature of certifying official/Title Date

Office of Archaeology and Historic Preservation, Colorado Historical Society
State or Federal agency and bureau

4. National Park Service Certification

I hereby certify that the property is:
[ ] entered in the National Register
[ ] See continuation sheet.
[ ] determined eligible for the National Register
[ ] See continuation sheet.
[ ] determined not eligible for the National Register.
[ ] removed from the National Register
[ ] other, explain
[ ] See continuation sheet.

Signature of the Keeper Date of Action

5. Classification

Ownership of Property
(Check as many boxes as apply)

[ ] private
[ ] public-local
[ ] public-State
[x] public-Federal

Category of Property
(Check only one box)

[ ] building(s)
[X] district
[ ] site
[ ] structure
[ ] object

Number of Resources within Property
(Do not count previously listed resources.)

Contributing	Noncontributing	
0	0	buildings
2	0	sites
1	0	structures
0	0	objects
3	0	Total

Name of related multiple property listing.
(Enter "N/A" if property is not part of a multiple property listing.)

n/a

Number of contributing resources previously listed in the National Register.

0

6. Function or Use

Historic Function
(Enter categories from instructions)

GOVERNMENT
EDUCATION/research facility
LANDSCAPE/unoccupied land

Current Functions
(Enter categories from instructions)

GOVERNMENT
EDUCATION/research facility
LANDSCAPE/unoccupied land

7. Description

Architectural Classification
(Enter categories from instructions)

No style

Materials
(Enter categories from instructions)

foundation
walls
roof
other EARTH
STEEL

Narrative Description
(Describe the historic and current condition of the property on one or more continuation sheets.)

8. Statement of Significance

Applicable National Register Criteria
(Mark ``x'' in one or more boxes for the criteria qualifying the property for National Register listing.)

[ ] **A** Property is associated with events that have made a significant contribution to the broad patterns of our history.

[X] **B** Property is associated with the lives of persons significant in our past.

[ ] **C** Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.

[ ] **D** Property has yielded, or is likely to yield, information important in prehistory or history.

Criteria Considerations
(Mark ``x'' in all the boxes that apply.)

Property is:

[ ] **A** owned by a religious institution or used for religious purposes.

[ ] **B** removed from its original location.

[ ] **C** a birthplace or grave.

[ ] **D** a cemetery.

[ ] **E** a reconstructed building, object, or structure.

[ ] **F** a commemorative property.

[X] **G** less than 50 years of age or achieved significance within the past 50 years.

Areas of Significance
(Enter categories from instructions)

SCIENCE
CONSERVATION
POLITICS/GOVERNMENT

Periods of Significance
1959-1979

Significant Dates
1959, 1961, 1962, 1973,
1960, 1963, 1970, 1971, 1972, 1979

Significant Person(s)
(Complete if Criterion B is marked above).
Willard, Beatrice E.

Cultural Affiliation
N/A

Architect/Builder
N/A

Narrative Statement of Significance
(Explain the significance of the property on one or more continuation sheets.)

9. Major Bibliographical References

Bibliography
(Cite the books, articles and other sources used in preparing this form on one or more continuation sheets.)

Previous documentation on file (NPS):

[ ] preliminary determination of individual listing (36 CFR 67) has been requested

[ ] previously listed in the National Register

[ ] previously determined eligible by the National Register

[ ] designated a National Historic Landmark

[ ] recorded by Historic American Buildings Survey

#_____

[ ] recorded by Historic American Engineering Record

#_____

Primary location of additional data:

[X] State Historic Preservation Office

[ ] Other State Agency

[X] Federal Agency

[ ] Local Government

[ ] University

[ ] Other

Name of repository:
Colorado Historical Society
National Park Service

10. Geographical Data

Acreage of Property less than one

UTM References
(Place additional UTM references on a continuation sheet.)

	Zone	Easting	Northing		
1.	13	437883	4473537	Rock Cut	(NAD83)
2.	13	439655	4471665	Forest Canyon	(NAD83)
3.					
4.					

[ ] See continuation sheet

Verbal Boundary Description
(Describe the boundaries of the property on a continuation sheet.)

Boundary Justification
(Explain why the boundaries were selected on a continuation sheet.)

11. Form Prepared By

name/title Cheri Yost/Park Ranger and Chase Davies

organization Rocky Mountain National Park date June 2007

street & number 1000 Highway 36 telephone (970) 586-1200

city or town Estes Park state Colorado zip code 80517

Additional Documentation

Submit the following items with the completed form:

Continuation Sheets

Maps

A **USGS map** (7.5 or 15 minute series) indicating the property's location.

A **Sketch map** for historic districts and properties having large acreage or numerous resources.

Photographs

Representative **black and white photographs** of the property.

Additional Items

(Check with the SHPO or FPO for any additional items)

Property Owner

(Complete this item at the request of SHPO or FPO.)

name Rocky Mountain National Park, U.S. Department of the Interior

street & number 1000 Highway 36 telephone (970) 586-1200

city or town Estes Park state Colorado zip code 80517

Division, National Park Service, P.O. Box 37127, Washington, DC 20013-7127; and the Office of Management and Budget, Paperwork Reductions Projects (1024-0018), Washington, DC 20503.

NARRATIVE DESCRIPTION

The Beatrice Willard Alpine Tundra Research Plots sit at high elevations in Rocky Mountain National Park. Alpine tundra is an ecosystem that is "located on mountains throughout the world at high altitude where trees cannot grow. The growing season is approximately 180 days. The nighttime temperature is usually below freezing."[1] Colorado has the largest extent of alpine tundra in the country, and "the character of the Colorado tundra is more complex, with a greater number of species, communities and processes" than other alpine tundra systems around the nation.[2] The Beatrice Willard Alpine Tundra Research Plots are largely unimproved landscapes. They lie along Trail Ridge Road, U.S. 36, which traverses the Continental Divide through Rocky Mountain National Park. Both research plots sit near parking areas, at the Rock Cut and Forest Canyon Overlook.

Rock Cut Plot

At an elevation of 12,110 feet, the Rock Cut Plot is 50'x40' and sits north of the road, near the Rock Cut parking area. To the north and south of the plot sit comfort stations. Between the north comfort station and the plot, an asphalt trail (paved in 1961) to the Toll Memorial departs the parking area and rises north into the alpine tundra. A four foot concrete sidewalk separates the plot from the parking lot. The plot slopes to the northeast and has a southwest facing aspect. Through it runs an old foot path, which Dr. Willard used to monitor how long it took to revegetate the tundra. Tiny tundra plants blanket the plot. Dr. Willard's original fences, installed in 1959, were one foot high wood posts with a single strand of wire running between them, protecting a smaller 5'x20' area. In 1961, Willard installed more substantial steel posts with wire and enlarged the protected area to further project the plots from human impacts and wayward foot traffic. The park again enlarged this exclosure (a fence used to keep something out of an area during research and monitoring studies) in 1962. In 1973, the park installed the existing brown-painted steel tube fence, which is three feet high. This 50'x40' fence buffers a larger area than the 5'x20' research plot, in order to prevent further trampling by visitors. A small steel sign at the base of the plot explains that the fence protects the research plot, which is used for long-term monitoring. This nomination includes the existing steel tube fence, installed in 1973, and the tundra area within this fence. It does not include the signs or asphalt paths outside the fence.

Forest Canyon Plot

Built in 1958, Forest Canyon overlook, accessed by a short path from the parking area,

1 In contrast, arctic tundra is "located in the northern hemisphere, encircling the north pole and extending south to the coniferous forests of the taiga. The arctic is known for its cold, desert-like conditions. The growing season ranges from 50 to 60 days." Available at http://www.ucmp.berkeley.edu/exhibits/biomes/tundra.php, accessed 6 December 2006.

2 Ann H. Zwinger and Beatrice E. Willard, *Land Above the Trees: A Guide to American Alpine Tundra* (New York: Harper & Row, 1972), preface x-xi.

provides quick access to marvelous scenery. Because visitors immediately damaged the tundra near the overlook, Dr. Willard established an exclosure here in 1959. The Forest Canyon Plot sits just west of the parking at an elevation of 11,716 feet. As at Rock Cut, Dr. Willard used short wood posts strung together with a wire to protect a 10’x10’ area. The plot has very little slope to it. At an unknown date (presumably 1961 or 1962), the park installed steel posts (similar to fence posts) to further protect the plot. This fence was removed at an unknown date, but a remnant of one of the steel posts sticks out from the ground about an inch. The Forest Canyon Plot today is less defined than Rock Cut, since there is not a fence surrounding it. The plot is covered in tundra plants and rocks. This nomination includes the 10’x10’ plot and the remnant steel post.

STATEMENT OF SIGNIFICANCE

The Beatrice Willard Alpine Tundra Research Plots are significant for their affiliation with Dr. Beatrice Willard, an internationally recognized tundra ecologist, who made significant contributions to local, state, and federal environmental policy. The two properties included in this nomination are alpine tundra research plots that Dr. Willard installed in Rocky Mountain National Park in 1959. Both properties represent Dr. Willard's life work as a tundra ecologist and fostered her role as an ecologist, educator, and negotiator. The period of significance begins 1959 and ends in 1979, the date of Dr. Willard's last major scientific monograph about the plots.

The Beatrice Willard Alpine Tundra Research Plots have achieved significance within the last fifty years. They are exceptionally significant "as they represent one of the first U.S. efforts incorporating science into long-term land management and planning. These are among the oldest study plots in alpine tundra or mountain environments in the world."[3] They are most likely the oldest permanent alpine tundra plots in the National Park System. Though alpine tundra research has been done at Olympic (Elk Mountain), Glacier, North Cascades, Mt Rainier, and Grand Teton National Parks, the sites established in these parks were temporary and/or were installed after the Beatrice Willard Alpine Tundra Research Plots.[4] The Beatrice Willard Alpine Tundra Research Plots significance will only increase over time since the scientific data collected is substantial and early, allowing for a baseline by which to compare changes over time. Alpine tundra plants are excellent indicators of environmental change. According to Willard, "The significance of these investigations to understanding the processes of natural vegetation recovery at high altitudes is especially important in light of the scarcity of alpine tundra nationally and globally. Moreover, because alpine tundra sites may have special importance as indicators of subtle changes brought about by increased acid rain, the Trail Ridge exclosures research data take on added value."[5] Ecologist David Cooper at Colorado State University concurs: he collected data in these plots as late as 2001 in order to write a scientific monograph on alpine tundra recovery.[6] These plots have demonstrated the need for careful management of alpine tundra, to protect it from excessive damage from man and continue to be important to ecologists. Furthermore, historian Janet Robertson notes Willard's "studies of how people affect tundra, conducted on Trail Ridge Road in Rocky Mountain National Park, have influenced the administration of public lands throughout the country. This remarkable woman…was a writer, a teacher, a researcher, a superb organizer, and a catalyst for sweeping national and international changes."[7]

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3 David Cooper, Colorado State University, to Jeff Connor, Bill Butler, and Terry Terrell of the National Park Service via email, 9 Jan 2003, on file RMNP.

4 Jerry Freilich, National Park Service, to author via email, 8 December 2006.

5 B.E. Willard, "Funding Proposal for Quantitative Analyses of Data from the Tundra Exclosures, Trail Ridge, Rocky Mountain National Park," 28 March 1988: 3.

6 See email correspondence between David Cooper, Colorado State University, and Jeff Connor, Rocky Mountain National Park, January 2003, on file RMNP. He published that article in 2007 with Willard as the lead author.

7 Janet Robertson, *The Magnificent Mountain Women: Adventures in the Colorado Rockies* (Lincoln: University of Nebraska Press, 1990), 180.

Dr. Beatrice Willard (1925-2003) grew up in California and led her own nature tours by age twelve, and she earned a B.A. in biological sciences from Stanford in 1947. She then attended the National Park Service's Yosemite Field School to learn the naturalist's trade. She worked seasonally as a park naturalist in Lava Beds and Crater Lake National Parks, becoming "one of the first uniformed women naturalists to have worked for the national parks since the 1930s."[8] In the 1950s, she earned a Ford Foundation grant to study European alpine ecology and attend the Eighth International Botanical Congress in Paris. She soon entered graduate school at the University of Colorado, working with Dr. John Marr, founder of the Institute of Arctic and Alpine Research (IAAR).

Dr. Willard's Rocky Mountain National Park study began in 1958, when the park contracted the University of Colorado to conduct an alpine ecology disturbance study. Alpine ecologist Beatrice Willard (advised by John Marr) spent 1958 doing reconnaissance work, and in 1959, she established research exclosures along Trail Ridge Road for an intensive five-year study on the effects of trampling and ecosystem recovery.[9] The park installed the exclosure at Rock Cut, a parking area along the road that had opened in 1933. In contrast, the second exclosure at Forest Canyon was adjacent to a parking area in 1958. Both areas showed great signs of human impact: vegetation was destroyed, lichen removed from rocks, and paths worn into sensitive tundra soils. Although Willard and Marr worked for the Institute of Arctic and Alpine Research associated with the University of Colorado, Willard determined to start "a long-range study of the alpine ecosystems of Trail Ridge that were natural and undisturbed by people." Thus, Willard like many of her contemporaries working in National Parks, extended the park's research budget.[10] Dr. Willard examined the "complexity of dynamic processes set in motion by visitor impact." Using the Zurich-Montpellier School of Phytosociology protocols, she also identified the plant species (including periodicity or when individual plant species were in bud, bloom, and fruiting), made observations about the vitality and general physical condition of plants (number, identity, establishment, and fate of seedlings), monitored which plants moved into open areas, and noted ecosystem processes (such as frost action and erosion). She monitored the plots for approximately forty years.

Dr. Willard authored or co-authored numerous scientific journal articles regarding the plots, including her M.A. in Botany (Plant Ecology) earned in 1960 and her Ph.D. in Botany (Plant Ecology) earned in 1963.[11] As is typical of scientific practices, Dr. Marr was a co-investigator and advisor to Beatrice Willard as she conducted her research while earning her degrees. During the initial five-year study, Marr managed the contract with Rocky Mountain National

8 Polly Welts Kaufman, *National Parks and the Woman's Voice: A History* (Albuquerque: University of New Mexico Press, 1996), 72.

9 An exclosure is a fence used to keep something out of an area during research and monitoring studies. Rocky Mountain National Park has many elk exclosures, to keep elk from browsing aspen and other forage.

10 B.E. Willard and J.W. Marr, "Effects of human activities on alpine tundra ecosystems in Rocky Mountain National Park, Colorado," *Biological Conservation* vol. 2, no. 4 (July 1970): 257-265; John W. Marr and Beatrice E. Willard, "Report on Research from 1 May 1959 to 1 May 1960 on Contract NPS #2 between the Park and the University," University of Colorado, Institute of Arctic and Alpine Research, June 1960.

11 Willard's 1960 degree was indeed a master of arts and not a master of sciences.

Park and was therefore considered by the National Park Service to be the "principle investigator." Because of this initial collaboration, the annual reports and other scientific journal articles were authored by Willard *and* Marr. Dr. Willard remained the lead scientist on the research plots for forty years. Willard's last major monograph on the plots came in 1979. In 2007, a colleague published a report on the regeneration of tundra with Willard as the lead author.

Willard and Marr's reports to the park during the forty year study included recommendations that had immediate management implications. Rocky Mountain National Park made changes to the management of its alpine tundra by implementing several of these recommendations. For example, the National Park Service had built the Forest Canyon overlook distant from the parking area, without a connecting trail for three months. Then, the park installed a sweeping trail, allowing breathtaking views to the valley below. Visitors followed the trail to the overlook, then created a new short-cut back to their cars. In 1959, the park, based on the observations and recommendations of Dr. Willard, paved this short cut. After these improvements, less than one percent of park visitors wandered from the trails. Similarly in 1961 at Rock Cut, the park paved the trail to the Toll Memorial and installed a nature trail along the path. These improvements kept visitors to the paths, reducing trampling on the alpine tundra, just as Willard had proposed.[12]

Dr. Willard's keen negotiation skills helped sway park management to implement many of the recommendations resulting from her research at the plots and change the way the alpine tundra was managed and protected. Dr. Willard held a research permit to continue her monitoring of the plots in the park through 1993 (she made "unofficial" visits annually until a few years before her death in 2003). Her 1992 report noted simply: "There have not been significant fluctuations in plant growth in 35 years."[13] The park today continues to cite her articles and shape tundra policy based on her recommendations.[14]

Dr. Willard's dissertation and subsequent scientific journal articles about her Alpine Tundra Research Plots have been cited by numerous scientists studying alpine tundra, especially related to human impacts. Dr. Willard also excelled in talking to non-scientists about the alpine tundra. In 1962, Dr. Willard started a field seminar program on the alpine tundra in Rocky Mountain National Park, which soon expanded to include other types of landscapes, resources, and eventually art classes, and she inspired other parks to create their own seminar programs. In 1972, Dr. Willard co-authored *Land Above the Trees* with illustrator-author Ann Zwinger. It is *the* seminal book on alpine tundra areas in the United States. This continues to be the most popular selling book on alpine tundra. Zwinger and Willard revised it in 1996. This

12 J.W. Marr and B.E. Willard, *"Persisting vegetation in an alpine recreation area in the Rocky Mountains, Colorado," Biological Conservation* vol. 2, no. 2 (January 1970): 97-104; B.E. Willard and J.W. Marr, "Effects of human activities on alpine tundra ecosystems"; B.E. Willard and J.W. Marr, "Recovery of alpine tundra under protection after damage by human activities in the Rocky Mountains of Colorado," *Biological Conservation* vol. 3, no. 3 (April 1971): 181-190.

13 See Investigator's Annual Reports available in the RMNP Museum Archives/Natural History Collection or Beatrice E. Willard Collection.

14 RMNP Resource Management Files; Timothy Devine, Backcountry/Wilderness Management Plan and Environmental Assessment (National Park Service, Rocky Mountain National Park: July 2001).

book is cited by seventeen other books on ecosystems and the alpine.[15] She co-authored several field guides about alpine wildflowers and three additional naturalist books on alpine tundra.

Dr. Willard's work at the research plots prepared her for public life. It was her on-going monitoring of the Alpine Tundra Research Plots in Rocky Mountain National Park, her ease in communicating to non-scientists about the research, and her ability to influence park decision-makers that earned her respect among alpine ecologists worldwide. Dr. Willard was an important Colorado environmental leader. She directed the Thorne Institute near Aspen, where she worked to negotiate compromises between mining interests and environmentalists. She helped organize the Rocky Mountain chapter of the Sierra Club and the Colorado Open Space Council. She counseled Colorado governors on environmental policies. She established the Colorado School of Mines environmental sciences program, and she was the first woman to chair a department at Mines. During her tenure there, she earned a United Nations Outstanding Environmental Leadership Award. She worked to establish Florissant Fossil Beds National Monument. She convinced Bill Coors to create a recyclable aluminum can after showing him the damage trash can inflict on the fragile alpine tundra.[16]

Dr. Willard's experience in setting management policies based on her scientific observations at her research plots made her highly influential in setting federal environmental policy as well. She worked to get the oil and mining industries and environmentalists to work together. She was a key advisor to Presidents Nixon and Ford, and she was the first woman to serve on the President's Council for Environmental Quality (CEQ). During her tenure at the White House, she consulted on the design and installation of the Alaska Pipeline. She aimed to install the pipeline with little damage to the artic tundra through which it ran; knowledge she gained from her alpine tundra studies in Rocky Mountain National Park. She was an environmentalist, but she was also a pragmatist. Indeed, she did not recommend that Rocky Mountain National Park managers close the alpine tundra, but rather they start an education campaign about how to care for it. This was her goal in life, to teach how man interacts with his environment and how to do so with as little damage as possible. No matter where this mission took her--to Boulder, to Aspen, to Washington D.C., to Alaska, to Golden, in oil company board rooms, in tense development meetings, at press conferences--every summer she returned to her Alpine Tundra Research Plots on Trail Ridge Road, to monitor and study the alpine tundra.[17]

Comparison to other research areas, sites, and plots

To compare the plots to other research areas, it is important to distinguish between research sites or plot and a research station. A research site or plot may be studied for a short time (several years) or monitored for the long term (decades or more) to detect changes over time. A research station is a place, usually associated with a university or non-profit organization, where buildings house researchers who then journey nearby to monitor their research plots and research equipment. These are usually associated with science "think tanks" focused on a

15 According to amazon.com.
16 See historic context at the end of the document for specific references.
17 Again, the historic context provides more details about Willard's national influence.

specific topic or ecosystem. For instance, the University of Colorado has the Mountain Research Station near Nederland, Colorado, run by the Institute of Arctic and Alpine Research (INSTAAR). See footnote below for other arctic or alpine research groups and stations.[18]

Colorado has several field stations, associated either with universities, federal agencies, or non-profit organizations, including:[19]

- INSTAAR (University of Colorado) founded in 1951 uses the Mountain Research Station near Nederland (facilities date to 1921). Niwot Ridge is the Long Term Ecological Research Site (LTER) associated with this research station. Dr. John Marr was instrumental in starting INSTAAR and getting Niwot Ridge designated an LTER site. See explanation below of LTERs.
- Mountain Studies Institute founded in 2002 uses a field station in Silverton (date of facilities not established).
- Catamount Field Station (affiliated with Colorado College and the University of Colorado at Colorado Springs) founded 1998 as Catamount Biological Field Station (Colorado Springs) (date of facilities not established).
- Rocky Mountain Biological Laboratory (originally affiliated with Western State University) founded in 1928 uses facilities in Crested Butte/Gothic (facilities date from 1880s to 1910s).
- Shortgrass Steppe Long Term Ecological Research station (affiliated with Colorado State University) founded in 1960s (facilities date to 1970s).

The National Science Foundation instituted a Long Term Ecological Research program in 1980, and selected twenty-six sites across the country for monitoring. In Colorado, the two sites are at Niwot Ridge and Shortgrass Steppe. Other LTER sites across the country are located in (Everglades) or near (Great Smokies, Olympic) National Park Service units.[20]

There are several other research plots listed in the National Register of Historic Places. All are associated with a university, focus on agricultural research, and are of national significance. The Morrow Plots at the University of Illinois (installed 1876, enlarged 1879) “were the first field

18 After World War II, the federal government, and specifically the Department of Defense, began to fund university-affiliated research stations at high elevations or in arctic regions throughout the nation to support research on astronomy, climate, human physiology at high elevations, and mapping. The University of Colorado founded the Institute of Arctic and Alpine Research (IAAR) (later known as INSTAAR) in 1951 and used the Mountain Research Station (established in 1921) as its high-elevation location (http://instaar.colorado.edu/). The University of California constructed a series of three research stations on White Mountain starting in 1950 (http://www.wmrs.edu). The Ohio State University started the Institute of Polar Studies (later the Byrd Polar Research Center) in 1960 (though data collection in the polar region dates to 1957) (http://www-bprc.mps.ohio-state.edu/). The University of Washington established the Polar Science Center (PSC) in 1978 with research plots in the arctic (http://psc.apl.washington.edu/pscweb2002/homepage.html). The University of Alaska, Fairbanks, founded the Alaska Geobotany Center in 1996 in partnership with INSTAAR, using plots established in Alaska (http://www.geobotany.uaf.edu/aboutus.html).

19 For a list of field stations nationwide, see Organization of Biological Field Stations: http://www.obfs.org.

20 The Long Term Ecological Research Network website is http://www.lternet.edu/, accessed 13 December 2006.

experiment plots established by a college in the United States….The Morrow Plots were of great importance in proving that prairie soil could be depleted by the continuous cropping of corn and, conversely, that crop rotation was an effective method of preventing soil exhaustion."[21] Research Plot 30 (a.k.a. the Agricultural Research Site), planted in 1894 at North Dakota State University, is listed "for its national importance in the history of agricultural experimentation relating to the identification of a pathogen which plagued flax production and the industry." It is also listed under Criterion B for its association with "well known agricultural scientist Henry L. Bolley [who] achieved international acclaim." Research Plot 2 (a.k.a. the Agricultural Research Site), planted in 1892 at North Dakota State University, is listed "for its role in agricultural history as the scene of significant discoveries about the effects of continuous cropping and root rot in wheat cultivation that had widespread implications for the raising of this cereal crop."[22] The Sanborn Field and Erosion Plots at the University of Missouri, established in 1888, have "made significant investigations with different soil treatments and cropping systems….One of the major contributions to agriculture as a result of these experiments was the knowledge that high yields of quality grain may be produced when the land is properly treated with chemical fertilizer or manure."[23] The Magruder Plots of Oklahoma State University were installed in 1892 (moved in 1947) are significant because they "have provided to the area's farmers information that has been crucial to the development of agriculture and thus to Oklahoma's economy."[24]

The Beatrice Willard Alpine Tundra Research Plots differ because they are within the boundaries of Rocky Mountain National Park, and scientists use the plots to study the alpine tundra ecosystem. They are not associated with a research station. At the plots, scientists study ecosystems and plant recovery after human impacts; they do not attempt to improve or monitor agriculture yields. However, like the agriculture plots, they are permanent (meaning the plot locations do not change) and the intention is to monitor and research the plots indefinitely. According to *Land Above the Trees: A Guide to American Alpine Tundra*, "more definitive studies have been made on the tundra of Colorado than any other part of the

21 John D. McDermott, Historian, Division of History, National Park Service, the National Survey of Historic Sites and Buildings, *National Register Nomination for Morrow Plots, Urbane, Illinois*, 12 April 1968.

22 Dr. A.A. Schneiter, Professor of Agronomy, North Dakota State University, *National Register Nomination for Agricultural Research Site/Research Plot 2*, 14 August 1991; Dr. A.A. Schneiter, Professor of Agronomy, North Dakota State University, *National Register Nomination for Agricultural Research Site/Research Plot 30*, 13 August 1991.

23 Donald F. Dosch, Landmark Program Specialist, National Park Service, Midwest Regional Office, *National Register Nomination for the Sanborn Field and Erosion Plots*, 24 January 1973.

24 Joe Stout and Kent Ruth, Oklahoma State University, *National Register Nomination for Magruder Plots of Oklahoma State University*, September 1978.

country," thanks to the work of Frederic Clements on Pikes Peak, Dr. Willard's long-term monitoring at the Alpine Tundra Research Plots in Rocky Mountain National Park, and the on-going science at the Mountain Research Station at Niwot Ridge.[25] The Beatrice Willard Alpine Tundra Research Plots in Rocky Mountain National Park are of exceptional importance to alpine tundra ecology due to their longevity and scope of scientific study.

25 Zwinger and Willard, x-xi.

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GEOGRAPHICAL DATA

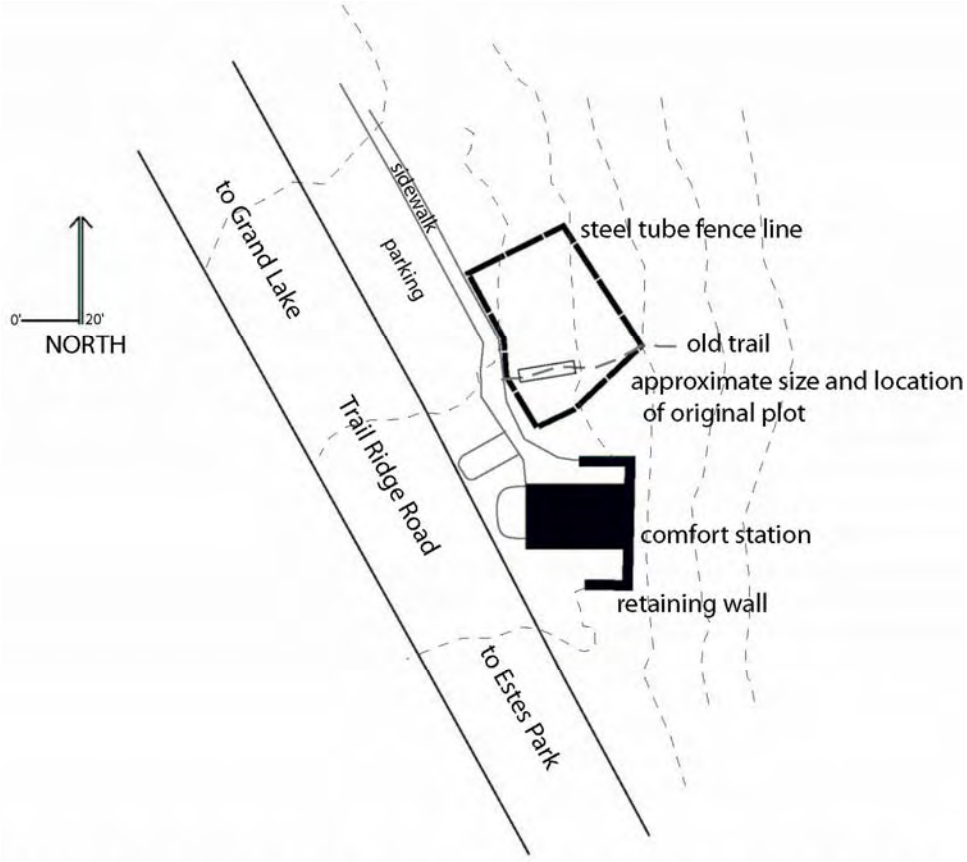
BOUNDARY DESCRIPTION

Both research plots are within the boundary of Rocky Mountain National Park. The two plots form a discontiguous district. The Rock Cut Plot boundary is the 50'x40' area surrounded by a steel fence, just east of the parking lot. The Forest Canyon Plot includes an unfenced 10'x10' area just west of the parking lot and south of the trail to Forest Canyon Overlook that represents the actual study area. The exact boundaries are defined by the scale maps labeled "Beatrice Willard Alpine Tundra Research Plot at Rock Cut" and "Beatrice Willard Alpine Tundra Research Plot at Forest Canyon Overlook."

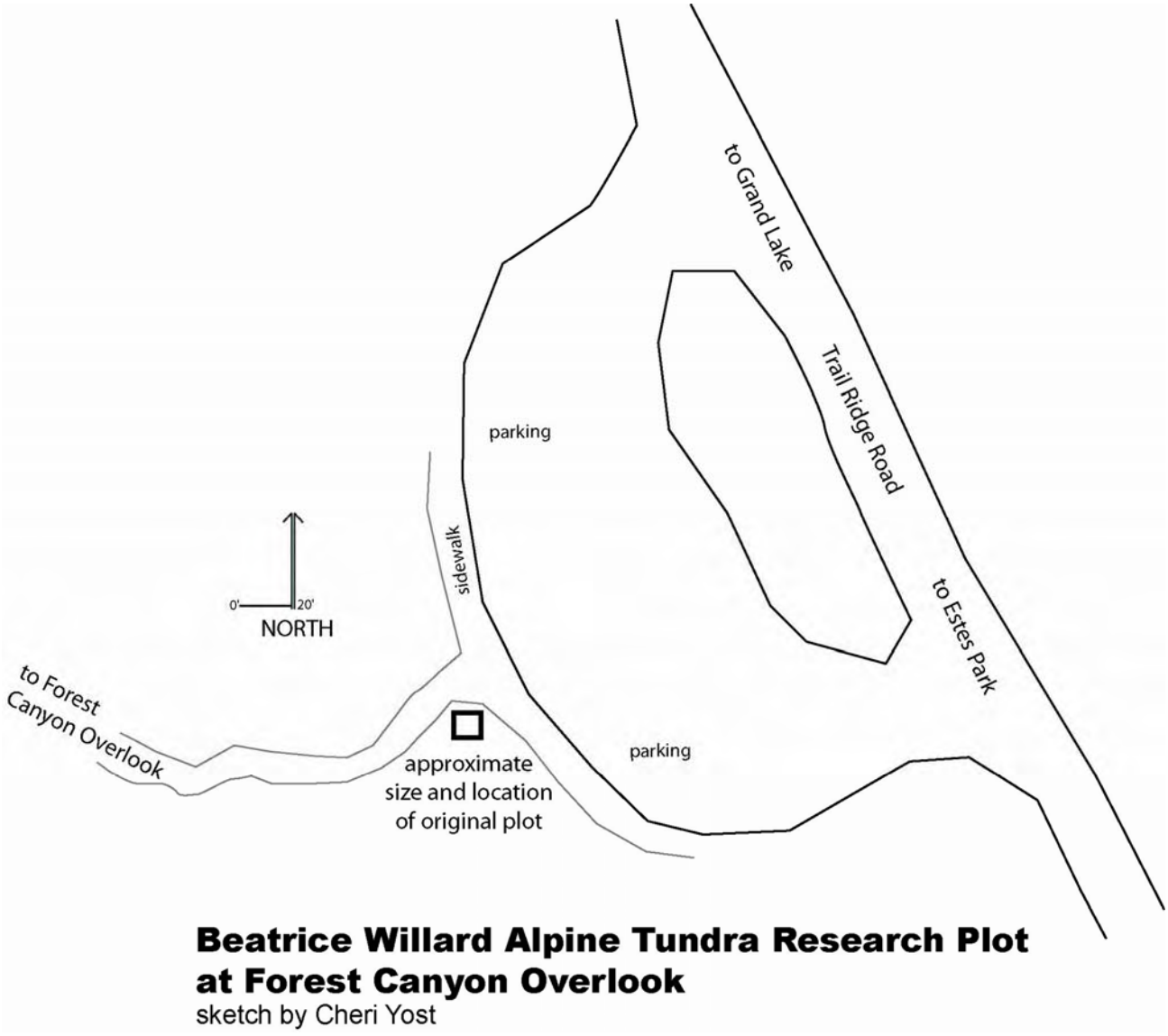
BOUNDARY JUSTIFICATION

The boundary at Rock Cut represents the area enclosed by the steel tube fence (50'x40') that protects the 100 square feet plot. The boundary at Forest Canyon only represents the 10'x10' plot that Willard monitored.

ADDITIONAL DOCUMENTATION: SITE MAP

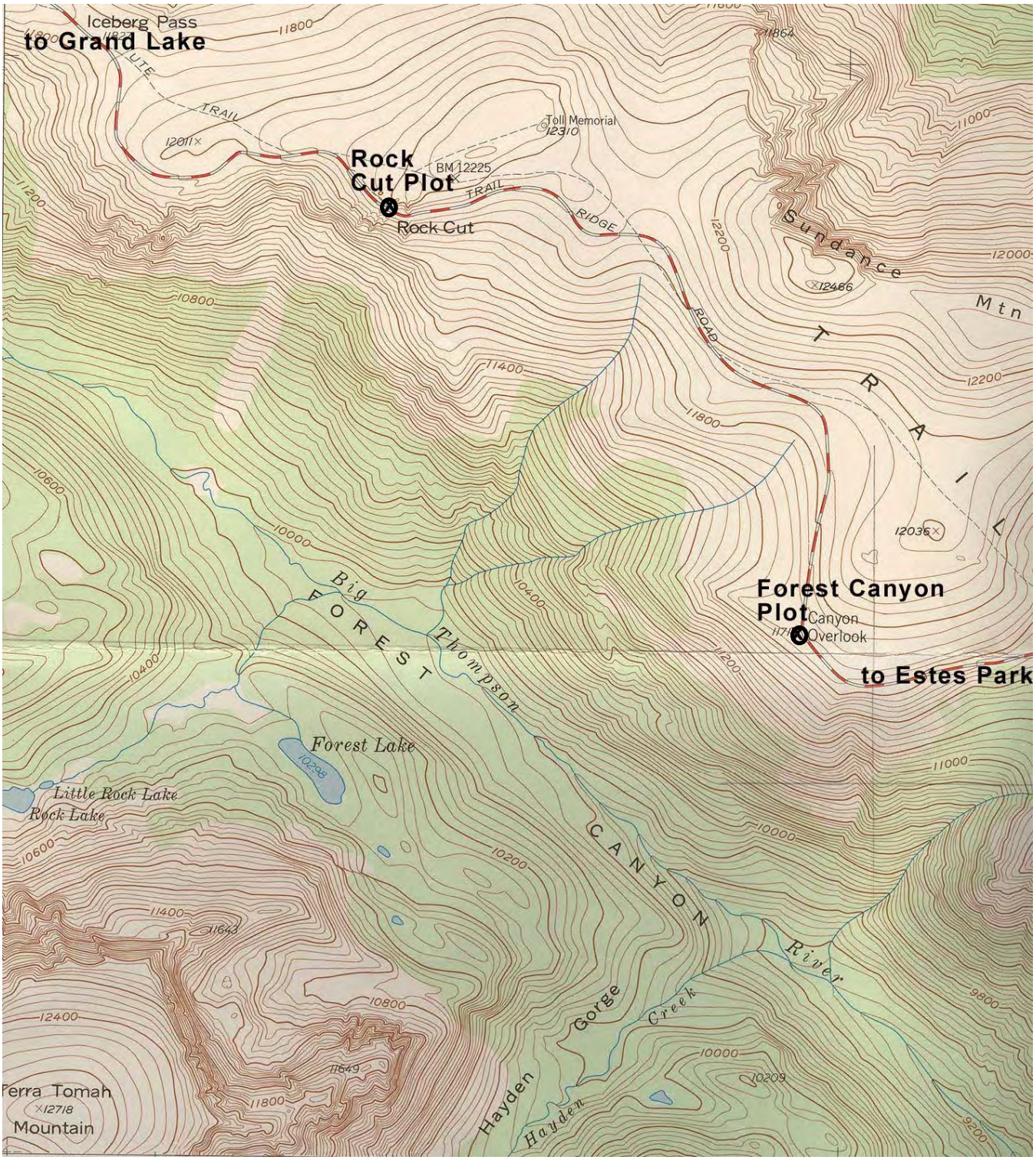


Beatrice Willard Alpine Tundra Research Plot at Rock Cut
sketch by Cheri Yost



Beatrice Willard Alpine Tundra Research Plot at Forest Canyon Overlook
sketch by Cheri Yost

ADDITIONAL DOCUMENTATION: USGS MAP



7.5 minute Trail Ridge, Colorado (1957, photorevised 1977)

ADDITIONAL DOCUMENTATION: PHOTO LOG

Willard, Beatrice, Alpine Tundra Research Plots
Larimer, Colorado (Rocky Mountain National Park)
Photographer, Adam Thomas
September 15, 2006
Negatives filed--no negatives, digital photographs

01) CO_ROMO_Willard1: Rock Cut Plot, View to northwest
02) CO_ROMO_Willard2: Rock Cut Plot, View to the north
03) CO_ROMO_Willard3: Rock Cut Plot, View to the northeast
04) CO_ROMO_Willard4: Forest Canyon Plot, View to the southwest
05) CO_ROMO_Willard5: Forest Canyon Plot, View to the northeast
06) CO_ROMO_Willard6: Forest Canyon Plot, View to the east

ADDITIONAL DOCUMENTATION:

A Brief Biography of Bettie Willard

Stephen and Beatrice Willard welcomed a daughter, also named Beatrice (called Bettie), on December 19, 1925. A landscape photographer and painter, Stephen took young Bettie along on his outings. Mrs. Willard shared this passion for nature, wildlife, and wildflowers and the land. She was active in the local chapter of the Garden Club of America. The family divided its time between the Mohave Desert and the Sierra Nevada. In these landscapes, Bettie began her lifelong career as environmental educator: by age twelve she guided friends to flowering plants and as a high school student started her own guiding business in the Mammoth Lakes, California, region.

Beatrice Elizabeth Willard enrolled in Stanford to pursue formal science training. In 1947, she graduated with a degree in Biological Sciences. She immediately enrolled in the Yosemite Field School of Natural History with hopes of becoming a National Park Service ranger. Since 1925, the National Park Service, with assistance from the California Fish and Game Commission and local universities operated a Field School to train park naturalists in the "study of living things in their natural environment." The seven week course had a prerequisite of two years of college work or equivalent and did not charge tuition. "Each student is expected to know and to identify all of the more common Yosemite trees, shrubs, wild flowers, insects, fishes, amphibians, reptiles, birds, and mammals."[26] It was not uncommon for women to be members of the class, though the ratio of males to females was often four to one. Still, when Willard completed the training in 1948, she could not find work as a National Park Service ranger-naturalist, which was still a relatively new career field defined and almost exclusively held by men.[27] Although women could break into the naturalist field--and many did so through the path of botany, an acceptable scientific field for women at the time--the National Park Service would not hire them. After the Field School, Willard told John Doerr, the National Park Service chief naturalist, that she wanted a job, to which he replied, "Did you realize we never hire women?" Dorr Yeager, naturalist for the Western Region, surveyed the superintendents to see if they would hire a woman. Four agreed they would, but Willard did not get a job with the National Park Service.[28]

Like many women interested in "nature studies," Willard started teaching. She began in Salinas, California, then Oakland, California, then to Tulelake High School in Oregon. The

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26 Harold C. Bryant and Wallace W. Atwood, Jr., *Research and Education in the National Parks* (Washington, D.C.: U.S. Government Printing Office (USGPO), 1932), Part I The Educational Program in the National Parks: Yosemite School of Field Natural History (no page number listed), available at http://www.cr.nps.gov/history/online_books/resedu/, accessed 5 January 2004.

27 Lodge and hotel owners hired many women as guides, including park father Enos Mills who owned the Longs Peak Inn. The first National Park Service "licensed" and designated female naturalists were Esther and Elizabeth Burnell who worked in Rocky Mountain National Park in 1917. Beginning in 1925, Ruth Ashton Nelson, one of Willard's mentors, worked at Rocky Mountain National Park's information desk. Although Nelson graduated from the Yosemite Field School in 1928, she continued to work the information desk until 1931, when she resigned after her marriage. Kaufman, 69.

28 Ibid., 70-72.

school had ten teachers and 140 students. She taught English, social studies, and all sciences except for physics. In the summer of 1952, she at last started working for the National Park Service. She worked for a summer at Lava Beds and then Crater Lake, becoming "one of the first uniformed women naturalists to have worked for the national parks since the 1930s."[29]

Woman ecologists were not unusual in the twentieth century; Willard was part of a long line of ecologically-interested, female scientists. According to Jean Langenheim, past president of the Ecological Society of America (ESA), early women ecologists were difficult to recognize because early pioneers in ecology were often chemists or biologists until 1893 when "ecology" was formally adopted as a sub-discipline of physiology at the Madison Botanical Congress.[30] Beginning early in the twentieth century, many women earned doctorate degrees in ecology (most commonly via a botany degree) at universities such as Chicago, Nebraska, Minnesota, Cornell, Wisconsin, and Illinois. However, "When women…sought jobs to which their doctorates seemed to entitle them, they generally found their options limited to teaching in high schools or women's colleges--and in some colleges only if they remained unmarried."[31] Others, such as Edith Clements and Edith Shreve earned doctorates and worked along side their more famous ecologist-husbands. Still others, like the celebrated Rachel Carson, became environmental advocates through their writing.[32] Willard, while following in the early tradition of entering ecology through botany, was part of a new generation of female ecologists conducting independent field work and, later, holding high posts in public office.[33]

While at her teaching post in Oregon, the Ford Foundation awarded Willard a one-year, $4,600 fellowship to study European alpine ecology and to attend the Eighth International Botanical Congress in Paris. Willard visited botanical gardens in England, Scotland, Paris, and Geneva. She studied in Geneva and Zurich, Switzerland; Montpellier, France; and Sweden. She met Ruth Ashton Nelson, a prominent author and botanist from Colorado at the Botanical Congress. Contacts made on this trip led to lifelong relationships, both personal and professional. By the end of the Congress, Willard was determined to study American alpine vegetation. She returned to Tulelake with this in mind.[34]

While at the Botanical Congress, Willard discovered the Institute of Arctic and Alpine Research

29 Ibid., 72.

30 Jean Langenheim, "The Path and Progress of American Women Ecologists", *Bulletin of the Ecological Society of America*, vol. 69, no. 4 (December 1988), 184.

31 6% of charter members in ESA were women. Langenheim 184 and 191.

32 Carson earned an MA in zoology from Johns Hopkins University in 1932. She wrote radio scripts for the U.S. Fish and Wildlife Service during the Depression, and later served as the Editor-in-Chief of all U.S. Fish and Wildlife Service publications. She translated "government research into lyric prose." Her most famous work, *Silent Spring*, came in 1962. Available on Rachel Carson website by Linda Leer, http://www.rachelcarson.org, accessed 22 Feb 2004.

33 Several historians have linked the feminist and environmental movements in what is called ecofeminism. The leading historian in this field, Carolyn Merchant, compares the feminist and ecological movements of the early 1970s in her book, *Earthcare: Women and the Environment*. Merchant writes that the two movements had similar values: all parts of a system have equal value, the Earth is a home, process is primary, there is no free lunch. Carolyn Merchant, *Earthcare: Women and the Environment* (New York: Routledge, 1996).

34 "Tule High Teacher Winds Fellowship," Undated and unreferenced newspaper article in the Beatrice E. Willard Newspaper Scrapbook (BEWNS) on file in Rocky Mountain National Park, 3.

(IAAR) in Boulder, Colorado.[35] At the Institute, Willard could apply the methods learned in Europe to her research. Willard began to monitor select Colorado alpine areas. In 1958, she began a study in Rocky Mountain National Park, advised by IAAR scientist Dr. John Marr. In 1959, the park installed two exclosures for her research along Trail Ridge Road: one at Rock Cut and one at Forest Canyon Overlook. For this work, the University of Colorado bestowed upon her both a M.A. in Botany (Plant Ecology) earned in 1960 and a Ph.D. in Botany (Plant Ecology) earned in 1963, though she continued to monitor the plots for the next forty years. The focus of her research was to study alpine plant associations and to determine recovery of alpine tundra after human impacts. She also studied human impacts on vegetation around Bear Lake, a popular spot in the subalpine. Willard's recommendations--that the park should prohibit people from abusing fragile ecosystems in the park, maintain good trails, designate and assign campsites to backpackers--were parkwide recommendations. Willard found that the tundra was especially fragile. Large numbers of visitors could destroy it rapidly. The recovery time would be many times longer than the destruction time—the plots had not recovered even after 35 years of monitoring. According to Willard, the National Park Service took a painfully long time to create new policies to protect the lands within its boundary.[36]

Another of her recommendations to the park was to initiate an education campaign to teach visitors how to use the alpine tundra without harming it. Willard preferred field studies; ecology could not be taught in lecture halls. So, having earned both her master's and doctorate in Botany (Plant Ecology) from the University of Colorado, she began teaching alpine ecology. In 1962, she conceived, initiated, directed, and taught the first field seminar in Rocky Mountain National Park. That first year, sixteen students--many from universities around the nation--paid the ten dollar fee. From Willard's class in 1962 grew the Rocky Mountain Field Seminar program. The field seminar program continues to this day, offering more than one-hundred classes from spring to summer, including alpine tundra ecology. Other national parks have copied this field seminar model. When in Rocky Mountain National Park, Willard always took her students to the Trail Ridge Road plots. According to one student, "she often asked the tundra seminarians to come assist her with the annual inventories of the plots - an effort to assure continued interest in and data collection of the plots."[37]

Her teaching experience in Rocky Mountain National Park quickly expanded to other alpine tundra teaching initiatives. Willard continued to teach field seminars in Rocky Mountain National Park and other places including the Aspen Center for Environmental Studies. Her field instruction included alpine ecology, wildflower identification, mountain ecology, and identification of grasses, lichens, and mosses.[38] In 1963 Willard co-authored a booklet, "Alpine Wildflowers of Rocky Mountain National Park," as a volunteer effort to benefit the Rocky Mountain Nature Associates, the park's non-profit friends group, which co-sponsored Willard's early field seminars.

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35 For a history of IAAR, see footnote 85.

36 However, years later she found that almost all of her original concerns had been addressed.

37 Chase Davies, student of B.E. Willard and alpine ecology teacher.

38 She taught the field seminar program for 30 years. She also taught seminars near Aspen for more than 20 years. *The Aspen Times*, 24 July 1980, in BEWNS, 54; *The Aspen Times, 29 July 1982,* in BEWNS, 55.

Thanks to her work in Rocky Mountain National Park, Willard soon became a nationally recognized expert in alpine ecology. In 1970 she published results of her ongoing research in the park as "Plant sociology of alpine tundra, Trail Ridge, Rocky Mountain National Park, Colorado" and “Effects of human activities on alpine tundra ecosystems in Rocky Mountain National Park, Colorado.” In 1971, came the article, "Recovery of alpine tundra under protection after damage by human activities in the Rocky Mountains of Colorado." In 1972 Willard co-authored her seminal book *Land Above the Trees: A Guide to American Alpine Tundra*. Willard's co-author, Ann Zwinger, drew beautiful line drawings of alpine plants. Willard wrote from her vast knowledge of the alpine tundra, based largely on her research at the plots in Rocky Mountain National Park. It was then the "only book describing alpine regions of the United States."[39] Now in its fourth printing, it covers plants, animals, climate, geology, land forms, and human history. It remains a standard reference for alpine tundra ecology and wildflower identification. In 1976 she wrote *Alpine Wildflowers of the Rocky Mountains*. In 1979, she wrote a major monograph on the Alpine Tundra Research Plots entitled “Plant Sociology of Alpine Tundra, Trail Ridge, Rocky Mountain National Park, Colorado.” She co-authored several guidebooks in the 1980s and 1990s and her last major publication came in 2000.

Willard's experience at Rocky Mountain National Park taught her how to influence policy makers and educate people about ecosystems. To advance these experiences, in 1965 Willard became executive director of the Thorne Institute, an environmental education and advocacy group based in Boulder, Colorado. In 1967, she became vice president, in 1970 its president, and later served on the Board of Trustees. Founded in 1954, Thorne's mission was to "help people to understand interrelationships in the environment and develop a personal concern for the survival and sustainability of the Earth." While at Thorne she helped develop the nation’s first environmental impact analysis procedures. Thorne became the place to learn environmental review procedures, assisting "business, industry [including the mining and burgeoning ski industries] and government in applying ecological principles to solve unusual and challenging environmental problems, and to show how ecology and economics are intertwined."[40]

At Thorne's helm, Willard thrived on creating environmental partnerships and moved to the forefront of Colorado's environmental movement. She would often meet with "regional leaders in environmental control." And she encouraged a "Committee on the Environment," a national planning agency reviewing "water and air quality, weather qualifications, waste disposal, noise pollution, herbicides and pesticides."[41] During this time she helped develop the Aspen Center for Environmental Studies, the Colorado Open Space Council, and the Colorado Chapter of the Nature Conservancy. She helped found and was first president of the Colorado chapter of

39 Zwinger and Willard, ix.

40 Later the mission would become education centered: "Founded in 1954, Thorne’s mission is to build Earth stewardship by connecting kids to nature through hands-on environmental education." Available at Thorne Institute website, http://www.thorne-eco.org, accessed 11 December 2006.

41 BEWNS, 9.

the Sierra Club.[42] She served on the Colorado Department of Health's Air Pollution Control Commission. She was trustee and secretary of the Rocky Mountain Center on the Environment, which was formed in 1968 to act as a neutral party in mediating environmental controversies. She met Bill Coors, who later credited Willard with convincing him to invent the recyclable aluminum can.[43]

By the late 1960s, Willard earned a reputation for environmental advocacy and mediation. In 1966, Willard created the Experiment in Ecology, an interdisciplinary approach to engineering, economics, and environment. At the first meeting, groups as diverse as the Colorado Chamber of Commerce, the Colorado Association of Manufacturers Environmental Committee, and the Colorado Open Space Council met to discuss major environmental issues facing the state. The rules of the meeting required candid questions and answers, content of discussion was kept within the circle at least initially, and when members agreed the participants would be free to discuss outside the group. Confidentiality allowed for honest dialog. During this first meeting, Willard met a young lawyer from American Metal Climax, a mining company eyeing the Williams Fork valley. He proposed that environmentalists assist with the development of the Henderson Mine. These citizen conservationists--a lawyer, a chemist, a metallurgist, a wilderness guide, and the ecologist Willard--met with executives from Climax. She noted that "the miners were really learning the concern and principles of ecology and the environmentalists were learning the problems and needs of mining engineers."[44] The group moved roads to save trees, dug an underground tunnel to move the tailings disposal pond to a less visible valley. This Experiment in Ecology fostered "abundant measures of openness, objectivity, willingness to tell all, ability to listen and to believe, but to question until truth comes forward." [45]

Three years later in 1969, the Experiment in Ecology would be translated into law in the National Environmental Policy Act (NEPA). NEPA is the seminal environmental law in place today, which requires all actions of a federal agency to be reviewed for impacts as Willard devised in the Experiment in Ecology. Willard noted that "the use of this process which requires looking at all feasible alternatives and weighting them from all various standpoints--

42 In 1965 she helped organize the Rocky Mountain Chapter of the Sierra Club. “In Memory: Extraordinary Ecologist, Beatrice E. Willard, Ph.D.,” *Peak & Prairie* (the newsletter of the Rocky Mountain Chapter of the Sierra Club), vol. XXXVII, no. 2, April/May/June 2003, 6.

43 Bill Coors said Dr. Willard came to him "with some pictures that she had taken up in the alpine tundra above timberline. One of them was of our beer can. She had taken a picture of our can in the tundra, then taken the can out and taken another picture of the depression the can had made. Then she showed me another picture she'd taken 10 years later. The depression was still there." Nancy Nachman-Hunt, "Mr. Aluminum can," *Boulder Weekly*, 22 March 2001, available at http://www.boulderweekly.com/archive/032201/coverstory.html, accessed 5 January 2006. More on Bill Coors and the aluminum can may be found in Tachi Kiuchi and Bill Shireman, *What We Learned in the Rainforest: Business Lessons from Nature* (San Francisco: Berrett-Koehler Publishers, Inc., 2002), excerpts available at http://www.ecoiq.com/magazine/features/feature131.html, accessed 5 January 2006.

44 B.E. Willard, "Ecological Considerations in Environmental Improvement," speech to the 21st Annual Pennsylvania Chamber of Commerce, Harrisburg, PA, 10 May 1973, in the collection of Chase Davies.

45 The 1966 panel on which she sat to discuss Population and the Quality of Life included then Denver attorney Richard Lamm, later governor of Colorado. *Boulder Camera,* 17 November 1966; B.E. Willard, "Why Communicate About the Environment?" a speech to Semi-annual Meeting of the Environmental Quality Committee of the National Association of Manufacturers, Fort Lauderdale, Florida, 16 May 1976, in the collection of Chase Davies.

economic, engineering, social, ecological and many others--is enabling agency administrators, both federal and state, corporate and executives, and the interested public to cooperate in producing decisions that accommodate all interests in a balanced fashion."[46] The Experiment in Ecology also led to continuing dialog amongst the nation's environmental leaders through the annual Seminar on Environmental Arts and Sciences (SEAS). The first seminar brought together members of federal agencies, the chairman of Consolidated Edison, members of the Canadian government, university professors, and was endorsed by Colorado Governor John Love. The 1984 seminar included state and national leaders from the universities in Colorado, Georgia, Minnesota, New Mexico, Wyoming, Virginia, Michigan, and Washington; federal agencies including the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, and the Bureau of Mines; business representatives from Mobile Oil, Adolph Coors Company, Kellogg Corporation, Getty Mining, and Anaconda Minerals; non-profits including the Sierra Club, the Environmental Defense Fund, and Thorne; and state leaders including Governor Richard Lamm.[47]

By the early 1970s, Willard was internationally recognized for her pioneering work and research in applied ecology and for her ability to conduct environmental mediation and partnerships. In 1972, President Richard Nixon offered her the position of Commissioner of the Atomic Energy Commission, which she turned down.[48] In October 1972, she accepted a position on the President's Council for Environmental Quality (CEQ). Established under NEPA in 1969 (later modified under the Environmental Quality Improvement Act of 1970), the CEQ "reports annually on the state of the environment; oversees federal agency implementation of the environmental impact assessment process; and acts as a referee when agencies disagree over the adequacy of such assessments." Furthermore, "NEPA assigns CEQ the task of ensuring that federal agencies meet their obligations under the Act." Appointees must be

46 B.E. Willard to National Association of State Development Agencies, White House Executive Office Building through John Vicerman, 16 March 1976, in the collection of Chase Davies. According to the Thorne Institute, the Henderson Mine "Experiment in Ecology was actually the very first Environmental Impact Study (EIS) done in the United States, long before they were required later by the National Environmental Policy Act (NEPA)." "Thorne Institute Proudly Celebrates 50th Anniversary," *Dragonfly News* (Newsletter of the Thorne Ecological Institute), Winter 2003, available at http://www.thorne-eco.org/pdfs/newsletter03view.pdf, accessed 11 December 2006.

47 Thorne Ecological Institute, "Seminars on Environmental Arts and Sciences, Summary of 1984 Proceedings," June 1985; *The Denver Post*, 24 June 1970.

48 Willard gave this explanation of her early refusals to serve: "Early in May, 1972 people in the White House charged with identifying women qualified for public office called me to inquire of my interest and availability. Flattered as I was at the inquiry, I pointed out that I was happily submerged in productive, innovative application of ecology to decision-making. As the single professional ecologist on the staff, I faced an extremely demanding spring, summer and fall with field work on over 20 contracts in "applied ecology", together with the annual Seminar on Environmental Arts and Sciences and the Alpine Seminar in Rocky Mountain National Park. Some staff additions were in the process of taking place but would not be functional until mid-summer at the earliest. So I thanked the White House people for considering me, but no thanks - at this time….Later in May, again in June and July I was approached by various people in Washington in regard to progress toward freeing my time for an appointment - this time as a member of the President's Council on Environmental Quality. Still, it was impossible for me to consider abandoning an organization I had devoted my talents to developing - to the end it was finally becoming recognized as a leader in the field of practical applications of the science to assisting agencies, organizations and corporations….By September, the Thorne Ecological Institute Executive Committee had decided that I must go to Washington. I was confirmed by the U.S. Senate in early October and sworn in as a member of the council on 19 October, 1972." Bettie Willard to Friends in a 1973 Christmas letter written from Washington DC, on file RMNP.

approved by Congress.[49] When Willard left the Thorne Ecological Institute to join the CEQ, she received congratulatory letters from a diverse group of public agencies and non-profit organizations, testifying to her abilities as an environmental advocate and no doubt reflecting her high-ranking position in the administration. [50]

Willard's nomination to the CEQ was significant because she was the first ecologist and the first woman appointee. In his congratulatory letter, Perry Hagenstein of the New England Natural Resources Center wrote: "it is nice to have a woman on the Council" and continued with "I am pleased that there is now an ecologist, and one of real standing."[51] Russell Train, the chair of the CEQ (in 1973 Train was appointed Environmental Protection Agency administrator), bragged that Willard was the "first trained ecologist and the first woman member" and that Willard "had been chosen not because she was a woman, but because she was an extremely competent woman."[52]

As feminism came to a climax during the early 1970s, Willard was at the forefront.[53] Historian Margaret Rossiter wrote of this period: "Hundreds of women and other feminists, becoming aware for the first time of the enormity of their marginalization and exploitation and the scale of the resources denied to them, were energized to seek change immediately." The biggest change came in 1972 with equal pay and affirmative action in academia.[54] In 1975, Willard

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49 White House Council on Environmental Quality website, http://www.whitehouse.gov/ceq, accessed 10 December 2003.

50 L.O. Timblin, Jr., Chief of the Applied Sciences Branch of the Bureau of Reclamation in Denver wrote: "your good work in trying to bring an intelligent concern to the management, use, and protection of our natural resources has been well rewarded." The Denver Chamber of Commerce noted Willard's "knowledge and objectivity in the field of environmental affairs." A fellow ecologist at the University of Michigan wrote of her "vast reservoirs of information, experience and ability" and her "boundless integrity." The Colorado state director of the National Park Service wrote the appointment was "fitting recognition of [her] long and faithful contribution to the conservation effort." Letter writers noted her "well-balanced viewpoint," her "sound judgement," her "dedicated and competent service," and her "usual competent manner." A member of the Southeastern Colorado Water Conservancy District wrote "thanks to your leadership, I feel a great deal of understanding was reached between individuals and organizations which might have otherwise remained apart." Other letters came from the Air Pollution Control Commission, the Coordinator of Environmental Problems in the Colorado Governor's office, members of Colorado's congressional delegation, the U.S. Army Engineering Division in New York, a commissioner of the U.S. Bureau of Reclamation in Washington, D.C., the U.S. Environmental Protection Agency, the midwest regional director of the National Park Service, the Rocky Mountain Center on Environment, the New England Natural Resources Center, the Society for Range Management, the Director of Utah's Salt River Project, and the President of the Sierra Club. L.O. Timblin, Jr. to B.E. Willard, 4 October 1972; Rex Jennings to B.E. Willard, 25 October 1972; Mark W. Paddock to B.E. Willard, 27 October 1972; J.L. Dunning to B.E. Willard, 5 October 1972; Karl F. Wenger to B.E. Willard, 26 October 1972; A.J. Pfister to B.E. Willard, 4 October 1972; Alfred L. Greibling and Gerald Kessler to B.E. Willard, 26 October 1972; Francis T. Colbert to B. E. Willard, 10 October 1972; Charles L. Thomson to B.E. Willard, 4 October 1972. All on file RMNP.

51 Perry Hagenstein to B.E. Willard, 15 November 1972, on file RMNP.

52 *The Denver Post,* no date, in BEWNS, 10.

53 Ann Schmidt, "Dr. Beatrice Willard: Boulderite Cautiously Optimistic on Outlook for Environment," *The Denver Post,* March 18, 1975. Always the activist, Willard helped found the group Executive Women in Government, to help orient women to public service at the executive level. Executive Women in Government website, http://www.execwomeningov.org, accessed 5 January 2006.

54 Margaret Rossiter, *Women Scientist in America: Before Affirmative Action 1940-1972* (Baltimore: Johns Hopkins University Press, 1995), xviii. Dr. Terry Terrell, former Rocky Mountain National Park Science Officer, gave this perspective on her experience as a woman scientist during this time period: "Female-scientist was an oxymoron." She said that today people acknowledge one first as a scientist and then one's gender, if that makes a difference. Terry Terrell, brief interview by author, 20 January 2004.

pointed out that

> "of a female population of about 107 million, there are today [1975] just over 100 women in posts of command or in high supervisory or policy making positions compared to several thousand men….Only ninety-three women have been elected to the Congress. There have been only three women Governors, three women cabinet members, and 15 women Ministers and Ambassadors….Today there is one woman in the cabinet, no women in the Senate, one woman Governor, and only 18 women representatives."[55]

At her post with the CEQ, Willard was an articulate advocate for the environment—just as she had been in Rocky Mountain National Park. Willard constantly fostered the notion that engineering, environment, and economics could work together. Willard believed that by applying technology, man would learn to harmonize with the natural ecological processes. She spoke to diverse audiences, and she energized leaders of government and industry to act responsibly regarding the environment. Fundamental to her messages was that the National Environmental Policy Act was necessary to reconcile economics and environment. She often called it "revolutionary" and an "Environmental Bill of Rights." She believed that NEPA was the "most encompassing and significant of all the legislation that resulted from the ground-swell of concern about the quality of our environment in the late 1960s…..This Act is a monumental, far-reaching piece of legislation."[56] Willard was especially fond of the full public disclosure required under NEPA, exactly the approach she had been advocating for ten years.

As NEPA became the broadest environmental legislation ever passed, Willard was in charge of piloting it. Willard traveled extensively as a member of the CEQ and spoke to a diverse number of audiences. In 1974, Willard was the keynote speaker at the Vail Symposium.[57] She spoke to municipal planners.[58] She spoke to chambers of commerce, wildlife and natural resource groups, science and technology groups, the National Sand and Gravel Association, the National Association of Manufacturers, Public Service Company, American Right-of-Way Association (a group to acquire and design utility corridors), Conoco executives, and at the High-elevation Revegetation workshop. She gave commencement speeches and dedicated

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55 B.E. Willard, "Human Ecological Channels for Change," a speech to students and faculty Southern Oregon college, Ashland Oregon, 5 August 1975, in the collection of Chase Davies.

56 B.E. Willard, “Address at Dedication of the Alfred H. Stockard Lakeside Laboratory,” a speech at the University of Michigan at Pellston, MI, 30 June 30 1973, in the collection of Chase Davies.

57 According to its website: “In 1971, the Vail Symposium was conceived as a once-annual, weekend “think tank” by Vail Town Manager Terry Minger, and supported by Mayor John Dobson and others to formulate goals and ideals for the purpose of guiding future change in the nine-years-young mountain recreation community. In the early years, the Symposium fostered the development of the Vail master plan, the formation of the Eagle Valley Forum, and was the platform from which President Gerald Ford made a major energy policy speech in 1976.” Available at http://www.vailsymposium.org/Pages%202(Programs)/history.html, accessed 27 December 2006.

58 She told the Conference on Planning Alternatives for Municipal Water Systems that "while human activity does not appear to be directly responsible for regional and global drought, we should look in a mirror, rather than at the skies, to see the cause of many other current water problems." B.E. Willard, "Planning Alternatives to Municipal Water Systems," a speech to Conference on Planning Alternative for Municipal Water Systems, Holcomb Research Institute, Butler University and the Technology Transfer Program, U.S. Environmental Protection Agency, French Lick, Indiana, 11 October 1973, in the collection of Chase Davies.

buildings. She spoke to engineers, environmentalists, a grassroots group trying to save Indiana Dunes, interior designers, and environmental educators. She spoke in all regions of the country and abroad.[59]

Willard was at the center of the national energy crisis when she served on the CEQ, and her experience in Rocky Mountain National Park as both an alpine tundra researcher and a policy maker put her at the forefront of the Alaska pipeline planning. She acted as mediator: "The action groups, the researchers and the people of the pipeline don't talk with each other, but they all do talk with me."[60] She made thirteen trips to Alaska and logged over one-hundred ten hours in the air evaluating the proposed route. To protect the environment around Valdez, Alaska, she traveled to Eurport in Rotterdam, Holland, then the busiest port in the world, to consult with officials about how they prevent accidents. As a leading alpine ecologist, Willard was able to make recommendations regarding probable effects of any oil spill, revegetation efforts, and permafrost.[61] She often commented on the energy crisis with grave warnings to "awaken man to his relationship and responsibility" and that man avoid the edge or "threshold, beyond which there is no return." She truly believed that with national coordination, the energy crisis could be dealt with as efficiently as the nation fought World War II.[62]

After resigning from the CEQ in 1977, Willard returned to Colorado to join the faculty at the Colorado School of Mines and her place as a state-wide environmental advocate. She was Mines' first environmental sciences professor. Having spent five years talking to decision and policy makers, she brought her message about integrating engineering, ecology, and economics to future decision-makers. In September 1978, Mines offered the first minor program in Environmental Sciences; by 1982, thirty-two students had earned the honor. The minors focused on environmental impact analysis, pollution control, environmental site planning and design, marine environments, and energy conservation. In her years as advisor to presidents, Willard worked on all these aspects of ecology.[63]

Willard's experience at Mines was not without challenges. She struggled with the school's board of directors, who refused to create an environmental sciences department until 1981. Female colleagues looked to her leadership as they fought gender discrimination (which Willard only referred to as gender ignorance). Willard mentored countless students on her environmental philosophies. She wanted her mining students to study the socioeconomic, environmental, and economic impacts of development, to analyze the political climate, and to

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59 While in Washington she also chaired a sub-committee of the Federal Interagency Committee on Education whose task it was to draw up an outline of what the content should be for environmental education. The group published a booklet entitled Fundamental of Environmental Education. B.E. Willard to Jean Langenheim, 1 March 1986, on file RMNP.

60 Notes from a meeting in Rotterdam, 11 April 1975, on file Rocky Mountain National Park.

61 "The Alaska Pipeline was going to bury an uninsulated pipeline in permafrost ground, then run 180 degrees F oil through it! It would have eventually created and been lost in the resulting bog. As it was, the company lost $2.5 billion and several years of time and effort, by not listening to Dr. Max Brewer, one of the world's foremost permafrost engineers. He offered to help them, free, at the very beginning. When the pipeline was finally built, it essentially followed his initial recommendations." *The Mines Magazine,* April 1981, 5, in BEWNS, 13-2. The official website for the Trans Alaska Pipeline is http://www.alyeska-pipe.com/.

62 B.E. Willard, "Ecological Considerations in Environmental Improvement," speech.

63 *Oredigger* (Colorado School of Mines newspaper), 19 Sep 1978, in BEWNS, 24.

create effective public relations campaigns. She wanted them to be well-rounded and open minded.[64]

During and after her time as educator at Mines, Willard continued to be a public servant and received awards of recognition. In 1976, Willard was secretary of the National Energy Resources Organization, a member of the Advisory Committee for Conservation Education to the State of Colorado, a member of the Colorado Environmental Inventory Advisory Committee, and chairman of the Denver Olympic Planning Committee.[65] She also contributed to the planning of Chatfield Dam and Lake. Her numerous awards included Colorado Conservationist-of-the-Year Award of the Colorado Wildlife Federation (1969) and the Department of the Army Outstanding Civilian Service Medal (1973), for acting as "a liaison between concerned citizens and the corps that made lasting contributions to water and related land resource development in Colorado." She received the Soil Conservation Society of America Award (1974), the American Motors Award for Professional Conservation (1977), and the Edward Hobbs Hillard Award by the Rocky Mountain Center on Environment (ROMCOE) for her "distinguished career in education, consulting and government." The American Institute of Mining, Metallurgical and Petroleum Engineers (AIME) gave her the Environmental Conservation Distinguished Service Award. In 1981, the U.S. Forest Service gave her a 75th Anniversary Award, saying:

> While you were a member of the President's Council on Environmental Quality we experienced your forcefulness by insisting that surface mining and reclamation follow certain ecological principles. We are also aware of your success in bringing the interest of government, the mining industry and the environmental community together in solving critical and important environmental problems. And, finally, your efforts in establishing an Institute of Industrial Ecology at the Colorado School of Mines so that graduating students will have a better understanding of how things in nature interact with their environment.[66]

She was honored with a United Nations Environmental Leadership Medal (1982). And her last award came fittingly from the Rocky Mountain Nature Association, recognizing her forty years

64 Langenheim, Past President of the Ecological Society of America, sees Willard's influence at Mines to be among her top achievements. She wrote that Willard's significant accomplishments to the field of ecology were: "she spent five years on the Council of Environmental Quality on the Executive Office of the President, where she had an important ecological overview role of the Alaska pipeline….She established and became head of the Department of Environmental Sciences and Engineering Ecology. She also became Director, Industrial Ecology Institute, thus forming a bridge between ecology and the mining industry. " Langenheim, 190. Willard's newspaper scrapbook has numerous articles about the struggles she faced while at Mines. See BEWNS, 50,13-2, and 22 for specific examples.

65 Willard always felt misrepresented when it came to her support of the Olympics in Colorado. When newspapers reported that she said the Olympics would not affect the environment, she retorted that she was not "concerned about the environmental impact of the construction that would have to be made for the events themselves….I was very concerned at what the off-site impact would be--the opportunistic activity of land developers without proper control." She believed "the Olympics could be a force for ecological good if the motto of the Olympics to express human perfection in mind, body and spirit was extended to include man's relationship with his environment." See BEWNS, 10 and 63; also “Boulder CEQ Nominee: Ecologist Hits Olympic Foes,” *The Denver Post*, 6 Oct 1972, 3.

66 *The Mines Magazine*, April 1981, 5, in BEWNS, 13-2.

of tundra ecology research (1998).[67]

Willard's greatest legacy may be that she taught multiple generations to be stewards of the American landscape through lectures, field seminars, meetings, and books. Indeed, she believed that "Man can live, work, and play in harmony with his environment. He has only to prove this fact to himself."[68] From these subtle actions and her obvious enthusiasm, Willard created ecological converts. After seeing Willard in her research plots in 1958, a woman came back to Rocky Mountain National Park in 1990 to take the alpine seminar. She recalled as a twelve year old seeing a woman "laying out garden-like plots with strings on the tundra not far from Trail Ridge Road."[69]

Her research at the plots and subsequent interactions with park management fostered her role as educator and negotiator. From this experience on, her goal in life was to teach how man interacts with his environment and how to do so with as little damage as possible. But no matter where this mission took her--to Boulder, to Aspen, to Washington D.C., to Golden, in oil company board rooms, in tense development meetings, at press conferences--every summer she returned to her plots on Trail Ridge Road.

Ecologist Beatrice Willard and Alpine Tundra Research in Rocky Mountain National Park

The Beatrice Willard Alpine Tundra Research Plots are significant as a representation of the evolution of ecology and scientific research within the national environmental movement. They also represent the history of science in the National Park Service. They are especially significant to Rocky Mountain National Park, as the results of the research influenced park management. The plots represent the mid twentieth century as rapid development swept the nation when scientists--specifically ecologists--collected data on the effects of man in the environment, which affected changes to the way that national parks (and other public lands) were managed. The alpine research plots are significant to Rocky Mountain National Park because they were the first research plots in the alpine tundra. These plots also represent the first park research that monitored the effects of man's effect on the alpine and greatly influenced park management decisions.

Part I: The Research Plots and the History of Ecology

67 Again the scrapbook has many sometimes undocumented newspaper clippings on her achievements. See BEWNS, 7, 13-2, 42, 43, 49, and 50.

68 "Energy and the Environment," keynote address to the Mid-Atlantic Regional Conference on Surface-Mined Land for Outdoor Recreation, at the Pennsylvania State University, University Park, PA, December1973, in the collection of Chase Davies.

69 *Loveland Times-Call*, 8 July 1990, in BEWNS, 34-35.

Science-based land management grew from nineteenth century westward expansion and the development of a national economy. Population growth and technical improvements in transportation and tools contributed to a shift in United States agricultural practices from subsistence to market farming (intensive farming of one crop, farming for export, using fertilizers). Market growth was dependent on production, and soon experts in "scientific" agriculture advised farmers of the most progressive tools and methods, the most productive varieties and seeds. Robert Morris Copeland bridged the gap between the nineteenth century romantic pastoral ideal and scientific farming in his 1847 book, *Country Life: A Handbook of Agriculture, Horticulture, and Landscape Gardening*.[70] In 1864, George Perkins Marsh published his landmark book, *Man and Nature* or, *Physical Geography as Modified by Human Action*, which questioned the effect man had on the landscape and warned of the dire consequences of continued insensitive development. Marsh advocated restoring landscapes through the application of science. *Man and Nature* signaled a change in landscape values facilitated by a growing legion of scientists.[71]

These scientists included botanists, biologists, and foresters studying wildlife and plants related to "efficient" use of the nation's natural resources. By 1891, the Forest Reserve Act gave the president the ability to set aside land to protect timber. Gifford Pinchot, who in 1897 was appointed the first chief of the Division of Forestry in the Department of Agriculture, preached the "gospel of efficiency" and championed "wise use" of resources, which included timber, game, grasslands and minerals. Pinchot, like many scientists of his time, focused on one individual plant or animal species and saw it as a commodity to be sold and carefully managed. It was his job to assure that there would be a continuous supply of resources and he used science to manage them.[72]

Around 1900, the field of ecology developed from three trends: botanical exploration, a laboratory (later field) based group of “physiologists” with zoological and botanical backgrounds, and Charles Darwin’s theory of evolution. Four distinct ecology fields emerged: oceanography, limnology (study of inland waters), plant ecology, and animal ecology.[73] Ernst

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70 Marsh-Billings-Rockefeller National Historical Park (NHP), “Conservation Timeline:1801-1900,” available at http://www.nps.gov/mabi/mabi/history/timeline1801.htm, accessed 2 January 2004; Library of Congress, “Documentary Chronology of Selected Events in the Development of the American Conservation Movement, 1847-1920,” available at http://memory.loc.gov/ammem/amrvhtml/cnchron1.html (first of six web pages), accessed 2 January 2004.

71 According to the National Park Service, "Man and Nature was well received by readers and influential upon those who were shaping American forestry policy at the time. It is widely considered a seminal text in the founding of the conservationist and environmental movements and, in the decade after its release, Americans began to heed Marsh's warnings and take steps to protect the nation's forestlands. Marsh-Billings-Rockefeller NHP, “Conservation Timeline: 1801-1900.” Clark University called Marsh a pioneer: "He was the first to raise concerns about the destructive impact of human activities on the environment….He was the first to suggest that human beings were agents of change, or "disturbing agents…. Marsh was the first to describe the interdependence of environmental and social relationships." Clark University website, http://www.clarku.edu/departments/marsh/, accessed 2 January 2004.

72 Historian Samuel Hays notes that prior to World War II, no one used the term "environment." Samuel P. Hays, "From Conservation to Environment," in Carolyn Merchant, ed., *Major Problems in American Environmental History* (Lexington, MA: D.C. Heath and Company, 1993): 504; Marsh-Billings-Rockefeller NHP, “Conservation Timeline: 1801-1900”; Marsh-Billings-Rockefeller National Historical Park (NHP) “Conservation Timeline:1901-2000,” available at http://www.nps.gov/mabi/mabi/history/timeline1901.htm, accessed 2 January 2004.

73 R.H. Jones, Department of Biology, Virginia Tech University, “Population and Community Ecology,” Lecture Notes, Spring

Haeckel coined the term ecology in 1866. Ecology is the study of the "relation of organisms or groups of organisms to their environment, or the science of the interrelations between living organisms and their environment."[74] Early ecologists promoted the so-called "balance of nature" and the idea of predetermined and consistent climax communities.[75]

One of the earliest American ecologists was plant biology professor Henry C. Cowles (1869-1939), who arrived at the University of Chicago in 1895. He soon began studying the Indiana Dunes, and formed a theory that “the composition of plant life in any setting must be understood as the result of constant flux and change in relations within plant communities and among communities and their environs.” This became the basis of dynamic ecology. Cowles was one of the founders of the Ecological Society of America, which organized in 1914.[76]

At the same time but independent of Cowles, pioneering ecologist Frederic Clements (1874-1945) of the University of Nebraska conducted field-based research and delved into both dynamic ecology and plant ecology, which focused on soils (acidity, temperature, texture, water and nutritional content), temperature, wind, water, climate, slope, light, organisms, propagation, animals (including humans), plant relationships, and succession. Though he researched the effects of climate and environmental factors on plant production to increase agricultural yields, he also studied "less useful" ecosystems, like the alpine tundra.[77] Supported by the Carnegie Institute of Washington starting in 1913, he and his ecologist wife, Edith, studied dynamic ecology at two field stations: an alpine laboratory at Windy Point (elevation 12,200’) on Pikes Peak and a coastal laboratory at Santa Barbara.[78] On Pikes Peak, the Clements’ “conducted a systematic study of succession in thousands of square miles of the surrounding mountainous area.”[79]

The development of dynamic ecology is an important milestone in American ecological history.

1994, updated 1996, 1997, 2000, 2002, available at http://www.biol.vt.edu/faculty/jones/biol5024/Cecol_lec1.html, accessed on 20 December 2006.

74 Ecology and economics share the same root, *oikos*, meaning home or habitat. Ecology is the "study of the structure and function of nature." It is concerned about relationships on all levels, from population to community to ecosystem. It combines both physical and biological sciences. Ecology is often divided into autecology (study of the individual organism or an individual species) and synecology (study of groups of organisms which are associated together as a unit). Eugene P. Odum, *Fundamentals of Ecology*, Second Edition (Philadelphia: W.B. Saunders Company, 1959), 3-6.

75 “A climax community is one that has reached the stable stage….Stability is attained through a process known as succession, whereby relatively simple communities are replaced by those more complex.” This definition comes from http://www.encyclopedia.com/doc/1E1-ecology.html, accessed 13 December 2006.

76 Library of Congress, “American Environmental Photographs, 1891-1936,” available at http://memory.loc.gov/ammem/collections/ecology/aepsp4.html, accessed 12 December 2006.

77 Clements first studied preserving soils, grazing, windbreaks, erosion and floods, and naturalistic landscaping. In a 1929 book, he and his co-author, John Weaver, wrote "The study of plant production, whether in botany, agriculture, grazing, forestry, plant pathology, or other fields, is beginning to study more thoroughly the intimate relations between plants or groups of plants and their environment." John E. Weaver and Frederic E. Clements, *Plant Ecology (*New York: McGraw-Hill Book Company, Inc., 1929), vii.

78 "Dynamic ecology concerns itself first and foremost with causes and processes and in consequence its dominant theme is one of change." B.W. Allred and Edith S. Clements, *Dynamic Vegetation: Selections from the Writings of Frederic E. Clements*, *Ph.D.* (New York: The H.W. Wilson Company, 1949), iii, iv, 1. The Carnegie Institution of Washington’s website is http://www.carnegieinstitution.org/about.html, accessed 13 December 2006.

79 Library of Congress, photographs.

Cowles was studying ecological change over time and geography. The Clements' were looking at disturbance, especially how western plant communities responded to disturbance by man. At the same time in Europe, scientists were developing methods to record organism adaptation and taxonomic descriptions. American ecologists were observing how plant communities develop and change at a time when the American landscape was drastically developing and changing. By the 1920s, ecology blossomed as scientists warned about the consequences of careless development brought about by prosperity. Roads, cars, and suburbs dramatically altered natural systems. Soon, the Dust Bowl of the 1930s verified their concerns. Monoculture farming coupled with severe drought created a crisis. The Clements', along with Cowles, developed a uniquely American ecology based on this evolution of the American landscape.[80] The Library of Congress summarizes it thus:

> The approach adopted by Clements and [his contemporary and student of Cowles Victor] Shelford marked a significant point in the transition of scientific research and theory from the examination of plant ecology and animal ecology to the study of bioecology. The concept of bioecology itself has now been superceded by a broader concern for understanding the whole structure of the ecosystem in all its scale and complexity. This encompassing focus on the ecosystem has been an important factor in recognizing, beyond the life cycles of plant and animal communities, the powerful and pervasive role of human civilization in shaping and altering the natural environment.[81]

After World War II, ecologists and conservationists emphasized the interrelationship between the environment and man. Published in 1949, Aldo Lepold (1887-1948) wrote *A Sand County Almanac* to "examine humanity's relationship to the natural world."[82] Though not an ecologist by training, Leopold believed that humanity had a responsibility to act as a part of nature, rather than as its conqueror.[83] *A Sand County Almanac* had an immediate effect on science, as ecologists began to study the impacts of man *in* nature rather than man *on* nature. Indeed, studying ecology and man's role within the ecosystem became more pronounced after 1950 as rapid development, including suburbs and highways, swept across the nation.[84]

Increasingly after 1950, ecology was moving in a new direction toward understanding

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80"American ecologists delved into understanding the dynamics between physical, chemical and biological processes that produced what was seen. This focus led naturally into developing principles of land management, which if used, could foster processes beneficial to human activities and reverse those detrimental to humans." B.E. Willard, "What the Indiana Dunes Mean to Ecology," a speech to Annual Meeting of Save-the-Dunes Council, Beverly Shores, IN, November 2, 1975, in the collection of Chase Davies.

81 Library of Congress, photographs.

82 The Aldo Leopold Foundation, http://www.aldoleopold.org, accessed 20 December 2006.

83 Aldo Leopold, *A Sand County Almanac* (New York: Ballatine Books, Oxford University Press, 1963), 238.

84 In 1954, ecologist George Clarke wrote: "Because of the lack of understanding of ecological principles the efforts of well-intentioned conservationists and agriculturists are frequently badly misdirected." He and others believed that the "goal in ecology is to understand the interrelations of organisms and their environments under *natural* conditions" (emphasis original). Still, he recognized man's increasing damage to the environment. He believed that "without intelligence man accelerates destruction." George L. Clarke, *Elements of Ecology* (New York: John Wiley & Sons, Inc. 1954), 3, 12, 19.

disturbance, dynamics, and most importantly man's role within the ecosystem.[85] At this time, the field of alpine ecology emerged. After World War II, the federal government, and specifically the Department of Defense, funded university-affiliated research stations at high elevations or in arctic regions throughout the nation to support research on astronomy, climate, human physiology at high elevations, and mapping. Research would provide the baseline and the monitoring necessary to make long-term decisions. With this research and scientific understanding, and most importantly with data, the nation could move toward military preparedness, and scientists would gain a greater understanding of alpine environments throughout the United States.

One of the Department of Defense-sponsored alpine research stations was affiliated with the University of Colorado and located on Niwot Ridge, west of Boulder. The University of Colorado Board of Regents established the Institute of Arctic and Alpine Research (IAAR) in 1951, after biology professor John W. Marr campaigned for an institution to assist with winter alpine ecosystem research. Marr was a leading scientist of the time, studying "ecosystem units" rather than looking at communities and environment as separate entities. He introduced alternative theories of climax communities, looking at them as a function of topography and local climatic conditions. The U.S. Army supported research at the IAAR because the climate work aligned with national defense needs. The army was looking for climate and mapping skills for alpine regions around the world; the IAAR was doing this research. Later the U.S. Atomic Energy Commission (now the Department of Energy) called on alpine researchers to gather data on radiation in alpine and watersheds. Other funding sources, including the National Park Service, supported research by Institute scientists.[86]

The Beatrice Willard Alpine Tundra Research Plots represent this evolution of ecology during the Post-World War II era. Beginning in 1958, an IAAR scientist funded by the National Park Service, Beatrice Willard (advised by Dr. Marr), began studying the alpine tundra in Rocky Mountain National Park. The following year in 1959, she established the alpine tundra research plots along Trail Ridge Road. Willard's methods followed ecological research principles of the time. Her 1958 field season produced plant identifications and a "basic analysis of the types of effects of visitor use and a method for evaluating the degree these effects have on ecosystems." She observed the plots at "regular, frequent intervals throughout the summer season." At each visit, she recorded plant species; ecosystem processes such as frost action, erosion; plant recovery; periodicity of individual plants (in bud, bloom, fruiting, etc); vitality of

85 The concept of ecosystem, which by the 1950s had replaced the idea of the biotic community, is based on the mathematical modeling of nature. From this new understanding rose field-based ecology focusing on "polyclimax," the concept that within an area, depending on varied impacts, there may be several smaller areas each with a different climax make-up, thus several climaxes are possible in an area. Indeed, it was a micro-scale study of the larger landscape. Carolyn Merchant, *Death of Nature: Women, Ecology and the Scientific Revolution* (New York: HarperCollins, 1990), 103.

86 Started April 1951 as the Institute of Arctic and Alpine Ecology, the name changed to the Institute of Arctic and Alpine Research (IAAR) in 1953. It is now called the now known as INSTAAR. The research evolved over time to include avalanche and natural hazards research, wilderness studies, mapping, and climate studies. Numerous federal and international agencies supported research at the field station on Niwot Ridge including the Bureau of Reclamation, U.S. Geological Survey, National Aeronautics and Space Administration, and the United Nations. Kathleen Slazberg, Nan Elias, Polly Christensen, eds., "50th Anniversary: The Institute of Arctic and Alpine Research, 1951-2001," available at http://instaar.colorado.edu/meetings/50th_anniv/index.html, 1-27, accessed 10 December 2003.

plant species, seedlings, and migration of species into open areas. Willard mapped the exclosure species so that she could compare existing composition to future (post-recovery) composition. Her mapping methodology followed that of Braun-Blanquet (1932), who studied ecological succession after grazing ceased in Swiss National Park, Switzerland. Following Zurich-Montpellier School of Phytosociology protocols, she analyzed the total vegetative cover or abundance of species and set a point scale from rare to covering more than seventy five percent of the area. She documented the plots and plants in photographs. Dr. Willard also examined the “complexity of dynamic processes set in motion by visitor impact.”[87] While Willard’s work exemplifies typical alpine ecology using the Swiss methods, her disturbance study exemplifies work of post-World War II dynamic ecologists.

The Beatrice Willard Alpine Tundra Research Plots also exemplify changing federal environmental policies after World War II. Willard’s disturbance study was of critical importance to Rocky Mountain National Park managers. She made policy recommendations to park management on stewardship of the alpine tundra, specifically how to protect it and educate visitors. Research could provide science-based management decisions. Not only was the National Park Service changing policies based on research results, this kind of ecological research was also influencing Congress to write a slew of environmental laws: the Wilderness Act (1964), the Land and Conservation Fund Act (1965), the Clean Air Act (1967), Wild and Scenic Rivers Act (1968), the National Trails Act (1968), the National Environmental Policy Act (1969), the Clean Air Act (1970), Clean Water Act (1972), and the Endangered Species Act 1973.[88] Of these, the most overarching for federal land managers was the National Environmental Policy Act (NEPA), which mandated protection of the environment based on scientific data and requires environmental impact statements be made prior to major development affecting the environment. The statements require baseline data, like the results that came from the inventory and monitoring of the research plots. The establishment of the research plots in Rocky Mountain National Park preceded the Congressional mandate by ten years.

Part II: Science in the National Park Service

While early conservationists like Gifford Pinchot championed protecting land for efficient use, preservationists like John Muir (who founded the Sierra Club in 1892) championed preserving wilderness. Muir and his followers believed wilderness had value in and of itself, not for the market products it could produce. To preserve lands for their aesthetic and recreational qualities, Congress created the National Park Service in 1916.[89] The purpose of the National Park Service (NPS), according to its Organic Act was to "conserve the scenery and the natural

87 Marr and Willard, "Report on research."

88 Library of Congress, chronology.

89 In 1872 Congress protected Yellowstone National Park for its aesthetic qualities. Other "environmental" groups begun during this period included the Wilderness Society and the National Parks Association, all of whom emphasized conservation rather than "efficient management." Hays in Merchant, 504; Marsh-Billings-Rockefeller NHP, “Conservation Timeline: 1901-2000”; Library of Congress, chronology.

and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."[90] As first director Stephen Mather developed and promoted the parks; he allowed heavy manipulation of the wildlife and landscape. Parks were controlling predators, suppressing fires, and building cabins. Indeed, for most of its history, the National Park Service emphasized development and recreation over science and landscape preservation. As historian Richard Sellars wrote in his book, *Preserving Nature in the National Parks* (1997), "to a large extent, natural resource management would serve tourism purposes." Throughout much of the first seventy-five years of the National Park Service, science and research had little influence on the management of the parks. The research plots in Rocky Mountain National Park signaled a change in management philosophy in the mid-twentieth century that eventually became the norm throughout the National Park System.[91]

For a time during the 1930s, scientists made progress in the National Park Service. Wealthy wildlife biologist George Wright funded his own program to study fauna. The National Park Service created a Branch of Research and Education. It hired "foresters" (not plant biologists or botanists) to prevent forest fires, insects, and disease. The National Park Service focused on wildlife and efficient use practices of an earlier scientific tradition.[92]

Two other important scientific developments occurred during the 1930s: the cooperation with university scientists and the designation of research reserves. Despite the lack of scientists in its ranks, the National Park Service encouraged universities to use the parks as laboratories and classrooms "to supplement academic study of the natural sciences." The NPS undertook this work "not to duplicate work done elsewhere nor to trespass upon fields amply covered by other Government bureaus, but solely to gather the scientific information necessary to the development of the museum, educational, and wild-life administration programs of the national parks." On the other hand, research benefited science as well: "studies undertaken by the Park Service deal with questions of particular interest to science, and the publication of the results contribute to the furtherance of knowledge and education throughout the country."[93]

Throughout the 1930s, the National Park Service established research reserves, "an area comprising a logical biotic unit, representative of virgin growth or exhibiting special or unique features, permanently set aside for scientific observation and research, with the understanding that it shall be as little influenced by human use and occupation as conditions permit."[94] Since they were not specifically mandated by Congress, the reserves were at the whim of a park's changing administration. Though Rocky Mountain National Park established a reserve in 1933,

90 The National Park Service Organic Act established what first director Stephen Mather called a "double mandate": use and preservation. The National Parks Act 1916 [H.R. 1552].

91 Richard West Sellars, *Preserving Nature in the National Parks: A History (*New Haven: Yale University Press, 1997), 11, 69.

92 Ibid., 123-127, 148.

93 Bryant, Part I The Educational Program in the National Parks: Research (no page number listed).

94 National Park Service, *The Proceedings of the First Park Naturalists' Training Conference held at Educational Headquarters, Berkeley, California, November 1 to 30, 1929*, available at http://www.cr.nps.gov/history/online_books/symposia/conference-pn1/index.htm, accessed 31 December 2003.

Sellars found no evidence of an "active" reserve in the park.[95]

By the start of World War II, the National Park Service abandoned the research reserves and laid-off most of its scientists, effectively dismantling its research program. In 1945, the surviving wildlife biologists vocalized their concerns about the "lack of organized information" in a report that recommended a research program "provide a constant flow of knowledge on the interrelations of life forms (ecology) essential for interpretation and management." Noting inadequate funds for in-house research, the report encouraged scientists and university students to use the parks as "field laboratories." The report also recommended more permanent positions be filled with "technical experts who would oversee the necessary research." Although the statement provided a list of biological research needs, the National Park Service's highest managers did not take action.[96]

During the Post-World War II era, as scientists struggled to rebuild the research program, Congress gave an average of $100 million per year to the National Park Service for Mission 66, a development and building program. Little of this went toward science, though some parks sponsored limited research through outside researchers from universities or other federal bureaus.[97] One example of service-wide funding for research is the 1957 appropriation for "research on reconnaissance of alpine and wilderness areas" to five national parks: Grand Teton, Yosemite, Sequoia, Mount Rainier, and Rocky Mountain. According to one of the researchers, "Alpine and wilderness areas were selected because of the apparently fragile, easily altered nature of their ecosystems."[98] Beyond the Clements' studies on Pikes Peak which started in 1913, little work in ecology was done in the alpine tundra anywhere in the United States. A 1951-1955 study by Robert Griggs in Rocky Mountain National Park commented that "Relatively little ecological work appears to have been done on mountain summit regions, other than descriptions of vegetation [i.e. Clements' work]." Researchers came to Rocky Mountain National Park because they needed vegetation "in an untouched, primitive condition" (meaning void of grazing)….The tundra on Trail Ridge seems as undisturbed as the vegetation…on uninhabited areas of the Alaska Peninsula."[99]

The Rocky Mountain National Park study began in 1958, when the park contracted with the University of Colorado to conduct an alpine ecology disturbance study. In 1959, alpine ecologists John Marr and Beatrice Willard established research exclosures (a fenced area to provide protection of the resources within from disturbance by humans and other animals) along Trail Ridge Road for an intensive five-year study on the alpine tundra and the effects of trampling and ecosystem recovery. The park installed the exclosure at Rock Cut, a parking area along the road which had opened in 1933. In contrast, the second exclosure at Forest Canyon was adjacent to a parking area that opened the previous year. Both areas showed

95 Sellars, 110-111.

96 The report was: National Park Service, "*Research in the National Park System, and its Relation to Private Research and the Work of Research Foundations,"* 10 February 1945. See, Sellars, 164-168.

97 Sellars, 158.

98 "Research in RMNP," *Estes Park Trail Vacation Edition*, March 1962; Marr and Willard, *"Persisting vegetation in an alpine recreation area."*

99 Robert F. Griggs, "Competition and Succession on a Rocky Mountain Fellfield," *Ecology* vol. 37, January 1956: 9.

great signs of human impacts: vegetation was destroyed, lichen removed from rocks, and paths worn into sensitive tundra soils.[100]

Willard's and Marr's annual results had immediate management implications and Rocky Mountain National Park made changes to alpine tundra management policies based on the scientists' recommendations.[101] For example, the National Park Service built the Forest Canyon overlook distant from the parking area, without a trail between for three months. Then, the park installed a sweeping asphalt-paved trail, allowing breathtaking views to the valley below. Visitors followed the trail to the overlook, then created a new short-cut back to their cars. In 1959, based on the observations and recommendations of Willard, the park paved this short cut. After these improvements, less than one percent of park visitors wandered from the trails. Similarly in 1961 at Rock Cut, the park paved the trail to the Toll Memorial, created an educational brochure about the alpine tundra, and installed educational signs along the path. These improvements kept visitors to the paths, reducing trampling on the alpine tundra, just as Willard and Marr had proposed.[102]

Despite advances like the research plots in Rocky Mountain National Park, the science program throughout the National Park Service continued to stagger. In 1958, the budget for scientific research throughout the entire system was $28,000. As Mission 66 continued, the backlash against lack of research and science in the parks accelerated and several internal reports indicated that the parks were "actually endangered by ignorance."[103] These were not enough to stall Mission 66 development. In most parks, scientists were not involved in making development decisions.[104]

Criticisms of Mission 66 tended to focus on the development of roads and facilities that would "modernize and urbanize" the parks, not the effect the developments had on ecosystems. Some groups, like the Sierra Club, however, were vocal critics for the environment. With rapid suburbanization and road building outside the parks, the necessity of ecological studies was becoming obvious. In 1962, Secretary of the Interior Stewart Udall requested studies on

100 Although Willard and Marr worked for the Institute of Arctic and Alpine Research associated with the University of Colorado, Willard's stipend and funded research did not cover her full-time. Instead, Willard took a stipend and spent the other half of her time starting "a long-range study of the alpine ecosystems of Trail Ridge that were natural and undisturbed by people." Thus, Willard like many of her contemporaries working in National Parks, extended the park's research budget. B.E. Willard, "Effects of Visitors on Natural Ecosystems in Rocky Mountain National Park" (M.A. thesis, University of Colorado, 1960); Marr and Willard, "Report on research", 1960.

101 As is typical of scientific practices, Dr. Marr was a co-investigator and advisor to Beatrice Willard as she conducted her research while earning her degrees. During the initial five-year study, Marr managed the contract with Rocky Mountain National Park and was therefore considered by the National Park Service to be the "principle investigator." Because of this initial collaboration, the annual reports and other scientific journal articles were authored by Willard and Marr.

102 Marr and Willard, *"Persisting vegetation in an alpine recreation area"*; Willard and Marr, "Effects of human activities on alpine tundra ecosystems," 257-265; Willard and Marr, "Recovery of alpine tundra under protection after damage," 181-190.

103 Sellars, 169.

104 In fact, Mission 66 backers believed that development would protect resources. The thought was: "if visitors were going to use certain areas, prepare for this by improving roads, trails, and park facilities that would limit the impact to specified areas. Public use would be contained, leaving alone the undeveloped areas of the parks." Sellars, 181.

science and resource management.[105] Several reports resulted, including a 1967, non-National Park Service study by Fraser Darling and Noel Eichhorn focusing on the "impact of man on the national parks." They concluded: “the national parks now face dangers from within…. These new dangers come from increasing number and densities of people, spending more of their increasing leisure time in the parks, bringing more of their automobiles and accompanying paraphernalia into the parks.”[106] They referred to the Willard-Marr study of the tundra in Rocky Mountain National Park as an example of how research led to good management decisions. They wrote that the asphalt trails were "obviously effective in guiding people" through the tundra, thus preventing damage to the ecosystem.[107]

National Park Service management policies began to shift toward embracing science, thanks in part to ecological studies like the Willard-Marr research at the alpine tundra plots. Science slowly began to infiltrate the parks.[108] In the 1970s, some parks improved their science programs by establishing in-park research offices or contracting research through nearby universities. By the late 1970s, the National Parks and Conservation Association published a state of the parks report identifying external threats to the parks. In 1980, a National Park Service study and report to Congress followed. The most significant recommendation in these documents was to begin an inventory of the parks' resources and to monitor them over time. Thanks to Dr. Willard, who continued to monitor the alpine tundra plots after the initial five-year study ended, Rocky Mountain National Park had already implemented this recommendation on one of its most significant resources.[109] Not until 1998 did Congress mandate the National Park Service use science to manage its resources.[110]

The research plots, therefore, represent that Post-World War II period when park visitation was dramatically increasing and when scientists began to question the effects of that increased visitation on ecosystems. During the 1950s, researchers came to parks to study the "pristine wildernesses" that was protected within the borders. Many of them, like Willard and Marr,

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105 As Sellars noted, "the Sierra Club was becoming a more aggressive, activist organization, willing to criticize public land managers more openly rather than rely on gentlemanly negotiations, as in the past." Two committees organized to review research and policy in the National Park Service. The result was two 1963 reports: the Leopold Report and the Robbins (National Academy of Sciences) Report. The reports encouraged understanding ecological complexities, making science the basis of management decisions, and using outside researchers to give objective recommendations. Sellars, 185, 189, and 200-219. The reports are available on line: W.J. Robbins (Chairman), E.A. Ackerman, M. Bates, S.A. Cain, F.D. Darling, J.M. Fogg, Jr., T. Gill, J.M. Gillson, E.R. Hall, C.L. Hubbs, C.J.S. Durham (Executive Secretary), *National Academy of Sciences Advisory Committee on Research in the National Parks: The Robbins Report*, National Academy of Sciences - National Research Council, the Advisory Committee to the National Park Service on Research: 1 August 1963, available at http://www.cr.nps.gov/history/online_books/robbins/robbins.htm, accessed 11 December 2006. A.S. Leopold (Chairman), S.A. Cain, C.M. Cottam, I.N. Gabrielson, T.L. Kimball, *Wildlife Management in the National Parks: The Leopold Report*, Advisory Board on Wildlife Management: 4 March 1963, available at http://www.cr.nps.gov/history/online_books/leopold/leopold.htm, accessed 11 December 2006.

106 F. Fraser Darling and Noel D. Eichhorn. *Man & Nature in the National Parks: Reflections on Policy* (Washington, D.C.: The Conservation Foundation, 1967), 5.

107 Ibid., 28 and 49.

108 Sellars, 213, 221-222, 280.

109 Ibid., 239, 262-263.

110 National Park Service, Natural Resource Challenge website, http://www.nature.nps.gov/challenge/challengedoc/index.htm, accessed 31 December 2003.

clearly recognized that the landscape was greatly affected by man. Indeed, the rate at which man changed the environment--facilitated in large part by economic forces that allowed for more access to the "wilderness"--startled park managers, politicians, and the general public. Something had to be done to protect the parks from its visitors. More science was required to understand the processes. Data had to be collected to make sound decisions. Management had to be convinced that development without consultation would permanently impair the parks for future generations.

Part III: Research in Rocky Mountain National Park

As with the National Park Service as a whole, little research was conducted in Rocky Mountain National Park. Although there were early independent scientists coming to the area to study, these studies did not influence park management. In 1908, the Clements' came to the area to describe alpine associations. That same year, Dr. W.S. Cooper studied vegetation types on Longs Peak and along the Continental Divide.[111] A 1924 article touted the arrival of a noted geologist: "Woman Geologist Makes Interesting Study of Rock Formations in Rocky Mt. National Park Region." Dr. Margaret Bradley Fuller from Northwestern University near Chicago wrote "monographs" about the development of the park's glacial features.[112] None of these studies were sponsored by the National Park Service.

The earliest park-sponsored research in Rocky Mountain National Park related to wildlife, specifically elk and deer and the effects of browsing (when animals eat shrubs, rather than grasses) on the park’s landscapes. Since 1915, when local promoters sponsored the transport of a herd of elk from Yellowstone, the elk population steadily grew, especially with the 1922-26 predator control program.[113] By 1930, Superintendent Edmund Rogers expressed the first concern for the health of the elk, deer, and bighorn sheep winter range (which was in the town and on private land browsed by horses and cattle) saying that it "must now be near its maximum capacity."[114] In 1933 and 1934, the park established twelve small exclosures on the winter range to monitor plant recovery.

The first research to directly influence park management related to elk. In 1942, the Pittman-Robertson Federal Aid to Wildlife Research group conducted an elk-range-and-food study.[115] The group took complete census data (sex, location, number) on the elk herd. The study

111 Beatrice E. Willard, "Plant Sociology of Alpine Tundra, Trail Ridge, Rocky Mountain National Park, Colorado," *Colorado School of Mines Quarterly*, vol. 74, no. 4, October 1979: 5-8.

112 *Estes Park Trail*, 25 July 1924, 17. In 1928-29, RMNP hired her as a naturalist because of her experience with public speaking and with a mandate to take lantern slides for the park's collection. Fuller was the first woman naturalist in Rocky Mountain National Park. Kaufman, 76.

113 Lloyd K. Musselman, *Rocky Mountain National Park: Administrative History 1915-1965 (*National Park Service, Office of History and Historic Architect, Eastern Service Center, Washington, D.C.: July 1971), 28.

114 The winter range then was much more limited than now. It did not include areas such as Beaver Meadows, Mill Creek, and Horseshoe Park. These were privately held until 1932. Rocky Mountain National Park, *Superintendent's Monthly Report*, Sept 1930, 5.

115 Federal Aid in Wildlife Restoration Act (Pittman-Robertson Act), 16 U.S.C. §§ 669-669i, September 2, 1937, as amended 1939, 1941, 1946, 1950, 1955, 1956, 1959, 1960, 1970, 1972, 1974, 1976, 1980, 1984, 1986 and 1989.

results suggested that the elk herd be reduced. After receiving approval in January 1944 from the Secretary of the Interior, a one-year reduction program began. Another followed in 1949-50. After that, an annual reduction continued until 1961. In 1964, a two year elk research program ended with a meeting of the Advisory Council and Technical Committee of the Rocky Mountain Cooperative Elk Studies, with representatives from the Colorado Game and Fish Department, Roosevelt National Forest, and the National Park Service. Their recommendations were implemented by park management.[116]

Although wildlife research dominated, flora was also a popular research topic, especially the identification of plants. Alpine plant identification had been common practice with scientists and laymen alike. In 1941, ecologist A.E. Holch compared alpine and front range plants. By 1956, three discontinued flora texts had been reprinted: Ruth Ashton Nelson's *Plants of the Rocky Mountain National Park* (1953), William Weber's *Plants of Colorado Front Range* (1953), and H.D. Harrington's *Manual of the Plants of Colorado* (1954). These books focused on plant identification, not ecological relationships between plants.

In 1951, Robert Griggs conducted the first modern ecological research in Rocky Mountain National Park. Griggs worked in alpine autecology (the study of individual species), studying the alpine tundra "species by species." He focused on fellfields, where "each individual plant has its own struggle for existence uncomplicated with others." His studies continued from 1952 to 1955.[117] No management recommendations came of his study, except to encourage long-term research of the alpine tundra. He noted: "No generalizations…can be drawn from a short period of observation. Each of the four seasons in which I have studied on Trail Ridge has differed markedly from the other three."[118]

After Griggs, in 1958 Beatrice Willard (with Dr. John Marr as advisor) began to research the tundra communities for her thesis at the University of Colorado.[119] Willard's research differed from Griggs in that she looked at the landscape with "ecological thinking…constantly twisting and turning her attention to see the many sides of a situation and how they relate to one another - and including human effects in the equations as equal with the other components. Humanity was a part of the ecosystem, not apart, not separate, not exempt from ecological principles, rules, systems, etc."[120] Willard and Marr worked in Colorado because

> Colorado has a larger extent of alpine tundra than any other section of the

116 Musselman, 137-146.

117 A fellfield is applied to the distinctive plant communities found on rocky, windswept ridgetops and other exposed windward sites. Griggs, 8.

118 Griggs, 12-13.

119 The early 1960s saw a flurry of alpine ecology research in the park. In 1962, Ward studied alpine vegetation. In 1963 and 1965, J.G. Holway and R.T. Ward studied snow cover and melt. G.G. Spomer and F.B. Salisbury studied specific alpine plants in 1961, 1962, and 1964. In 1968, Salisbury analyzed the alpine. Further species specific investigations came in the 1960s by Lee Eddleman and the early 1970s by K.L. Bell and Eddleman. W. Kiener did phytosociological work, similar to Willard's, in the 1930s on Longs Peak, but his work was not published until 1967. First names do not appear because first names of scientists are rarely provided in journal articles. Willard, *Mines Quarterly*, 5-8.

120 Ibid.

> country; the character of the Colorado tundra is more complex, with a greater number of species, communities and processes; more definitive ecological studies have been made of the tundra of Colorado than any other part of the country; and it is the tundra most easily accessible to visitors.[121]

Willard's work was in direct response to the Mission 66 development in Rocky Mountain National Park. But she was cautious in basic assumptions. She noted in 1959 that

> The landscape is itself dynamic even in the absence of human use, and human use imposes additional processes on a natural dynamic system. The project, then, was not only to study processes in which visitors are directly involved, but also to learn the major “natural” processes active in the ecosystems concerned. Otherwise, there would be danger of assigning to man effects that he really had no part in producing.[122]

Willard and Marr began observing natural processes and visitor impacts throughout the park in 1958. These sites were at Bear Lake, Upper and Lower Hidden Valley where a ski resort blossomed in winter, and in the alpine tundra along Trail Ridge Road. From these observations, they chose two locations--one near Rock Cut and one near Forest Canyon Overlook--to install exclosures. Park workers installed the exclosures on 2 June 1959. The one near Forest Canyon overlook lay along a Mission 66 trail in use for one year. The other at Rock Cut, sat on a slope with varying degrees of visitor trampling. The Rock Cut parking lot was first developed in 1932 with the construction of Trail Ridge Road. Both exclosures were 100 square feet. Forest Canyon was a square containing 50 percent "highly damaged" vegetation and fifty percent "little permanent effect of impact" vegetation. The Rock Cut exclosure was five feet wide and twenty feet long. The fences surrounding the two enclosures consisted of steel fence posts, extending three feet above the ground surface. From the posts, two strings of wire fifteen and thirty inches from the ground kept humans out. Signs placed nearby briefly explained the research. Still, Willard encountered unanticipated human impacts, including visitors trampling around her exclosures, as many believed that was where captive animals were kept. In 1961 and 1962, Willard simply expanded the size of her exclosures, keeping the same 100 square feet to study within them. She also studied visitor trampling at Fall River Pass, Toll Pass, Iceberg Lake, Little Rock Cut, and Tundra Nature Trail. No exclosures were installed at these areas.

Willard came to several conclusions after her five year study. The 1967 report of Fraser Darling and Noel Eichhorn summarized her research plot work best:

> the work [of Willard and Marr] is fascinating, not least for its sidelights on human behavior in national parks….Dr. Willard thinks vigorous efforts are constantly

121 Zwinger and Willard, (preface x-xi).

122 Beatrice E. Willard and John W. Marr, “Effects of Visitors on Natural Ecosystems in Rocky Mountain National Park: Five-Year Study, 1958/59 – 1962/63,” University of Colorado, Institute of Arctic and Alpine Research, 1959-1963 (A final report for each year is in this volume. There is no overall 5 year final report).

> necessary to remind people not to take stones and flowers, and conversely, not to leave litter….Even plain walking is markedly deleterious: one year's walking appears to allow recovery, but after two years' use there is none. Cut and fill scars need turfing because there is no appreciable natural recovery after 20 years. Placement of campsites should be guided primarily by the exigencies of alpine ecology and horse use should be prohibited in the few meadow areas….Channeling of visitor use has been found to be the most effective way of reducing visitor impact adjacent to parking areas. Once channeling is resorted to, informal paths made by unchanneled visitors must be obliterated….Dr. Willard and her colleague emphasize that ecosystem balance and carrying capacity must be determined in each case; they use the term "visitor consumption" as the equivalent of "carrying capacity" which we would normally use for animal use. The ecological processes set in motion by visitors differ in detail from those activated by grazing animals, but the end result is more far-reaching in destruction of ecosystems in localized areas.[123]

In her 1963 dissertation, she concluded that "Trail Ridge is probably the least disturbed alpine tundra region in the Front Range and possibly the Colorado Rocky Mountains."[124] Still, she had established a base line for disturbance, a scale of visitor impact, estimated recovery periods, and most importantly, she came up with a list of management recommendations.

Willard's recommendations included: "determine carrying capacity for all ecosystems, maintain use well below carrying capacity, anticipate visitor movements and channel use, provide well-routed and well-maintained trails, establish formal backcountry campsites, and provide a many-fold and vigorous visitor education program regarding impacts."[125] As a result, the park paved trails, designated backcountry sites, and focused its education program in direct response to the plot research results. Superintendent Roger Contor told the *Denver Post*, that, "As a result of Dr. Willard's suggestions in her report, we've installed fences and walkways and kept the people in limited areas." He noted that Willard's study revealed that it was impossible to "collect tundra seed, much less grow it," so preventing disturbance was most critical. The park installed "more substantial" fencing around the plots in 1973.[126]

Because much disturbance came from the park's own development, the maintenance crews that made improvements began to work more closely with resource managers to prevent severe alterations. Post-disturbance restoration, such as seeding, immediately followed maintenance activities.[127] While the Civilian Conservation Corps in the 1930s also followed this

123 Darling, 40.

124 Willard and Marr, “Effects of Visitors on Natural Ecosystems…Five-Year Study, 1958/59.”

125 RMNP Resource Management Files, “Backcountry/Wilderness Mgmt – Implementation Crew Day Use,” Project II ROMO-N-490.100 (initial proposal 1994, last update 15 Jan 1998); RMNP Resource Management files, “Day Use Visitor Mgmt,” Project ROMO-N-290.000, 1992.

126 B.E. Willard, "Investigator's Annual Report, Recover of Alpine tundra systems Following Human Trampling," 29 January 1975.

127 RMNP Resource Management files, “Disturb Site Restoration Dev[elop] Seed Mix Fr[om] Native,” Project ROMO-N-050.300, 1992.

practice, it became mandatory after the research plot studies.[128]

Willard's work at the research plots also influenced park planning and management. Willard helped direct the 1965 Back Country Management Plan. The report states that

> the most significant research program done in the Park on Visitor Impact was accomplished by Dr. Beatrice E. Willard with the assistance of Dr. John W. Marr….Dr. Willard…made several recommendations that would be pertinent to the Park's back country. These recommendations, which were subjected to review and approval by the Park Staff (see Memorandum of October 29, 1963, to Regional Director from Superintendent, N-22) have been incorporated or considered by the Committee in the preparation of this report.[129]

The 1976 Park Master Plan summarized Willard's findings:

> The key to controlling man's impact is to channel use through facilities designed and grouped to insulate the resources. A few visitors wandering randomly about, or even following a single route for a few seasons, will not cause serious damage. On the other hand, where many concentrate their walking, serious destruction of natural resources can occur in a few days. Around sites where concentrations are encouraged, the visitor must be guided along established routes. Traditional approaches may be inadequate. Elevated walkways, partially enclosed or severely restricted access offering only a view, will be necessary at selected sites. Large groups will be restricted from the more fragile areas.[130]

The Master Plan recommended designating corridors and restoring the native ecosystems. Resource Management project files note: “Most of the Willard and Marr recommendations have been adopted and many areas have been reclaimed and restored. Restoration and reclamation treat the symptom of the visitor impact problem, while channeling use, delineating and maintaining trails, limiting backcountry camping, and education are directed at prevention.” This same project statement refers to the Willard/Marr research as the first of six visitor use impact studies.[131]

In hindsight, the most significant management recommendations resulting from the alpine research plots related to education and interpretation since the park initiated a multi-faceted alpine tundra education program. In 1962, the University of Colorado, the Estes Park Chamber of Commerce, the Rocky Mountain Nature Association, and the National Park Service sponsored the first summer field seminars, or educational sessions for the public. Willard and

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128 Ibid.

129 "A Report to the Superintendent for a Back Country Management Plan in Rocky Mountain National Park," May 1965, 80 pages. When the Backcountry/Wilderness Management Plan was approved in 2001, it cited Dr. Willard’s work at the plots. See, Devine.

130 *Rocky Mountain National Park Master Plan,* National Park Service, Rocky Mountain National Park: 1976.

131 RMNP Resource Management files, Project ROMO-N-290.000.

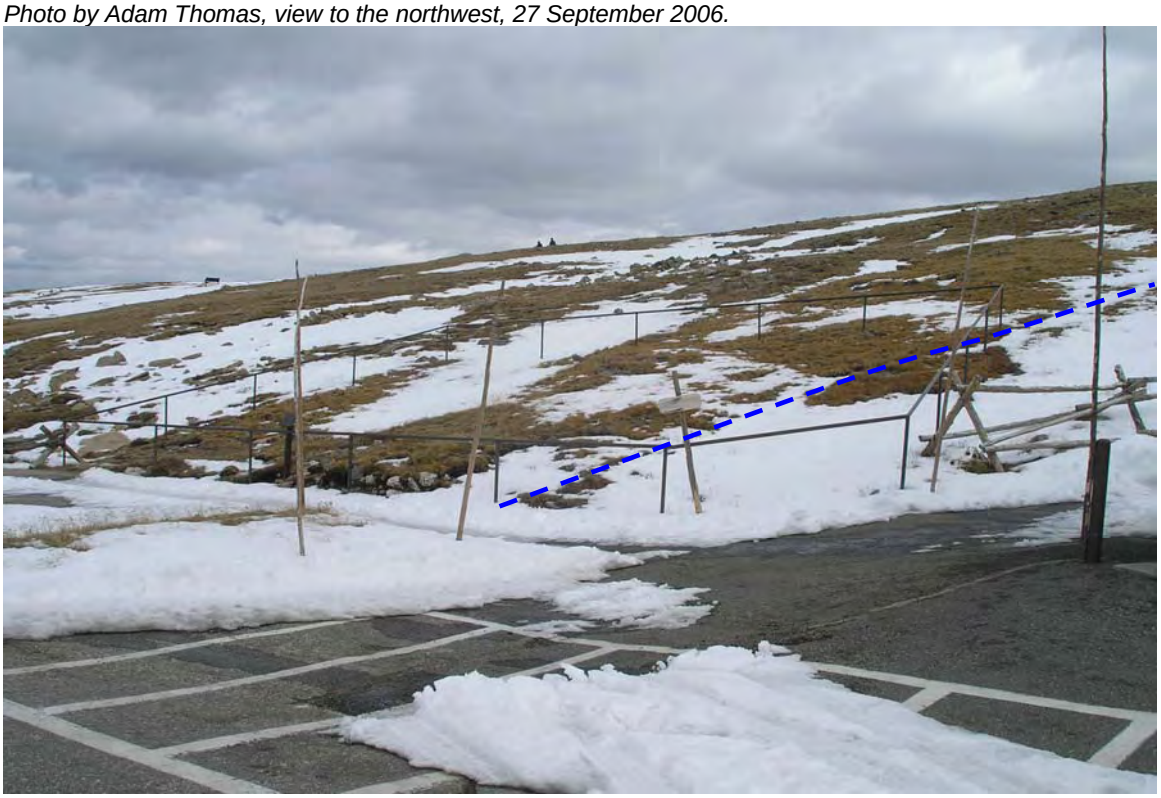
Ruth Ashton Nelson taught the first class, on alpine tundra ecology.[132] By 1964, more than forty people registered for the one-week courses, including Dr. Robert L. Burgess, Assistant Professor of Botany, North Dakota State University; Elizabeth Sprague, Department of Biology, Sweet Briar College, Virginia; E.H. Brunquist, Denver Museum of Natural History; Dr. Fred A. Glover, Colorado Cooperative Wildlife Research Unit, Colorado Statue University; and Dr. Gerhard Bakker, Associate Professor of Life Sciences at Los Angeles City College.[133] The Alpine Visitor Center (built 1965) included a large exhibit on tundra ecology, informed in part by Willard's research. Park brochures and ranger led programs taught visitors about how to avoid trampling.[134] All of these alpine tundra education initiatives continue today.

After earning her PhD in 1963, Dr. Willard continued to study and monitor the Alpine Tundra Research Plots for forty years. Her publications noted that recovery was painfully slow at Rock Cut. The area around Forest Canyon Overlook recovered quickly, with the exception of the cushion plants which never fully recovered after 20 years of monitoring. Despite the disturbances evident along the road, Willard determined in 1979 that, "Trail Ridge tundra has many features in common with the tundra of other parts of the Rocky Mountains, but it has the distinction of being the most pristine yet studied. It may be a virgin landscape, except for the small areas disturbed in modern times by the Park road and visitors, and by the Ute Indians and prehistoric peoples who used it as a major transmontane route."[135]

The research plots are significant to Rocky Mountain National Park because they represent the first adequate baseline provided for Trail Ridge alpine ecology and visitor impacts. From these data, park researchers have developed a full baseline for comparing it to like areas in the Arctic Circle and in Europe.[136] The monitoring of the plots and scientific data collected lead to numerous management decisions about controlling visitor use and impacts. Furthermore, education campaigns based upon recommendations by Willard implemented a new understanding of the alpine tundra's recovery time. These data continue to be referenced today in resource management and park education documents and for making sound, scientifically-based management decisions.

132 Musselman, 167.
133 Rocky Mountain National Park, *Superintendent's Monthly Report*, June 1964.
134 Rocky Mountain National Park, *Superintendent's Monthly Report*, August 1965.
135 Willard, *Mines Quarterly*, vi.
136 Ibid., v.

Above, photo 01: The Rock Cut Plot is protected by a steel tube fence.
Photo by Adam Thomas, view to the northwest, 27 September 2006.



Above, photo 02: The blue line marks the old trail, which Beatrice Willard monitored to see how long revegetation would take in this disturbed area. *Photo by Adam Thomas, view to the north, 27 September 2006.*

Above, photo 03: The Interpretive sign teaches visitors about the sensitive tundra and the research plots.
P*hoto by Adam Thomas, view to the northeast, 27 September 2006.*

Above, photo 04: A close up of the 10x10 plot near Forest Canyon.
Photo by Adam Thomas, view to the southwest, 27 September 2006.

Approximate location of corner post remnant

Above, photo 05: The blue box shows the approximate outline of the 10x10 plot.
Photo by Adam Thomas, view to the northeast, 27 September 2006.

Above, photo 06: The 10x10 plot near Forest Canyon is directly adjacent to the trail and parking lot.
Photo by Adam Thomas, view to the east, 27 September 2006.

Beatrice Willard studies the Forest Canyon Plot on September 13, 1961.
Photo courtesy Chase Davies

Beatrice Willard studies the Forest Canyon Overlook plot in June 26, 1961. She used colored toothpicks to mark plants.
Photo courtesy Chase Davies

Beatrice Willard studies the Forest Canyon Plot on September 16, 1960.
Photo courtesy Chase Davies

Beatrice Willard stands next to the newly installed nature trail exhibit on June 21, 1962.
Photo courtesy Chase Davies

Beatrice Willard, member of the President's Council on Environmental Quality, pauses from her work at Rock Cut in July 1975.
Photo courtesy Chase Davies

01
Willard, Beatrice, Alpine Tundra Research Plots
Larimer, Colorado (Rocky Mountain National Park)
Photographer Adam Thomas
15 September 2006
digital image
view to northwest (Rock Cut)

02
Willard, Beatrice, Alpine Tundra Research Plots
Larimer, Colorado (Rocky Mountain National Park)
Photographer Adam Thomas
15 September 2006
digital image
view to north (Rock Cut)


THE FRAGILE TUNDRA
Millions of people now travel where elk, bison, and bighorn once roamed. Foot traffic began to damage the alpine tundra, and so research plots like this were built in 1950 to learn how sensitive tundra plants are.
Now we know. Alpine tundra takes centuries to heal. Please stay on trails in Tundra Protection Areas. If possible, walk on rocks when hiking cross country.

03
Willard, Beatrice, Alpine Tundra Research Plots
Larimer, Colorado (Rocky Mountain National Park)
Photographer Adam Thomas
15 September 2006
digital image
view to northeast (Rock Cut)

04

Willard, Beatrice, Alpine Tundra Research Plots
Larimer, Colorado (Rocky Mountain National Park)
Photographer Adam Thomas
15 September 2006
digital image
view to southwest (Forest Canyon)

05

Willard, Beatrice, Alpine Tundra Research Plots
Larimer, Colorado (Rocky Mountain National Park)
Photographer Adam Thomas
15 September 2006
digital image
view to northeast (Forest Canyon)

06
Willard, Beatrice, Alpine Tundra Research Plots
Larimer, Coloraclo (Rocky Mountain National Park)
Photographer Adam Thomas
15 September 2006
digital image
View to east (Forest Canyon)